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The potential for tropical fruits production in Tonga: a feasibility and constraints analysis

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2 Executive summary

This report summarises the findings of the tropical fruit feasibility study conducted in the kingdom of Tonga. It proposes project initiatives for consideration to develop and progress specific activities to improve the production of tropical fruits in Tonga, which directly and indirectly could raise Tongan domestic income and employment through an increase in the value of the tropical fruits sector.

Given its favourable climatic and physical conditions and, its relative abundance of suitable land, Tonga would appear to have a comparative advantage in tropical fruit production. The kingdom's geographic position relative to New Zealand and Australia is also an advantage. Markets and access to markets are also important considerations.

Subsistence and part time growers dominate the tropical fruits sector in Tonga. There is lack of diversification of tropical fruits and markets that highlights a higher degree of risk associated with earnings. It is important to take note that remoteness of the islands and high costs often make efficient marketing both within and between the islands difficult.

While Tonga's development plans emphasize a developing private sector, advancing agricultural productivity, revitalizing export industries such as squash and vanilla bean, and developing tourism, economic growth must be supported by increased productivity of primary produce. The increases would require significant levels of investment, improved organisational arrangements, and a skilled and motivated labour force.

Workshop surveys showed the over-riding outcome expected by participants was to increase the long-term income derived from the tropical fruit sector through increasing productivity and improved market access. Productivity and sustainability, in turn, require the adoption of more efficient farming practices and techniques. This is likely to involve knowledge and skills training directly.

Fruit and vegetables are a significant component of the diet of the people of Tonga and could become increasingly important for generating export income. Fruit flies however impose a huge economic drain and cause considerable crop losses. Many fruits and vegetables, mainly bananas, coconut, papaya, and taro, were previously exported to New Zealand, Australia and Japan. These countries regard fruit flies as a major threat.

Given its low productivity levels, there is significant scope to increase the production of the Tongan fruit industry. Improving the prospects of fruit production, for example, by introducing new fruit species, replacing fruit imports where appropriate, and to export fruit, were identified as key priorities.

To enable the probability of success in future projects, a number of pertinent issues would need to be considered;

- capacity building and community engagement

- product development
- increasing domestic markets
- importation of new genetic material
- demonstration trials to facilitate transfer of technology
- information access and development.

This information and knowledge could be committed to advance economic sustainability, diversify risks, create jobs, and increase householder and stakeholder income. With these skills in place, the opportunities that exist in exporting surplus production could then be progressed at some future time.

What is required is trained and skilled Tongans in production and supply chain technologies, information access, development of products suited for local conditions and, coordinated research and maintenance of demonstration and field trials to promote the adoption and adaptation of improved production technologies.

The project presents a few elements that could assist in the economic growth of Tonga by:

- investing in the people of Tonga through strengthening their knowledge base
- fostering commitment from subsistence producers through training and adoption of improved production and post harvest technologies and thereby improving incomes
- promoting cooperation and the formation of co-operatives or grower associations and in so doing supporting and enhancing production of quality produce
- enhancing commitment and engagement between agencies, and strengthening partnerships within and between the region.

3 Introduction

The tropical climate of Tonga and the highly productive soils are well suited to tropical fruit production. Currently, there is no ‘commercial’ fruit orchard to take advantage of supplying fruits for domestic and tourist consumption, or for import replacement.

Rural Tongans rely on plantation and subsistence agriculture. Squash pumpkins, vanilla beans, and root crops such as cassava and yams, coffee, noni and kava are the major cash crops. While traditional root crops appear to offer little potential to increase household earnings tropical fruits could provide an increased income stream.

With the development of tourism in Tonga, there is increasing demand for fruits. The shortfall for consumption currently is met by imports.

Although Tonga exports small quantities of produce mainly taro, yams and squash to New Zealand, volumes have significantly reduced because of poor quality, and pest and disease problems. There are no current exports of banana, papaya, mango, pineapple and watermelon, primarily due to lack of disinfestation capability.

In 2004, 235 tonnes of fruit and nuts were imported into Tonga; 40 tonnes nuts, 166 tonnes temperate and stone fruit, 21 tonnes citrus and 5 tonnes other dried and fresh

fruit however, tropical fruits including banana, pineapples, avocados, guavas and mangoes accounted for only three tonnes or 1.3% of imports. By comparison, 269 tonnes of tropical fruits, were traded on the domestic scene.

Fruit and nut imports increased by 13% from 235 tonnes in 2004 to 265 tonnes in 2005. The value of the fruit imports were up by 80% from 418 000 Pa'anga to 755 000 Pa'anga, with the increase chiefly due to orange imports and increase in apple prices (Stat. Dept., Foreign Trade Reports, 2007). [Currency is in Tonga $ (Pa'anga) unless specified otherwise].

National food security is a key priority identified by the Government of Tonga and this is dependent on the continuation of subsistence farming in conjunction with the on-going commercial production of crops in Tonga.

The Tongan Ministry of Agriculture, Food, Fisheries and Forestry (MAFFF) is committed to increased horticultural (fruit) development and this is a high priority to improve self-sufficiency and increase productivity of backyard and smallholder fruit production.

Increased productivity is important for improving agricultural performance. The improved productivity would also help alleviate poverty and improve accessibility of food by households. Government investment in rural infrastructure, agricultural research and extension and the development appropriate price incentives can accelerate agricultural performance.

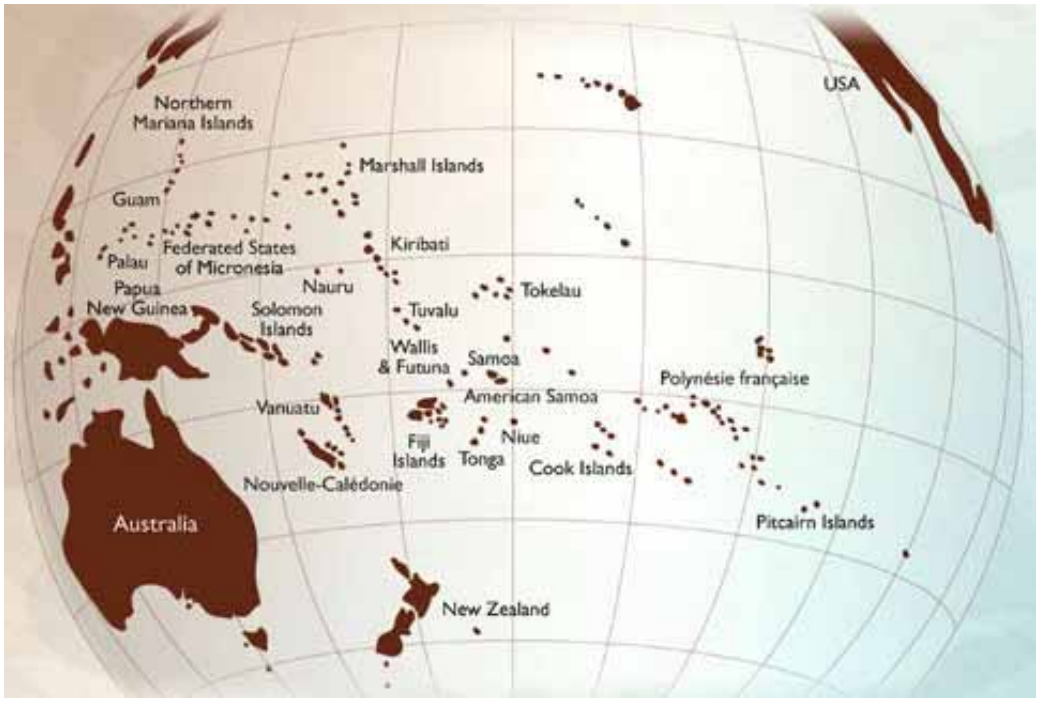
3.1 Tonga

The Kingdom of Tonga has a land area of 748 km^2, spread over 172 widely scattered islands, with only 48 of them inhabited. Many of the uninhabited islands are used for subsistence primary production, horticulture, fruits gathering, fishing and grazing livestock.

The island archipelago is divided into three main island groups, in terms of population and economic importance, Vava'u, Ha'apai and Tongatapu. The largest island, Tongatapu, on which the capital city of Nuku'alofa is located, covers 257 km^2, approximately 35% of the land mass.

3.1.1 Geographical Location

The Kingdom of Tonga, is located in the southern Pacific Ocean between latitude 15° and 23.5° South, longitude 173° and 177° West (Figure 1), lying north-east of New Zealand and east of Fiji. The kingdom's capital, Nuku'alofa is located on the main island of Tongatapu.



Source: Pacific Agricultural Plant Genetic Resource Network (PAPGREN).

Figure 1. Tonga and other Pacific islands and their position relative to New Zealand and Australia

3.1.2 Demographics

The population of The Kingdom of Tonga was reported to be 102 000 (National Geographic, 2004) with most people living on the main island of Tongatapu. An increasing number of Tongans, approximately 35 000 or 34% of the population have moved into Nuku'alofa, Tonga's capital and only urban and commercial centre. The principal language is Tongan with English being widely spoken.

3.1.3 Land use and soil resources

Land resource may be an issue for commercial horticulture production. Privately owned land is generally less than eight acres (approx. 3.47 ha) and land is not transferred in ownership, however it can be leased. The land tenure system could present limitations for the development of large-scale commercial horticulture production and the likelihood of large farms that are able to generate economies of scale and sufficient product for export appears limited.

A number of smallholders could combine land resources and operate the farm as one unit hence saving on capital equipment such as tractors, spray units, and packing equipment as alternative models of operation.

Dickinson and Burley (2007) reported that Tonga human populations are concentrated on non-volcanic islands underlain by limestone covered by air fall tephra blankets, weathered to form rich agricultural soils. Cowie (1980) reported on a detailed soil survey of Tongatapu where the various soil groups were related to the age and depth of volcanic tephra. To summarise, volcanic ash of different ages and thicknesses form the basis of the soils of Tonga.

It was beyond the scope of the project to carry out a detailed analysis of soils and their suitability for horticulture. It is reasonable however to assume that the two largest “high” islands of Tongatapu and Vava’u have soils suited to the sustainable

production of a range of fruit and root crops. For this reason, soils are not considered as a limitation to tropical fruit production.

Source: http://www.infoplease.com/atlas/country/tonga.html

Figure 2. The Kingdom of Tonga and neighbouring islands. The main islands and island groups

Howlett (1998) in a report on sustainable land tenure in the South Pacific indicated that in Tonga there "is a need to increase participation of farmers in technology development." That,

- farming on sloping land is relatively new and appropriate technologies are required
- there is loss of soil organic matter and biomass from present farming practices
- there is need for appropriate land use policies.

3.1.4 Climate

The climate of Tonga is tropical with a distinct warm period and a cooler period. The mean maximum temperatures vary from 25°C to 32°C while mean minimum temperatures range from 18°C to 24°C. The higher temperatures are experienced from December to February while the lower temperatures are experienced from July to August.

Climate graphs in Appendix 1 illustrate the mean maximum and minimum temperatures, monthly rainfall, and average monthly rain days for the main islands of Tongatapu, Vava'u and Ha'apai.

The annual rainfall ranges from 1700 to 2970 mm moving from Tongatapu in the south to the more northerly islands. Monthly rainfall is highest from December to April (≥150mm) on all three main islands with the period from May to November generally

recording less than 150 mm per month. The average number of rain days per month range from 10 to 21 days, which suggests that rainfall is well distributed throughout the year.

The temperature and rainfall data show that conditions are generally ideal for the production of tropical fruit crops. Crops requiring low temperatures for flower induction such as lychee, longan and some mango varieties, may perform better on Tongatapu where lower temperatures are experienced during the cooler months. Despite the favourable climate for tropical fruit production, Tonga is prone to natural disasters, e.g. cyclonic events, high seas (tsunami) and seismic activities.

Storms and cyclones (hurricanes) present major hazards to the production of tropical fruits and nuts for commercial, domestic and community level horticulture production. The Tonga Meteorological Service records (Appendix 2) revealed that 58 events from gale to severe cyclone grade have affected parts of Tonga from 1960 to 2006. That is equivalent to 1.2 events per year.

Records from cyclone Vaianu, with a gale force storm (34 to 47 knots) that tracked from the northern to the southern islands of Tonga in February 2006, reported that damage was mostly inflicted on fruit bearing trees. Structural damage was limited to power lines, and 70% of the banana and breadfruit crop was wiped out (Anon, 2006).

Clarke (1992) documented the effects of cyclone Ofa, which struck Western Samoa in February 1990. He recorded severe damage to root crops, e.g. taro, yam and cassava, vegetables, kava, and fruit trees (banana, breadfruit, papaya, mango, avocado, Vi, cocoa). Trees with high canopies suffered almost 100% damage and significant loss. This level of destruction was also confirmed in tropical north Queensland following Cyclone Larry which struck in March 2006 (Diczbalis and Chay, 2006).

3.1.5 Economy

Tonga's economy is characterized by a large non-monetary sector and the principal economy is based on the remittances from more than half of the country's population living abroad, mainly in Australia, New Zealand, and the United States.

Fishing and agriculture is the second largest income source. Squash, vanilla bean, kava and root crops are the principal agricultural export products. Tourism is the third largest income earner for Tonga.

Agriculture accounts for about 25% of GDP (gross domestic product). The main commodities are squash, vanilla beans, root crops, fish, and other marine products. In 2005 exports of squash, fish, vanilla beans, and root crops accounted for $24.65 million with $136.80 million worth of imports of food, machinery and transport equipment, fuels and chemicals. Note: Currency in Tonga $ (Pa'anga) unless specified otherwise. The major export markets were Japan, New Zealand, U.S., Australia, and Fiji. Imports were mainly from New Zealand, Australia, Fiji, U.S., and Indonesia (Government of Tonga, 2006).

The manufacturing sector consists of handicrafts and a few other very small-scale and cottage industries, which together contribute only about 3% of GDP. Large trading companies found throughout the South Pacific dominate commercial business activities.

The tourist industry is relatively undeveloped however, the government recognizes that tourism could play an important role in future economic development, and efforts are being considered to increase this potentially important source of revenue. The tourist industry is also a potential consumer of "tropical" fruits, with many visitors actively seeking new taste sensations.

3.1.6 Agricultural System

"Agriculture is the principal sector of the economy. It contributes about one-quarter of GDP; supplied 60% of total merchandise exports in the period 1998/99 – 2003/04 and is the main source of livelihood for much of the population. The Agricultural Census 2001 revealed that 64.2% of 15 738 households were agriculturally active, with 59.0% of these engaged solely in production for home consumption, 38.6% engaged in subsistence production with some supplementary production for sale, and 2.4% involved in commercial production."

(Page 80, Kingdom of Tonga - Strategic Development Plan Eight, 2005-2007).

"If agriculture is to become an engine for growth, there will need to be an increased emphasis on commercial production, and further diversification of the production base in order to reduce risk, bearing in mind that the subsistence sector also might need assistance in raising productivity. Tongan farmers have shown an ability and willingness to diversify production in response to price signals, but such diversification needs to be combined with sustained, faster growth in total agricultural production."

(Page 81, Kingdom of Tonga - Strategic Development Plan Eight, 2005-2007).

"Government's agricultural policy objectives are to: (1) increase and diversify commercial agricultural production throughout the country for domestic sale, import substitution and export; and (2) ensure food security based on traditional farming systems."

(Page 83, Kingdom of Tonga – Strategic Development Plan Eight, 2005-2007).

Tongan agriculture is based on smallholder developments. The Crown owns all land, with almost two-thirds allocated to adult males over 16 years of age to meet their families' subsistence needs. Only some of the land however is used productively and this has constrained wage growth in Tonga. Sefanaia (1988) provided an estimate of land allocated to households in 1988. An assumption of the actual area available is shown in Table 1. Approximately 32 000 ha appeared to be available for agriculture.

Table 1. Number of households and allocated agricultural area in Tonga in 1988

Number of Households	*Area range and* (Area used in calculation) (ha)	Total Area (ha)	Percent of total
7751	< 4 (2)	15 502	47.6
1276	4-6 (5)	6380	19.5
684	6-8 (7)	4,788	14.7
493	>8 (12)	5916	18.2
Total 10 204		32 586	

Table 2 shows the proportion of households that were engaged in agricultural activities 13 years later, in the 2001 survey. There were a total 15 738 households, with close to 65% of these allotments used actively for agricultural purposes. This would equate to about 35 000 ha of the area tax allotments.

While the number of households or tax allotments increased by about 5500 in 13 years the level of agricultural activity remained more or less unchanged, 32 500 ha in

1988 and 35 000 ha in 2001 land cultivated. The smaller island groups of Niuas and ‘Eua showed the highest level of agriculturally active allotments, about 90%. Ha’apai and Vava’u allotments accounted for around 83% while Tongatapu households were around 54% active in agricultural activities.

The table also shows the status of the tax allotment, whether actively used by the owner or household for cropping, rented out, under bush and forest or other. Of the total tax allotment of 53 725 ha, 31 216 ha was cropped. About 21 500 ha of the tax allotment was rented out, with 83% rented out without remuneration.

Table 2. 2001 Survey of household and allotments, allotment status and level of agricultural activity in the five island groups of Tongatapu, Vava’u, Ha’apai, ‘Eau and Niuas

Proportion of Households with Respect to the Level of Agricultural Activity to the Total Households, by Location of Households:2001

Location of Household	Total Households	Proportion of Households (%), by level of Agricultural Activity		
		Non-Agricultural	Minor Agricultural	Agriculturally Active
Tonga	**15 738**	**30.4**	**5.3**	**64.2**
Tongatapu	10 583	38.6	7.3	54.2
Vava'u	2625	15.4	1.4	83.2
Ha'apai	1298	15.6	1.5	82.9
'Eua	863	9.0	1.3	89.7
Niuas	369	8.9	0.5	90.5

Source: Agriculture Census 2001

Number of Households Owning Tax Allotment and Number and Area of Owned Tax Allotment, by Present Status of Tax Allotment: 2001

Present Status of Tax Allotment	No. of Households Owning Tax Allotment	Number of Owned Tax Allotment	Area of Owned (ha) Tax Allotment
Total	**6447**	**6577**	**53 725**
Cultivated under crops by owner/ household	3695	3734	31 216
Rented out to other households for pay	245	245	3769
Rented out to other households without pay	2102	2124	17 881
Fallow	2311	2317	18 190
Under bush/forest growth	689	701	7316
Other Status	241	243	2424

Note: the total does not add up to the details since a tax allotment may be under several present status.
Source: Agriculture Census 2001

3.1.7 Water Resources

There are limited surface water resources available on the islands of Tonga. The islands of ‘Eua, Niuafo’ou and Niuatoputapu are the only islands with surface water storage. The water resources of Tonga are primarily in the form of groundwater, and this itself is limited (White, 2007).

Ground water is unlikely to be available for commercial fruit production as limited ground water is generally required for community supply. This limitation may have

implications on the ability to develop a commercial export orientated horticulture industry. The consequences on local supply and domestic food security are less serious as in most sites annual rainfall is generally adequate to support fruit production (Appendix 1 Climate Graphs).

4 Feasibility study

Tonga is committed to increased horticultural (fruit) development and it is a high priority to improve self-sufficiency and productivity of backyard and smallholder fruit production.

Priorities set out by the Minister of Agriculture for the agricultural sector for MAFFF (Government of Tonga – Strategic Development Plan 8, 2005-2007) to work on include:

- Food security - promote agriculture for the enhancement of food security.
- Export - promote and encourage potential crops for export to increase foreign earnings.
- Market diversification – develop potential and new crops for exports and markets are identified.

This study evaluates current production and production technology, market characteristics, current and potential demand and the supply chain. An assessment of markets and market access issues associated with potential export markets and an analysis of economic feasibility were other important elements in the study. The investigation included industry exposure and fact-finding visits to Tonga, and technical and scientific inspections.

4.1 Project objectives

The purpose of the study was to undertake an investigation into the commercial potential of a tropical fruit industry in Tonga.

The objectives of the project were:

1. To provide an overview of the current tree fruits industry and market in Tonga.
2. Investigate and conduct a marketing exposé and economic analysis of the potential for tropical fruits production for the domestic market, import replacement and the export market.
3. Identify and define the major constraints to the development of a tropical fruits industry in Tonga.
4. Identify risk factors, likely impact, resource requirements and potential collaborators.

4.2 Methodology

The four major components appropriate to the study were:

1. Desk research, data collection and analysis, and review of work carried out by other agencies, for example, the South Pacific Commission (SPC), Food and Agriculture Organisation of the United Nations (FAO), the European Union (EU), Asian Development Bank (ADB), AusAID and NZAID.

2. Technical field inspections, visits and project workshops in major regional agricultural centres in order to gather data and information on the current state of tropical fruit production in Tonga, markets and R, D&E activities relevant to this project.
3. Investigate the potential export market in New Zealand. Discussions and visits with the New Zealand Ministry of Agriculture and Forestry (MAF) Quarantine Service, Pacific Island Trade and Investment Commission (PITIC), markets and private industry including importers and distributors.
4. Report on the status of the tropical fruit industry in Tonga: production issues and constraints to production, distribution and marketing constraints, economic analysis of selected target crops, potential markets and other production risks.

4.3 Outputs/Outcomes

The output would be a report which:

- provides an overview of the current tree fruits industry and market in Tonga
- provides a marketing and economic analysis of the potential for tree fruits production for the domestic market, import replacement and the export market
- defines the major constraints to the development of the industry in Tonga
- identifies risk factors, likely project impact, resource requirements and potential collaborators
- makes recommendations regarding the need for further work.

5 Project visits

5.1 Field Visits

5.1.1 Vani Research Station, Tongatapu

The team visited Vani Research Station to view the exotic tropical fruit collection. The collection was established in the late 1980s. A planting date and field plan could not be obtained. Prior to arriving at the site, we were informed that some of the land on which the collection had been planted had been resumed.

The state of the orchard is best described as run down and poor. Much of the collection is smothered by vegetation. Grass, weeds and climbing vines are left uncontrolled and cattle are used to control grass in the section still owned by the Research Station (Plates 1a and b).

Trees are identified visually and identified in Appendix 4 “Tropical Fruit and Nut Species with a Common and Tongan Name”.

Observations of the office complex, machinery and general facilities suggested that MAFFF staff were working in facilities that urgently required upgrading.

Plate 1. Vani Research Station, Tongatapu. Grass weeds and vines smothering trees in the orchard of tropical fruit tree collection.

5.1.2 Ene'io Botanic Gardens, Vava'u

Ene'io Botanic Gardens is an agro-tourism project initiated, managed and owned by the ex-director of MAFFF, Haniteli O. Fa'anunu (Plate 2a, b and c). The garden has an excellent collection of tropical fruits and ornamental plants and is open to visitors by appointment. Tropical fruits species identified in the Gardens are included in Appendix 4 Tropical Fruit and Nut Species with a Common and Tongan Name.

There is a café in the Gardens that utilises and sells the fresh produce and processed product produced here. Yam, sweet potato and taro chips are important products produced at the centre and these together with a range of fruit juices are available for sale at the café. There is a need to improve the information available for food processing with particular reference to food drying technology.

Mr O. Fa'anunu has considerable experience in propagation and runs a small retail nursery attached to the gardens.

Plate 2a. Looking towards the ocean from the Ene'io Botanic Gardens, Ene'io Beach

Plate 2b. Label on tree – identification of specimen

Plate 2c. Mr Haniteli O. Fa'anunu, owner of Ene'io Botanic Gardens showing the team around the complex.

5.1.3 Vava'u Tourist Bureau, Vava'u

Vava'u with many sheltered harbours, bays and coves is home to a large number of charter yachts. It is becoming more popular with tourists, with many arriving on cruising ships stopovers.

The visit to the Vava'u Tourist Bureau was useful and informative. Mr. Bruno Toke, director of the Bureau gave an insight regarding tourist numbers, visitor types, tourist activities, etc. (see Section 7.3 on Tourism).

The majority of tourists visiting Vava'u are on short stays, about 24-48 hours as part of cruise ship tours. Visits to fresh markets and to tropical fruit farms are possible if those activities are available. Mr. Toke stated that there is a need for brochures describing the range of local fruits and vegetables. A recently published Map of Vava'u and street guide to the Neiafu, the island's capital, highlighted 15 fruits and vegetables, including cassava, breadfruit, taro, papaya, kava, avocado, giant taro, vanilla, yam, pineapple, pele, banana, coconut, noni and pandanus.

5.1.4 Mixed farms, Vava'u

The project team visited two typical Tongan smallholder farms. The first farm was four acres in size with two acres actively cultivated to cassava, yam, taro, pineapple, papaya and breadfruit. Produce from the farm is the secondary source of income. The farm owner works the farm part time and derives his main income as an employee of a local telecommunication company. Much of the produce grown is for personal and extended family use and some of the produce bartered for other requirements.

The second farm, consisting of eight acres with a further four acres leased, is run as a full time farm enterprise by two brothers. The crops grown include cassava, yam, taro, pineapple, papaya and breadfruit. Kava and vanilla are grown and processed.

Pineapple is an excellent fresh market crop and presents good income opportunities. Processing crops such as vanilla is actively tended when the market price is favourable otherwise, it is left to take care of itself.

The major costs incurred in farm production include fuel for small farm machinery such as mowers, and whipper snipper's, etc. and transportation costs. The local market in Neiafu and Nuku'alofa in Tongatapu are the main markets for their products.

Plate 3a. Mr Viliami Kami (left) and Vic O'Keefe (right) inspecting Xanthsoma taro

Plate 3b. Mixed farm of coconut, taro, pineapple and banana

Plate 3c. Mixed farm of kava and cassava

Plate 3d. Low input vanilla orchard

5.1.5 Vanilla Farm, Vava'u

A high technology vanilla operation owned by New Zealander John Ross was included in field visits. Vanilla plants are grown on trellises under artificial shade and at a high density (1.0 x 1.5m) with overhead sprinklers (Plate 4a). With such a planting system, disease control is a potential problem with rapid spread once an outbreak occurs.

Plate 4a. High technology vanilla production

Plate 4b. Vanilla drying as part of the curing process

5.1.6 Mango (cv. Kensington Pride) Orchard, Vava'u

We visited a recent planting of mango, cultivar Kensington Pride. The orchard is a partnership and owned cooperatively by a tourist operator Mr. Jeff Lestrange and a local farmer. The orchard is four acres in size with trees planted at 8 x 5 m spacing. The trees were imported from Australia via MAFFF quarantine in Nuku'alofa. The mango trees are planted directly into pasture. At the time of the visit, cattle from a neighbouring paddock had broken into the orchard and were seen damaging trees.

Plate 5. Young mango trees, cv. Kensington Pride, planted into pasture with occasional Xanthasoma taro

5.1.7 Ha'apai Island Field Visits

Visits to a number of sites of interest was organised following the Ha'apai Growers workshop. Time was considerably shorter than originally planned due to the delayed flight from Vava'u.

Ha'apai Forestry Nursery. This is a rudimentary facility, which could be useful for tropical tree fruit propagation and distribution. The manager suggested that water availability could be an issue. The facilities would need upgrading however they would be a useful component of a potential fruit tree establishment project.

Plate 6. Facility at Ha'apai Forestry Nursery

Wild Pummelo. A number of "wild" pummelo trees were identified while traversing the island. The quality of the fruit was good considering the lack of care. Local islanders said that they did not like pummelo. These fruit however have good potential on the tourist market.

A visit was made to a backyard tropical fruit and nut collector with a range of fruit and nut trees. Specimens of longan, macadamia, Ai nut (*Canarium harveyi*), feijoa, avocado, breadfruit, custard apple, carambola, guava and a Barringtonia species (cutnut) were recognised.

Plate 8. A Barringtonia species of cutnut found in the home garden in Ha'apai

5.1.8 Ma'ui'ui Organics Enterprises, Green Waste and Compost Facility, Nuku'alofa

The Nuku'alofa green waste and composting facility is being developed by Mr Ofa Fakalata, former senior agronomist with MAFFF. The facility is primarily a collection point for green waste and organic materials from Nuku'alofa. The intention is to create a high value compost that can be sold to home gardeners and to commercial organic fruit and vegetable producers. The project has received funding via the solid waste management project funded by the Australian and Tongan governments and managed by Ms. Sonia Chirgwin.

5.2 Grower Workshops

Grower workshops were held on the three main island groups of Vava'u, Ha'apai and Tongatapu to assess the current horticultural environment. The planned visit to 'Eua was abandoned due to a change in aircraft schedule.

The workshop agenda included;

- An introduction of the scoping study and the cooperation between the Tongan Ministry of Agriculture, Food, Fisheries and Forestry (MAFFF), Australian Centre for International Agricultural Research (ACIAR) and Queensland Department of Primary Industries and Fisheries (DPI&F).
- Synopsis of tropical fruit production and fruit marketing in Queensland, with emphasis on tropical exotic fruits. This presentation was given to expose and illustrate to the participants the range of fruits grown, commercial production, and aspects of the supply chain. The presentation is attached as Appendix 3.
- Grower consultation process to identify, assess and report on fruit production issues and requirements in Tonga.

The grower consultations focussed on five main themes:

1. What fruits and nuts do you grow?
2. Major production problems
   - Pests
   - Diseases
   - Climate
   - Inputs and supplies
3. Markets
   - Packaging
   - Transport
   - Market information
4. Horticulture skills
   - Propagation and planting source
   - Irrigation and water management
   - Fertiliser management (fertigation)
5. Financial aspects

6. What fruits are you interested in?

Workshop participants were divided into groups of eight to 12. Males dominated the workshops with one exception in Ha'apai where approximately half the participants (13) were women.

5.2.1 What fruits and nuts do you grow?

A large range of fruits and nuts are grown in Tonga. Popular small holding crops include

- avocado
- banana (Cavendish, Lady Finger, plantains)
- breadfruit
- citrus (limes, oranges)
- coconut
- guava
- mango (common or stringy types)
- noni
- pacific chestnut
- pacific lychee (Tuan)
- papaya
- pineapple
- soursop
- Syzygium
- Watermelon.

Table 3 shows the fruit and nut crops commonly grown in the three island groups of Tongatapu, Vava'u and Ha'apai.

Table 3. The range of fruits and nuts grown in the three main island groups of Tonga

Vava'u	Ha'apai	Tongatapu
Avocado	Avocado	*Annona* species
Banana (Cavendish)	Banana	Avocado
Banana (Hopa)	Banana - plantain	Banana
Breadfruit	Breadfruits	Breadfruit
Canarium sp (Ai)	Citrus spp.(orange, lime)	Citrus
Cashew Nut	Coconuts	Mango
Cocoa	Guava	Pacific Chestnut
Coconut	Granadilla	Pacific Logan
Citrus species (orange, lime)	Mango	Papaya
Guava	Noni	Passionfruit
Macadamia	Papaya	Pineapple
Mango	Pacific Lychee	Soursop
Noni	Passion Fruit	
Pacific Chestnut	Vi (Spondias)	
Pacific Lychee	Poundo	
Papaya	Sugar Apple	
Passion Fruit	*Syzygium*	
Sapodilla	Watermelon	

Soursop
Sugar Apple
Syzygium
Watermelon
Polynesian Cherry
Tutiti
Vi (Spondias)

Fifty-two different fruit and nut species were recorded during field visits and compared against a record of fruit and nut species with a Tongan name supplied by MAFFF.

Appendix 4 lists the tropical fruit and nut species with a Tongan name, a common name, scientific name and its presence in Tonga as identified by the project team.

5.2.2 Major production problems

There were numerous production problems declared (Table 4). The main production concerns identified that were similar across the island groups include;

- Climate
  - Drought
  - Natural disasters
  - Excess rainfall
- Pests and Disease
  - Winged vertebrates
  - Fruit fly
  - Rhinoceros or elephant beetle (*Xylotrupes gideon*)
  - Anthracnose in mango (*Colletotrichum gloeosporioides*)
- Cultural
  - Lack of technology due to high costs and inadequate returns
  - Lack of new varieties of existing crops
  - Lack of irrigation infrastructure and water resources

5.2.3 Markets

The discussion/answer regarding markets and marketing produce often returned to the query, “What markets?”

Generally, farm plot production was distributed and consumed within the extended family group. Surplus production was sold in local markets around the main island centres. A few growers said they concentrated on inter island trade of produce (for example, pineapples from Vava’u to Tongatapu), but the remoteness of the islands and high transport costs, often made marketing both within and between the islands difficult.

There were several market topics identified in the study, which are relevant to development of a sizeable fruit industry (Table 5). Broadly, these were:

- Markets

  - Opportunistic market occasions are associated with church and festive season gatherings when large numbers of expatriate Tongans arrived home
  - Local markets were easily over supplied during peak cropping periods
  - Export market opportunities were severely constrained by the requirement for disinfestation
- Packaging and postharvest
  - Lack of suitable packaging of fresh produce destined for inter-island trade, for example, mangoes are packed into old hessian or plastic fertilizer bags
  - Spoilt and/or damaged fruit during transport
- Transport
  - Transport options are severely limited for both intra- as well as inter- island movements
  - Inter-island airfreight capacity is non-existent with all room utilized for the transport of passengers
  - Infrequent and sporadic ferry services between the main islands
- Market information
  - Limited and restricted distribution of market information and hence growers were not made aware of market prices.

5.2.4 Horticulture skills

Traditional horticulture skills are strong and passed on from generation to generation, with the levels of skills sufficient for growing traditional crops and home garden production. For export, the growers who lack the large-scale production skills joined one of the few co-operatives to set production quotas and push the sale of their produce.

There appears to be a general need to provide education and training programs for the farmers, both commercial and subsistence (Table 6), to adopt sustainable methods of farming which can increase productivity and at the same time safeguard the natural heritage. Since the most appropriate organisation to deliver such training is largely staffed by unskilled technical and support staff, the first priority would be to provide those technical staff with the appropriate mix of training and education programs.

Significant technical assistance has been contributed by Australia, Germany, Japan, New Zealand, Taiwan and the United States for many years.

Growers are interested in new fruit crops. They are interested in production methods including

- Propagation methods
- The propagation of new crops/fruits however is not part of the traditional knowledge base and would require appropriate training and instruction
- Irrigation and fertiliser management
- Postharvest handling and packing for markets and market access. These practices and procedures were poor to non-existent.

5.2.5 Financial aspects

Growers raised the issue of costs of production and returns (Table 7) particularly in relation to the implementation of intensive production techniques. Chemical and fertilizer costs are high as all the products are imported.

5.2.6 What fruits are you interested in?

Growers are interested in a range of fruits (Table 8), with particular interest in new varieties of fruits they already know (citrus, mango and papaya). There was some reticence in suggesting crops that they have not heard about or have limited experience however several common selections were made across workshop groups. These included lychee, rambutan, pitaya and guava.

Table 4. Major Production Problems identified at grower workshops in the three island groups

Vava'u	***Ha'apai***	***Tongatapu***
• Insect, fruit flies affecting papaya, orange • Bananas - banana leaf spot and diseases, banana weevil borer, Bunchy Top • Seasonality (used all year round production) • National disaster (Cyclone / drought) • Rats/ Bats • Mango - Anthracnose • Organic Production • Pineapple - weeds, rats • Vi - flower drop • Banana, Cavendish - Yellow Sigatoka, scab moth • Hopa - Bunchy Top, wind • Mango flower drop and sooty leaves • Papaya - lack of planting, selection • Citrus - fruit piercing moth, lack of planting, market • Coconut - Rhinocerous beetle, new trees (height), storms • Watermelon - pests, fumigation facility • Breadfruit- no market for fresh or processed fruit • Soursop - no market for fresh or processed fruit • Polynesian cherry (Fekika) - fruit piercing moth, fruit fly • Chestnut (ifi) - climate, winds • Tava - fruit piercing moth, fruit fly	• Training on horticulture propagation • Seedling propagation / management • Banana – pig damage, Banana Leaf Spot/diseases, Bunchy Top • Mango – fruit flies, bat damage, harvesting (bruises) • Coconut – Rhinocerous beetles, number of trees decreases • Oranges – harvesting problems, fruit flies, decrease in fruit numbers • Papaya – need papaya seeds for back yard • Breadfruits – harvesting, natural disasters, too much production • Mango – Anthracnose, wet, fruit fly, bats • Banana – export • Papaya – fruit flies, bats	• Banana/Mango – Banana Leaf streak, scab moths, Anthracnose, nematodes, fruit flies • Papaya – climatic disorder • Fruit malformation • Rainfall – flower drop induction • Input supplies – fertiliser, pesticides, equipment and parts – high costs and availability inconsistent • Quality of fertiliser not monitored • Pilot or demo orchard (tree crops) • R&D, need technical assistance, to focus on potential fruit tree varieties

Table 5. Market issues identified at grower workshops in the three island groups

Vava'u	***Ha'apai***	***Tongatapu***
• Limited domestic market, oversupply in peak times • Little market price signals fed back to growers • Church conferences, Christmas, domestic focus of industry • No infrastructure, cool stores to extend shelf life and product distribution • Reduce peaks and troughs in production/harvests • Banana/Papaya (Domestic/Tourist) • Mango in bags to Nuku'alofa (poor quality) • Pineapple in bags • Packaging (needs improvement) • Ferry to Nuku'alofa • Sunburn to produce, exposed to sun • Dirty local market • Packing unripe / immature fruit • Storage techniques • Market access is limited • Marketing of dried product required. Issue raised by resort owner.	• Domestic transport • Inter island transport and freight costs • Packaging - bruising • Lack information for domestic markets • Fresh produce arriving overripe in Nuku'alofa • No vegetative propagation • Harvesting / storage facilitation – lack of • Training on processing – drying, juice, jam, etc. • Minimal market opportunity for fresh product • No processing facilities for all products	• Sold in the central market: Limes Vi Papaya Banana/plantain Coconut • No grading standards and guidelines • Quality inconsistent and poor • Local presentation at sale depots = poor • Lack / no packaging guidelines and policy – still coconut basket – plastic bags • Inter islands transport not confident, expensive • No cooling systems in inter island shipping • Tongatapu / Vava'u / 'Eua – farm roads need to be improved • Lack market information, not distributed to growers, some of the information are questionable • Need improvement on market information and reports by MAFFF, publish and forecast

Table 6. Horticulture Skills identified at grower workshops in the three island groups

Vava'u	***Ha'apai***	***Tongatapu***
• Training required • Update technology e.g. use glasshouse for vanilla production • Observe other production regions and supply chains ie Qld Tropics	• Propagation – budding, grafting • Drip irrigation, training for vegetable production • Inputs – fertiliser for melons, nil for trees, limited access to input supplies • Harvesting aids	• Access to existing planting material of existing varieties not an issue • E-commercial outlets sell trees • Skill development in irrigation needed. • No courses attended e.g. pruning canopy management, etc. • Off season pineapple production • Farmers training on fruit tree propagation (introduced crops) e.g. mango, orange, lime, rambutan, papaya • Irrigation for young seedlings • Irrigation and fertiliser management skills, and R&D • Land preparation

Table 7. Financial aspects identified at grower workshops in the three island groups

Vava'u	***Ha'apai***	***Tongatapu***
• Some are interested to pay for seedlings and some do not • Growers state that they focus on banana, pineapple, papaya and noni as these are the crops that they can get reasonable returns • Organic production – growers unable to provide generic costs as they don't use any external inputs • No data for costs / returns	• Tractor hire $60/hr • Labour costs $5/hr • Fencing costs, from pigs • Costs of equipment • Seedlings • Interest rate 15% Tongan Development Bank loans	• Compost, leaves, mulching • Roadside stall costs $ vs Central market costs $ • Herbicides / fertilisers – pineapple banana only, shade trees • Tree crops (fruit) are long-term crops • By-product and value adding, R&D to assist with products such as juice and fruit cocktails for local market can help improve returns • Cost of production inputs e.g. chemicals, fertilisers, spraying equipment, labour? • Economic analysis for fruit tree production

Table 8. What Fruits are you Interested in?

Vava'u	***Ha'apai***	***Tongatapu***
• Fruit that grows well in Vava'u • One that will have a market • Mango • Rambutan • Guava • Orange – Cook Island Varieties • Papaya • Coconut (dwarf variety) • Lychee • Banana (new varieties)	• Mango - new varieties • Citrus – new varieties (oranges, limes) • Guava – introduced varieties for export • Guava - new varieties • Rambutan • Pineapple • Lychee • Rambutan • Red Papaya (solo) • Dwarf Vi • Passionfruit • Dragon fruit	• Mango new varieties and improved local varieties (selections) • Citrus (new varieties of orange, lime kola (sour orange)) • Lychee • Rambutan • Abiu • Pitaya (dragon fruit) • Mangosteen • Star apple • Longan • Passionfruit (purple) • Pineapple

6 Economic analysis

6.1 The Tongan farming system

The predominant farming system in Tonga is subsistence farming, that is, many smallholder farms that grow small areas of various crops, mainly vegetables and root crops as these are grown in quick rotations with minimal risk and provide the family or household with a range of food to eat throughout the year. The farming system tends to intersperse ground crops among tree crops, mainly coconuts that are grown in abundance as well as bananas, citrus and mangoes. Monoculture commercial tropical fruit tree crops are uncommon in the Tongan traditional farming system. This makes it difficult to analyse using conventional gross margin methods.

Subsistence farmers are extremely risk averse and require a high level of food security. Therefore, crops that require long term investment in capital, land and labour before a return is generated in most cases are beyond their means and not commercially desirable crops. However, the Tongan people are very interested in gaining access to improved varieties of fruit trees, mainly from a home consumption perspective. Subsistence farmers tend to be more concerned about getting food on the table this week than putting aside investment for the future. They use very little inputs such as fertiliser or sprays and most of the weeding is done manually. Input supplies are costly due to high transport costs because of the isolation of the islands. In terms of growing tree crops for commercial production, they have limited knowledge of the horticultural requirements necessary, for example, propagation, pruning, harvesting, transporting and packaging.

Tongan farmers are also less likely to grow fruit tree crops as their single source of income because of the high risk from cyclones. Cyclones can cause total devastation of tree crops. Since Tonga is highly susceptible to these events, each summer season the risk of crop losses from damage to trees or flowers and immature fruit breaking off is too great for farmers who depend on the produce of their land for survival. Other problems that are prevalent in the farming system are lack of irrigation, climatic variation, labour, damage caused by pigs and theft of produce.

The Tongans grow a longer-term crop, kava (*Piper methysticum*), from which the roots and the stems are the main parts used. Kava plants are low shrubs and therefore tend to survive well under cyclone conditions. The market for kava is very strong as kava drinking is a prominent activity in Pacific Island culture, and is used for medicinal, religious, political, cultural and social purposes throughout the Pacific.

The Tongan Islands are somewhat isolated and scattered, thus the transport costs are high. The main reason that transport costs are so high is because the size of the market is limited with monopolized transport services setting high rates. This point alone is a major obstacle to the development of a commercial fruit industry.

The factors discussed above and the type of farming system present in Tonga does not lend itself to growing large areas of monoculture, fruit tree crops. The current farming system appears to be most suitable to the tenure system, Tongan culture and the needs of the farming families. The integration of better varieties of fruit trees and the management of existing varieties within the farming system is viewed as one of the most positive and most constructive way to benefit Tonga, now and under the current cultural, social and political environment.

There is potential for Australia to assist Tonga in the provision of improved varieties of mangoes, citrus and other specialty fruit species to incorporate into the existing farming system. This can benefit Tonga by being able to produce different varieties by extending the production period of fruit thus providing health benefits and improve food security. With a better range of fruit varieties available, it may help decrease the pressure on some imported fruits.

There is a need for training Tongan farmers in pruning, propagation and general fruit tree horticulture, and harvesting techniques that could aid Tonga in maximising the benefits of the fruit they currently grow and may grow in the future.

6.2 Tropical fruit production – economic perspective

Tonga presently produces a range of tropical fruits that are available in the local markets when in season including bananas, papaya, mangoes, breadfruit and citrus. These fruit are produced by small farmers and are usually excess production to family requirements. There appears to be very limited commercial fruit producing enterprises in Tonga as there are a number of significant impediments to the development of a commercial tropical fruit tree industry in Tonga.

Appendix 5 shows the gross margin analysis of various tropical fruit tree crops, e.g. bananas, papaya, mangoes, breadfruit and citrus that currently grown in Tonga. The gross margins of these crops demonstrate that the potential earnings from tropical fruit tree crops are positive.

Several methods are available to analyse the profitability of a horticultural investment. We have chosen the simplest analysis, gross margins, to present an overview of the profitability of various fruit production.

A summary of gross margins of the predominant tropical fruit tree crops that grow in Tonga is provided below, in Table 9. Note that the details provided are for a number of years for each crop. The reason for this is that the production of horticultural tree crops is characterised by a series of phases: an establishment phase, an increasing production phase to full production followed by a steady state phase and then a decline in production until the decision is made to replant or remove. The period for the establishment and production phases varies depending on the particular crop.

Points to note from the gross margin summary are:

- The gross margins as presented in Appendix 5 are somewhat unrealistic as monoculture tree crops are uncommon in the typical Tongan farming system (refer next section).
- Variable costs of production are generally minimal because of the lack of chemical and fertiliser inputs in use. This is mainly due to the high costs for inputs. Inputs such as pesticides and fertilisers are imported primarily from New Zealand. The supply of many products such as chemicals and fertilisers is often erratic as merchants seem unwilling to carry the stock value of expensive chemicals.
- The main input used is labour which is valued at $6 per hour.
- Transport costs are extremely high, further contributing to the high costs of inputs. The northern islands are further disadvantaged by transport costs as they suffer inter-island transport costs as well as import costs to the main island.

- Production yields could be improved with the use of inputs, however due to the high costs and the risks involved in this form of expenditure the likelihood of this happening is limited.
- There is very little expenditure on marketing produce. Much of the excess production is sold in the local market where it is simply laid out on tables, with minimal or no packaging.
- Of the fruits assessed papaya is the best income earner, however, it requires greater expenditure on variable costs (inputs – pesticides, fertiliser) and labour and is most prone to cyclone damage thus making it a higher risk crop.
- Bananas are grown in abundance and could be a good income earner, however they suffer from price fluctuations and are very prone to cyclone damage.
- Varieties of citrus are available in Tonga with limes being the most prevalent. Lime juice is very popular within the tourist market. Limited oranges are grown, however, oranges are imported, thus presenting opportunities for the production of oranges.
- Local varieties of mango are grown throughout the islands. There appears to be real opportunities for a range of new varieties to improve the product range and to increase the production period.

The true fruit tree crops that have a juvenile phase such as mango, citrus and breadfruit take a longer time before an income is generated and not as profitable compared to banana and papaya. Furthermore sourcing planting material may be limited as new and improved varieties need to be imported and the problem may be greater following a cyclone for replanting. Growers however have a product mix for their income sources and this may help diversify the risks.

Table 9. Summary of gross margin for banana, papaya, citrus and breadfruit (per acre)

GROSS MARGIN BUDGET SUMMARY							
CROP	**Growth Stage**	**Yield (in kg)**	**Price (T$)**	**Gross Income**	**Variable Cost**	**Labour Cost**	**Gross Margin**
Banana	1st 12 months	8,500	$0.57	$4,845	$763	$855	$3,228
	1st ratoon	8,000	$0.57	$4,560	$424	$510	$3,626
	2nd ratoon	7,500	$0.57	$4,275	$382	$465	$3,429
	3rd ratoon	7,000	$0.57	$3,990	$369	$405	$3,216
	4th ratoon	6,500	$0.57	$3,705	$294	$390	$3,021
	5th ratoon	6,000	$0.57	$3,420	$282	$375	$2,764
Plantain	1st 12 months	3,601	$0.62	$0	$685	$85	-$771
	1st ratoon	3,421	$0.62	$2,121	$188	$44	$1,888
	2nd ratoon	3,061	$0.62	$1,898	$173	$44	$1,680
	3rd ratoon	2,881	$0.62	$1,786	$166	$44	$1,576
	4th ratoon	2,701	$0.62	$1,674	$159	$44	$1,471
	5th ratoon	2,521	$0.62	$1,563	$151	$44	$1,367
Papaya	Year 1	2,220	$0.53	$1,177	$948	$639	-$411
	Year 2	27,750	$0.53	$14,708	$973	$1,500	$12,235
	Year 3	20,812	$0.53	$11,030	$959	$1,170	$8,901
Mango	Year 1	0	$1.96	$0	$31	$398	-$430
	Year 2	0	$1.96	$0		$294	-$294
	Year 3	0	$1.96	$0		$288	-$288
	Year 4	0	$1.96	$0		$336	-$336
	Year 5	424	$1.96	$830		$432	$398
	Year 6	847	$1.96	$1,660		$468	$1,192
	Year 7	1,271	$1.96	$2,490		$504	$1,986
	Year 8 +	1,694	$1.96	$3,320		$528	$2,792
Lemon / Lime	Year 1	0	$1.93	$0	$31	$398	-$420
	Year 2	0	$1.93	$0		$54	-$54
	Year 3	0	$1.93	$0		$48	-$48
	Year 4	266	$1.93	$513		$192	$321
	Year 5	532	$1.93	$1,027		$216	$811
	Year 6	799	$1.93	$1,542		$252	$1,290
	Year 7 +	1,065	$1.93	$2,055		$276	$1,779
Orange	Year 1	0	$1.96	$0	$31	$398	-$430
	Year 2	0	$1.96	$0		$54	-$54
	Year 3	0	$1.96	$0		$48	-$48
	Year 4	0	$1.96	$0		$48	-$48
	Year 5	266	$1.96	$522		$192	$330
	Year 6	532	$1.96	$1,044		$216	$828
	Year 7	799	$1.96	$1,565		$252	$1,313
	Year 8 +	1,065	$1.96	$2,087		$276	$1,811
Breadfruit	Year 1	0	$0.51	$0	$24	$398	-$423
	Year 2	0	$0.51	$0		$294	-$294
	Year 3	0	$0.51	$0		$288	-$288
	Year 4	0	$0.51	$0		$336	-$336
	Year 5	1,331	$0.51	$681		$720	-$39
	Year 6	2,662	$0.51	$1,362		$756	$606
	Year 7	3,993	$0.51	$2,043		$780	$1,263
	Year 8 +	5,324	$0.51	$2,724		$804	$1,920

Note: A gross margin analysis is the difference between the gross income and the variable costs of an enterprise. Variable costs include crop operations, harvesting and marketing costs. Gross margins do not take into account overhead costs such as rates, electricity, insurance, living costs and interest.

7 Market situation analysis

The market section of the report is developed using information collected from

- the 12 day visit to Tonga,
- a two day visit to Auckland, New Zealand and,
- previous published reports.

7.1 Tongan domestic market

7.1.1 Cash vs. non-cash economy

It is important to note that a significant "non-cash" economy operates in Tonga. A significant proportion of the goods and services traded are through this non-cash economy i.e. gifts to friends and relatives, in-kind contributions, gifts for church activities and bartering.

Table 10 details the annual Tongan household and per capita expenditure in a 2000/01 survey. Expenditure on food accounted for approximately 40% of total annual cash outgoings. The patterns of food expenditure were similar throughout the island groups, however people residing in the Ha'apai group and 'Eua appeared to show a higher proportion of consumption of own food items (non-cash expenditure).

Table 10. Average annual total expenditure per household, by major expenditure group and island division, 2000/01

						T$
Major group	**Tongatapu**	**Vava'u**	**Ha'apai**	**'Eua**	**Niuas**	**Tonga***
Cash expenditure	**12 150**	**10 161**	**6415**	**9861**	**6440**	**11 012**
Food	5346	4775	2984	4166	3326	4914
Transportation	1809	1562	1021	1630	499	1653
Other goods and services	4995	3824	2410	4065	2615	4445
Non-cash expenditure	**4790**	**6021**	**5631**	**6239**	**8106**	**5258**
Food	1529	3120	3298	3421	5619	2189
Housing	2752	2243	1789	2190	1289	2506
Other goods and services	509	658	544	628	1198	563
Total expenditure	**16 940**	**16 182**	**12 046**	**16 100**	**14 546**	**16 270**
% food expenditure to total	**41**	**49**	**52**	**47**	**61**	**44**

Source: Household Income and Expenditure Survey 2000/01, Statistics Department
* Average annual expenditure of all households in the kingdom of Tonga
1 Australian Dollar = 1.85618 Tonga Pa'anga
1 Tonga Pa'anga (TOP) = 0.53874 Australian Dollar (AUD)
There were more households on the main island of Tongatapu (approx. 70% of the population live on the main island) which would bias the average up.

Table 11 extracted from the Tongan Government 2001 Household Income & Expenditure Survey (HIES) details cash expenditure on food items. The total annual national cash expenditure on food was $81.8 million Pa'anga. The major food items that Tongans spent most of their cash income on include mutton flaps, chicken pieces, fish, bread, vegetables (primarily root crops) and canned meat. Cash expenditure on fresh fruit was the seventh ranked item, totalling $3.4 million Pa'anga in 2001. On average, Tongans spend $37 per capita, per annum on fresh fruit.

Table 11. Average annual household and per capita expenditure, percentage distribution of expenditure within expenditure groups, and total annual national cash expenditure on groups of items

Code	Food	Average annual cash expenditure Household T$	Per capita T$	Percentage distribution (within group) %	Total annual national cash expenditure T$million
0001-0049	Fresh fruits	202	37	4.1	3.4
0050-0069	Dried fruit	3	1	0.1	0.1
0070-0099	Canned, bottled and frozen	22	4	0.5	0.4
0100-0159	Fresh vegetables	447	81	9.1	7.5
0160-0179	Canned, bottled vegetables	13	2	0.3	0.2
0180-0189	Frozen vegetables	5	1	0.1	0.1
0190-0199	Dried vegetables and processed vegetable	2	0	0.0	0.0
0200-0209	Beef (fresh, chilled, frozen)	350	63	7.1	5.8
0220-0229	Mutton (fresh, chilled, frozen)	627	114	12.8	10.4
0230-0239	Lamb, hogget (fresh, chilled, frozen)	5	1	0.1	0.1
0240-0249	Pork (fresh, chilled, frozen)	48	9	1.0	0.8
0250-0259	Fresh, chilled and frozen meat n.e.s.	6	1	0.1	0.1
0260-0279	Prepared meat and small packs	86	16	1.7	1.4
0280-0289	Canned meat	295	54	6.0	4.9
0290-0299	Cooked meat	14	2	0.3	0.2
0300-0309	Chicken (fresh, frozen)	350	63	7.1	5.8
0310-0319	Other poultry (fresh, frozen)	5	1	0.1	0.1
0320-0329	Cooked poultry	10	2	0.3	0.2
0400-0439	Fresh and frozen fish	344	62	7.0	5.7
0440-0469	Shellfish and crustaceans	37	7	0.8	0.6
0470-0489	Canned and bottled fish	130	24	2.6	2.1
0490-0499	Prepared fish n.e.s.	1	0	0.0	0.0
0500-0509	Egg	54	10	1.1	0.9
0510-0529	Milk, cream, yoghurt	124	23	2.5	2.1
0530-0539	Butter, cheese	138	25	2.8	2.3
0540-0569	Vegetable oils and fats	56	10	1.1	0.9
0600-0619	Bread	490	89	10.0	8.1
0620-0639	Cakes, buns, pastries (not take-away)	76	14	1.5	1.3
0640-0649	Flour, flour-based mixes	108	20	2.2	1.8
0650-0659	Breakfast cereals	6	1	0.1	0.1
0660-0669	Cereal pudding bases	0	0	0.0	0.0
0670-0679	Cereals	20	4	0.4	0.3
0680-0689	Pasta	86	16	1.7	1.4
0690-0699	Cereal products n.e.s.	6	1	0.1	0.1
0700-0709	Sugar	164	30	3.3	2.7
0710-0719	Syrups, dessert sauces	4	1	0.1	0.1
0720-0729	Honey, jam, spreads	16	3	0.3	0.3
0730-0739	Beverages	71	13	1.4	1.2
0740-0749	Cordial, soft drinks	189	34	3.8	3.2
0750-0769	Confectionery	148	27	3.0	2.5
0800-0809	Condiments, herbs, spices	31	6	0.6	0.5
0810-0829	Sauces, gravies, essences, sweeteners	30	5	0.6	0.5
0830-0839	Dessert powders and crystals	0	0	0.0	0.0
0840-0849	Prepared soups, meals and desserts	6	1	0.1	0.1
0850-0859	Canned foodstuffs n.e.s.	6	1	0.1	0.1
0860-0879	Other food stuffs	69	12	1.4	1.1
0880-0889	Bulk groceries n.o.d.	23	4	0.5	0.4
0900-0909	Food consumed in eating places	137	25	2.8	2.3
0910-0939	Take-away foods	100	18	2.0	1.7
	Total for Food	**4914**	**892**	**100.0**	**81.8**

Source : Household Income and Expenditure Survey 2000/01, Statistics Department

Per capita consumption of tropical tree fruits

Tongans are extremely price sensitive in their purchasing habits. Price is a significant contributing factor in purchase decisions. Fruit blemishes and marks do not appear to deter Tongans from purchasing fruit, so long as the price is reasonable.

Comments about soft fruit were made on a number of occasions. There is a perception that the softer type fruits such as guava are more likely to have been stung by fruit fly or infected with internal breakdown or fruit rots. Consequently, the demand for these fruits is weaker than fruits that are considered more robust, e.g. banana, papaya, citrus and watermelon.

The HIES tables give an indication of the ratio of cash to non-cash expenditure and income. Recommendations on how to best further develop the tree fruit industry in Tonga could only be made once an understanding of the broad income and expenditure patterns of the island divisions is gained.

Table 12 provides a simplistic impression at buying, consumption and income capacity and pattern. A quick scan suggests that the ongoing success of a commercial fruit orchard is more likely to succeed by targeting consumers in the Tongatapu market as opposed to the Ha'apai market.

Inhabitants in Tongatapu have higher disposable incomes and consume less of their own produce. There are more households in Tongatapu than Ha'apai (10 583 compared to 1298, from Table 2) and the level of agriculturally active households is 54% in Tongatapu and 83% in Ha'apai.

Table 12. Total annual income (T$) per capita by main source, and island division#

Main source of income	Tongatapu	Vava'u	Ha'apai	'Eua	Niuas	Tongan Average[#]
Cash income	**2597**	**1913**	**1815**	**1692**	**1802**	**2335**
Wages & salaries	1039	513	313	423	297	**830**
Remittances from overseas	562	253	260	340	299	**461**
Sales of own produce	261	595	573	556	651	**375**
Bank loan	254	163	118	124	127	**216**
Other cash sources	481	389	551	249	428	**453**
Non-cash income	**1024**	**870**	**1600**	**1091**	**953**	**1040**
Consumption of own produce	396	462	1075	633	386	**474**
Imputed rent	490	368	366	408	283	**448**
Other non-cash sources	138	40	159	50	284	**118**
Total income (cash and non-cash)	**3621**	**2783**	**3416**	**2783**	**2755**	**3376**

Source: Household Income and Expenditure Survey 2000/01, Statistics Department
[#] See Table 2 for an indication of number of households

7.1.2 Central Markets

A central market is located on each of the island groups: Talamahu Market in Tongatapu, Utukalongalu Market in Vava'u and Fanga'ihesi Market in Ha'apai.

Friday evening and Saturday morning are the busiest time in the markets as most families stock up for Sundays Christian Sabbath and weekend family gatherings.

Product for sale at the Talamahu Market, Nuku'alofa in May 2007 included leafy vegetables, Pak Choy, shallot, yams, tomato, capsicum, ginger, chillies, garlic, limes, potato, onion, coconut, beans, rhubarb, papaya, radish, carrot and bitter melon.

A MAFFF employee coordinates the allocation of the stall areas to growers/sellers. A fee of between $2.00–5.00 Pa'anga is charged by the Tongan government depending on location.

Plate 9. Outside the Talamahu Market, Nuk'ualofa

Plate 10. Utukalongalu Market, Vava'u

The Talamahu Market and many other parts of the Central Business District were closed in the aftermath of the November 2006 riots. The Talamahu Market was relocated to a government site at Tofoa, and some growers chose to sell produce on the side of the road. The Talamahu Market was reopened in April 2007. Some vendors have not returned to the Talamahu Market though, and preferred to continue selling their produce at roadside stalls. Selling from the roadside stalls allow growers to continue to sell their produce after the Talamahu Market closes around 5:00 pm although many of these roadside stalls have the disadvantage of being exposed to the elements.

Prices and throughputs from Talamahu Market are collated by MAFFF and Statistics Department staff. Data and summaries are published and distributed to Senior Officers in Government and 'industry'. Distributing market throughput and price information, including fruit price variations between markets more broadly, particularly to commercial producers on the outer islands would be beneficial.

Plate 11. A roadside stall in Fanga

Data on the volume of supply of each produce type, in common trade units were sourced from the daily records of the Talamahu Market. A survey is undertaken every Friday morning during which random samples of 10 common trade units are weighed and their respective prices recorded. Price and weight information from the survey are used to derive the total volume (in metric tonne) and value of supply of produce.

The 2006 average price range per CTU (common trade units) for fruits sold in the Talamahu Market is outlined below (Table 13).

Table 13. Average price range per CTU (common trade units) for pawpaw, pineapple, avocado, orange, lemon, mango, breadfruit and bananas

	FRUIT						
	Pawpaw	**Pineapple**	**Avocado**	**Orange**	**Lemon**	**Mango**	**Breadfruit**
CTU	pce	pce	pce	heap	heap	heap	bskt
$/CTU	$1.06-$2.60	$1.87-$7.20	$1.00-$2.00	$1.63-$2.00	$0.40-$2.00	$0.50-$2.00	$6.75-$12.00
$/kg	$1.34-$2.88	$2.87-$9.44	$1.77-$2.72	$1.60-$2.73	$2.88-$15.38	$1.81-$2.22	$0.45-$0.92

	BANANAS			
	Banana	**Plantain**	**Pata**	**Ripe Banana**
CTU	bunch	bunch	bunch	hand
$/CTU	$3.11-$11.86	$1.38-$18.45	$3.18-$3.86	$1.90-$4.90
$/kg	$0.45-$1.40	$0.84-$2.03	$0.37-$0.43	$1.78-$5.87

Key: pce = piece, bskt = basket, $ Pa'anga

Consistency of trade weights for those fruits sold by the heap, basket, bunch or hand is questionable, particularly when at the time of sale the produce is not weighed nor sold in standard sized packaging / cartons, trays or punnets.

7.1.3 Transport / freight inter-island

The Tongan inter-island ferry, the MV Olovaha operates between the island groups of Tongatapu – Ha'apai – Vava'u – Niuas. http://www.olovaha.com

The weekly voyage time between Nuku'alofa and Ha'apai is nine hours. From Ha'apai it is a further 13 hours north to Vava'u. Once a month there is a service to the most northern island group, the Niuas, the voyage takes 2.5 days.

The ferry service would carry significant volumes of produce and livestock between the island groups. However, reliability of the service timetable, the lack of effective packaging and refrigeration at the ports and on board the ferry, limit its capacity to carry highly perishable tropical fruits efficiently.

Plate 12. Olovaha Inter-island Ferry

Plate 13. Olovaha Ferry, open container

Plate 14. Aircraft service in Tonga

At the time of printing there are two inter-island airlines operating in Tonga. Both offer limited capacity freight services. Pictured above (Plate 14) is an Air Fiji / Airlines Tonga aircraft (Harbin Y12 17 seater).

Very little produce however is freighted by air between the islands because of the high cost. The airfreight rate for produce is approximately

- $1.00 Pa'anga / kg Tongatapu – Vava'u
- $0.85 Pa'anga / kg Tongatapu – Ha'apai.

The reliability of inter-island air and sea freight service is a major issue, and discourages growers from utilising the services. Some proactive growers from the northern island groups are utilising the Olovaha Ferry service to supply the Talamahu Market with tropical fruit during periods of high demand. The growers pack the containers at the port and accompany the fruit to market on the MV Olovaha.

7.2 Commercial operations vs. subsistence farming

There were approximately 15 700 households in Tonga in 2001. About 65% of the households produced food for home consumption. Table 14 details the extent of subsistence agricultural activity in Tonga, and this varied between island groups, from 23 to 68%. With such a high proportion of households producing their own food, any new commercial tree fruit orchard established specifically targeting the local market could face considerable competition from homegrown fruit. The proportion of fruit produced by households however is not discernible from the table and it is expected that much of the production is mainly the traditional food crops.

Table 14. Proportion of Households with Respect to the Level of Agricultural Activity to the Total Households, by Location of Households, 2001

Location	Total Number of Agriculturally Active Households	Level of Agricultural Activities		
		Subsistence Only	Subsistence with Cash Cropping	Commercial Crop Producer
Tonga	**10 102**	**5964 (59%)**	**3896 (38.6 %)**	**242 (2.4%)**
Tongatapu	5735	3880 (67.7%)	1691 (29.5%)	64 (2.8%)
Vava'u	2183	933 (42.8 %)	1210 (55.4%)	40 (1.8%)
Ha'apai	1076	837 (77.8%)	236 (21.9%)	3 (0.2%)
'Eua	774	183 (23.6%)	557 (72%)	34 (4.4%)
Niuas	334	131 (39.2%)	202 (60.5%)	1 (0.2%)

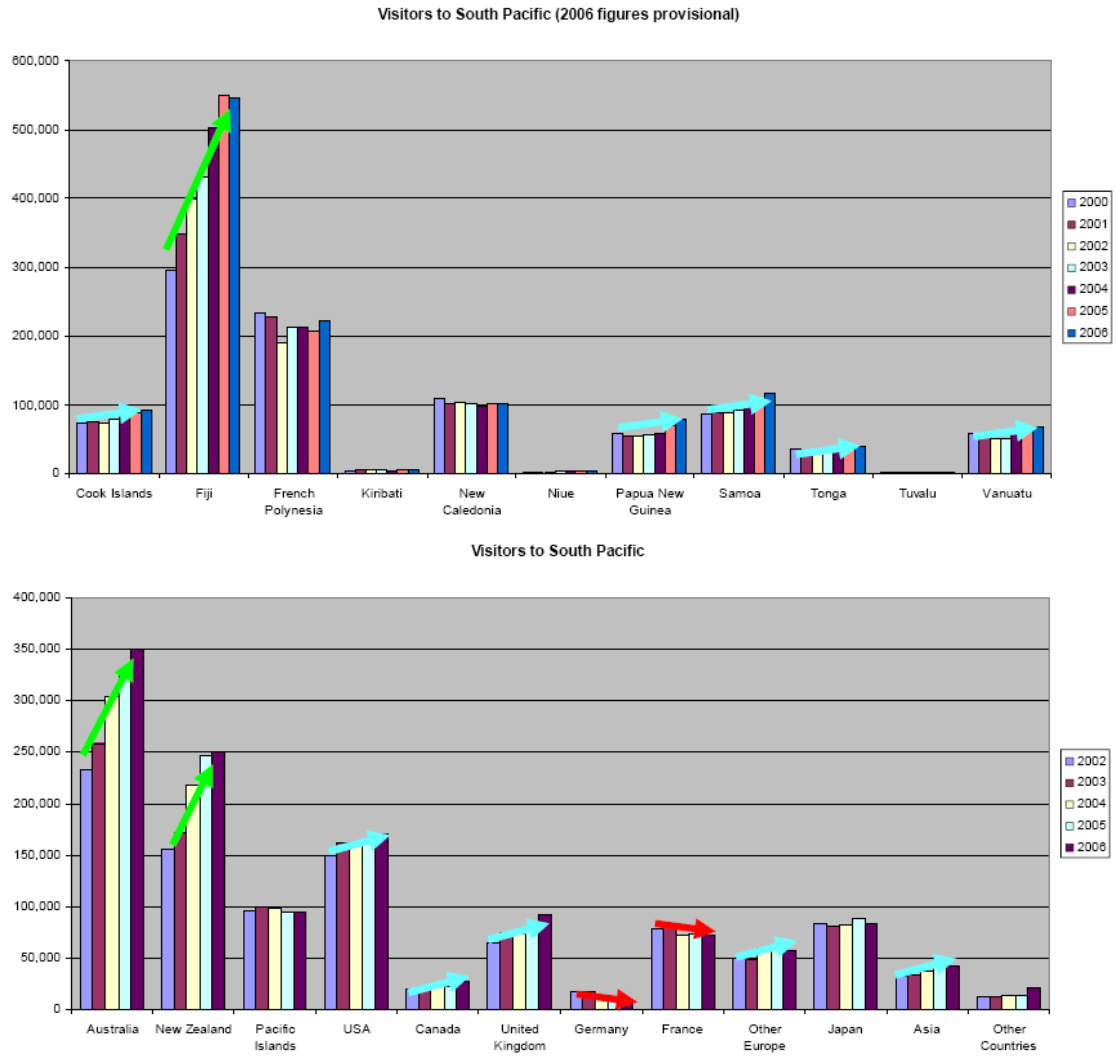
Source: Agricultural Census 2001

7.3 Tourism

Tonga has a small tourism industry in comparison to other South Pacific Island countries. About 25 000 tourists visit Tonga each year. Many of the tourists arrive from Australia, New Zealand, the USA and other Pacific Islands (Figure 3). Not included in these figures are a significant number of expatriates returning to Tonga to visit friends and relatives, mainly during the Christmas holidays.

Vava'u has growth potential as a tourist destination. Local restaurant and resort owners indicated that they have a need for better access to consistent supply of small volumes of high quality fruit and vegetables for their food service operations. About 55% of the agriculturally active households in Vava'u produced crops for cash income (Table 14) and only about 2% are commercial producers, suggesting that there may be scope to increase supply and increase the diversity in the range of fruit and vegetables.

The number of visitors and excursionists increased from 50 419 in 1999 to 56 894 in 2003, as shown in Table 15, with a breakdown of the visitor type to Tonga, and the data also suggests increasing numbers in the future. However, indicative 2007 tourism numbers for the traditional May-November period point to a significant drop in visitations from Australians and New Zealanders (Tourist Bureau of Tonga, *pers comm*.). The ongoing impact of the November 2006 civil unrest on the Tongan tourism industry is likely to have significant effect.



Source: South-Pacific Travel

Figure 3. Visitor information by island destination and country of departure

Many tourists are unaware and uninformed of the names or the varieties of fruits that are sold in the markets in Tonga. Generally, visitors have never been exposed to the suite of tropical fruits and there may be an opportunity for niche marketing. There may be a need and opportunity for the market and individual vendors to provide better information on the produce for sale in the market i.e. local name, western name, uses, etc.

Table 15. Visitors and visitor types to Tonga between 1999 and 2003

Total Visitors and Excursionists to Tonga					
Visitors	**1999**	**2000**	**2001**	**2002**	**2003**
Air Visitors	30 949	34 694	32 386	36 585	40 110
Cargo Passengers	0	0	3	41	20
Yacht Visitors	2644	2492	1994	2404	2278
Naval Crew	742	583	802	2439	724
Sub-Total	**34 335**	**37 769**	**35 185**	**41 469**	**43 132**
Excursionists					
Cruise ship Passengers	7738	4755	3960	5171	6473
Cruise ship Crew	5285	3125	2311	3039	4356
Foreign Vessels	3061	2811	2521	3897	2933
Sub-Total	**16 084**	**10 691**	**8 792**	**12 107**	**13 762**
Grand Total	**50 419**	**48 460**	**43 977**	**53 576**	**56 894**

Source: South-Pacific Travel

7.4 Import replacement

Tonga relies heavily on foreign foods, and significant volumes of highly refined western foods that are low in fibre and high in fat and sugars are imported. In contrast Tonga imports only modest quantities of fruit, between 235 − 350 tons per annum (Table 16 and 17). Apples, pears and oranges are the main fruits imported (Table 17), while imports of tropical tree fruits (banana, mango, avocado, etc.) are insignificant.

Table 16. Imports of fruit and vegetables into Tonga, by volume & value (Pa'anga)

IMPORT ITEMS	2000		2001		2002		2003		2004		2005	
	Qty	Value	Qty	Value	Qty	Value	Qty	Value	Qty	Value	Qty	Value
Vegetable Products	449	522 598	515	618 265	436	703 216	507	705 749	613	667 769	504	761 755
Fruit Products	353	660 782	348	809 555	312	834 440	269	955 082	235	418 708	265	755 930

Source: Tonga MAFFF

Table 17. Breakdown of Fruit Imports by quantity, value (Pa'anga) and percentage of total agricultural imports

	2003			2004			2005		
Fruit Products	Qty	Value	%	Qty	Value	%	Qty	Value	%
Nuts	29.70	444 752	**0.88**	40.40	148 072	**0.27**	44.90	174 981	**0.30**
Bananas	-	-	**0.00**	2.23	8460	**0.02**			
Pines, Avocado, Guava, Mango	1.80	4142	**0.01**	0.24	273	**0.00**	0.09	55	**0.00**
Oranges	67.70	134 260	**0.27**	14.68	25 662	**0.05**	53.34	128 479	**0.22**
Mandarins	0.26	1313	**0.00**	0.85	1204	**0.00**			
Lemons	0.59	1220	**0.00**	2.07	5210	**0.01**	1.31	2618	**0.00**
Grapefruit	1.20	6521	**0.01**	2.73	16 823	**0.03**	8.62	55 167	**0.09**
Citrus Fruit	0.64	3778	**0.01**	0.31	1074	**0.00**	0.71	4109	**0.01**
Apples, Pears	140.40	279 591	**0.56**	165.12	195 743	**0.36**	137.80	329 861	**0.56**
Apricots, Cherries, Peaches	0.20	1086	**0.00**	0.47	914	**0.00**	1.27	5330	**0.01**
Fresh Fruit	4.60	7333	**0.01**	2.09	3547	**0.01**	3.76	10 675	**0.02**
Dried Fruit	21.60	70 777	**0.14**	3.71	10 202	**0.02**	12.86	43 199	**0.07**
Peel of Citrus and Watermelon	0.07	309	**0.00**	0.59	1524	**0.00**	0.32	1456	**0.00**
Sub-Total	**268.76**	**955 082**	**1.90**	**235.49**	**418 708**	**0.77**	**264.94**	**755 930**	**1.29**

Source: Tonga MAFFF

There are challenges with regard to the relative cost of imported product versus locally grown. There is no “buy local” campaign implemented by industry or government to encourage consumption and purchase of local produce. With price being a major determinant in purchasing pattern, purchasing home-grown produce could remain immaterial to Tongans. The country has a long history of imported foodstuffs, and this is unlikely to change in the near future. Even the recent depreciation of the Tongan Pa’anga had little impact to increase overall domestic agricultural production.

7.5 Exporting

Export Air Service. International flights operate only from Fua’amotu International Airport on the main Island of Tongatapu, using services provided by Air New Zealand, Virgin Blue and Air Fiji.

Current flight schedules and aircraft types out of Tonga are listed below and from the website, http://www.tongaairports.com/info-schedule.html.

- Virgin Blue Schedule (TBU-SYD), Boeing 737 operates twice a week and (TBU-AKL) Boeing 737, twice a week
- Air New Zealand Schedule (TBU-AKL), Boeing 767 operates twice a week
- Air Fiji Schedule (TBU-SUV), ATR42 Turbo Prop operates three times a week, and (TBU-NAN) Boeing 737, twice a week.

The 737 and Turbo Prop aircraft have limited space for carriage of commercial quantities of horticulture produce. Air New Zealand’s 767 aircraft and associated ULD (Unit Load Device) containers are more suited for export of perishable and fragile produce. Most ULDs however are not refrigerated, which could be an issue on long flights.

While no commercial quantities of produce are currently being air freighted to New Zealand, a considerable number of UMU boxes (Plate 15) are sent to Tongans living in New Zealand as unaccompanied baggage. UMU paks are the boxes that Tongans use to send produce, mainly breadfruit via airfreight to New Zealand.

Plate 15. UMU boxes used for packaging as air freighted cargo

Sea freight export. (South Pacific Line – Tonga – New Zealand – Australia). Consolidated loads of root crops are regularly sent to New Zealand via sea freight. Crowley, *et al.* (2003) in their report, "Tonga: Agriculture Sector Review, ADB Technical Assistance Consultant's Report" reviewed the agricultural sector in Tonga and proposed a phased development program, emphasising on market-oriented development, to essentially raise income created by the agricultural sector. Outputs to enhance the value of the primary sector were also presented.

7.5.1 HTFA (High temperature forced-air) plant

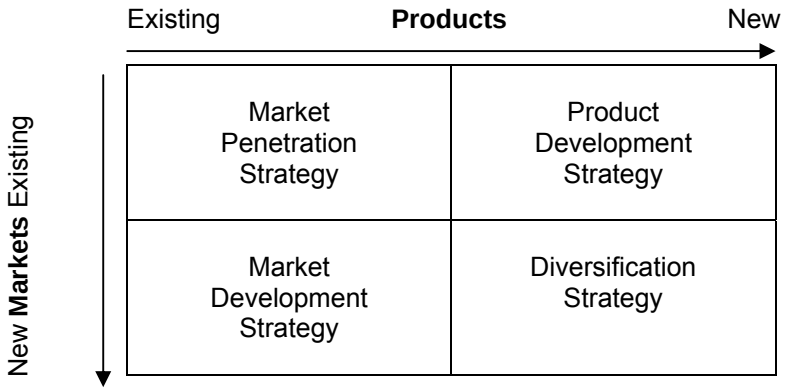
Plate 16. The High Temperature Forced-Air treatment plant established in the early 1990s and associated storage, now lying idle

High temperature forced-air quarantine treatment plants were established for fresh fruits infested by Tephritid fruit flies in the early 1990s on Tonga. While there were Tongan agri-business developments identified in this study, for example, establishment and operation of the high temperature forced-air (HTFA) treatment plant to allow the export of fruit fly host produce (e.g. breadfruit, papaya, tomatoes, capsicum and eggplant) to New Zealand, we were unable to identify concerted effort in a planting program that was set up to take advantage of the HTFA plant. As at August 2007 the HTFA plant had been laying idle for nearly two years. Contributing factors to the cessation of operation of the plant included Tongan MAFFF stepping back from commercial involvement in the operation and the limited volumes and quality of produce coming through the plant to fill AV containers.

7.6 Tropical tree fruit market development options.

The Ansoff Matrix (Ansoff, 1957) is one of a number of 'classical marketing concepts'. It is a useful tool, which can help in identifying and deciding on product and market growth strategy. It outlines four possible courses of action or strategies for market growth. The matrix has a PRODUCT and a MARKET axis.

Figure 18. Ansoff matrix (adapted from Ansoff, 1957)



Ansoff's product/market growth matrix suggests that a business' attempt to grow depend on whether it markets new or existing products in new or existing markets.

Based on information collected in this report and using the Ansoff Matrix, some future development options for the Tongan tree fruit industry are outlined below.

Table 17. Possible future development options for the Tongan tree fruit industry

Growth Strategy	Description & Level of Risk	Specific Examples
Market Penetration (Existing Market, Existing Product)	Growth is achieved with existing products in their current market segments, aiming to increase market share. Low Risk.	• Increase domestic citrus production. Capturing the market share of imported citrus. • Increase fruit consumption among Tongans, promote local fruit supply.
Product Development (Existing Market, New Product)	Growth is achieved by developing new products that are targeted at existing markets. Medium Risk.	• Introduce new varieties of traditional fruits (mango, tropical citrus). • Introduce new fruits (rambutan, lychee). • Process / value add existing fruits (frozen breadfruit chips, pureed mango / banana, dried mango / banana).
Market Development (New Market, Existing Product)	Growth is achieved by targeting existing products to new markets. Medium Risk.	Export existing fruits to New Zealand.
Diversification (New Market, New Product)	Growth is achieved by diversifying into new businesses by developing new products for new markets. High Risk.	Export of processed fruit products to New Zealand, Australia, USA, Europe.

The project team recommends that growth in the tropical tree fruit industry in Tonga focus on implementing Market Penetration and Product Development strategies, directing efforts on the existing market with existing and new products. The level of risk using these two growth strategies is low to medium.

Market penetration is aimed at increasing market share of current produce and securing dominance of growth markets. This can be achieved by a combination of competitive pricing strategies and promotional campaigns. It is unlikely to involve

much investment in new market research. Increasing market share may include improving fruit quality, increasing supply, postharvest treatment and packaging.

In product development, new products are introduced into existing markets. It can involve the development of modified products, which can appeal to existing markets. Value adding and simply processed product can make use of surplus production as well as open new markets. New fruit varieties and fruits can extend the season and provide greater selection.

8 Exports

8.1 Exporting to New Zealand and Australia

The New Zealand market offers Tongan growers and exporters the opportunity through its large domestic Pacific Island market for Pacific and traditional produce, particularly for tropical and other 'exotic' produce. However, the market for fresh produce faces intense competition from recognized and established overseas competitors including Australia, USA, Philippines, Ecuador and Mexico who supply large volumes of reliable and consistent supplies of citrus, bananas, pineapples and mangoes. Overall, however, Pacific imports represented less than 2% of all fruit and vegetables imported into New Zealand.

Limited export opportunity exists for tree fruit and root vegetable exports to Australia. Tonga is unlikely to be able to compete with existing tree fruit and tropical food growers in Northern Australia who are regularly oversupplying the Australian market with produce.

Discussions with importers and other contacts in the private sector in New Zealand highlighted a few critical issues. New Zealand importers prefer to deal with the larger exporters because of the potential risks that may be involved in supply by smaller dealers. The established commercial companies generally have extensive and established distribution networks and experience in dealing with the necessary import procedures. Importers cannot afford to and may be unwilling to change readily sources of supply, particularly where the new source is unproven.

Previous surveys of New Zealand importers reported problems associated with imported Pacific products, particularly from Tonga. There were problems in:

1. Supply - inconsistent supply, inadequate communication and information
2. Volume – insufficient volume, making shipments uneconomical
3. Quality - poor quality products; marking, bruising, poor grading, mixed sizes and ripeness in the same box and inadequate packaging.

Given that the first two factors can be overcome, quality remains the single most important issue that confronts importers of Pacific produce.

The experience with Tongan exporters had been disappointing and New Zealand importers seem very reluctant to engage with Tongan exporters. Some steps for Tonga to improve the situation could include the formation of growers' co-operatives and specialised marketing sector for the continued supply of large volumes of produce; education and training in horticultural systems and techniques, training and education in supply chain and postharvest management to ensure supply of quality produce.

Grandison (2003) in his report provided detail on the requirements and experience for exporting Pacific produce to meet the requirements of the New Zealand market. The report provides an excellent guide for intending exporters, and contained succinct information on the supply chain, market research, information on specific produce, contacts and related references.

As the New Zealand's Ministry of Agriculture and Forestry's (MAF) import regulations are being constantly revised, it is recommended that individuals or groups considering exporting to New Zealand should contact and consult the Pacific Islands Trade and Investment Commission (PITIC), Auckland for current quarantine regulations and support. For the most current import standards, refer to New Zealand MAF's website, *http://www.biosecurity.govt.nz/commercial-imports/plant-imports/introduction*.

8.1.1 Bilateral relationship

Relations between New Zealand and Tonga are underpinned by a shared Polynesian heritage and extensive people-to-people linkages. Remittances to the Kingdom from the Tongan community in New Zealand and Australia are an important source of foreign exchange and income to Tonga.

Tonga is New Zealand's sixth largest export market in the Pacific. Total two-way trade for the year ending December 2005 came to almost NZ$50 million. New Zealand exports to Tonga for the year ending December 2005 came to approximately NZ$48 million and these were primarily meat, wood, butter, petroleum, furniture and plywood. In the same year imports from Tonga, mainly beans, root vegetables, scrap iron, fruit and plants, only came to approximately NZ$1.7 million. The main source of imports for Tonga is New Zealand, due to favourable regional shipping arrangements, and this accounted for more than 40% of the market. Fiji, Australia, the United States and China are the other significant sources of imports.

A Tonga-New Zealand Business Association was set up in Nuku'alofa in 1993 to assist in promoting bilateral trade and economic linkages. Regional and international developments such as the negotiation of regional trade agreements (PICTA, Pacific Islands Countries Trade Agreement and PACER, Pacific Agreement on Closer Economic Relations) and Tonga's application to join the WTO attempted to create a new working environment and, it was anticipated that this could become a forward-looking framework for the further development of trade relations.

A recent report (Nathan Associates, 2007 from Island Business, http://www.islandsbusiness.com) however suggested that for Tonga and Vanuatu, which derived 33% and 27% of their total revenue from tariffs, these island countries instead stood to lose up to US$10 million annually.

8.2 Fresh fruit and vegetables

The phytosanitary requirements for fresh fruit and vegetables permitted into New Zealand were summarised (5357kb), and available from http://www.biosecurity.govt.nz/files/imports/plants/standards/152-02.pdf. Import health standards (IHSs) for fresh fruit and vegetables and documents that relate to the requirements that must be met before risk goods can be imported into New Zealand may be found in the New Zealand MAF Biosecurity website, http://www.biosecurity.govt.nz/commercial-imports/import-health-standards/search?keywords=fresh+fruit&country=&sort_by=0&submit_search=searc

h. A summary of approved commodities from Tonga may be accessed from the website.

The list of these standards is located from the webpage below: http://www.biosecurity.govt.nz/commercial-imports/plant-imports/relevant-import-health-standards-and-application/fresh-or-frozen-fruit-and-vegetables

All host material (fruit and vegetables) of fruit fly species (Diptera: *Tephritidae*) of economic significance shall only be imported under the terms of a bilateral quarantine agreement (BQA) between the New Zealand Ministry of Agriculture and the head of Tonga's national plant protection organisation.

Only inert and/or synthetic material may be used for the protection, wadding, packaging and shipping materials of fresh fruit and vegetables.

The benefits of Tonga's regional fruit fly projects assessed by McGregor (1996) in 1996 study were estimated at USD6.9 million. These estimates were reassessed downward to USD3.8 million in 1999 with the decrease largely due to the decline in Tonga's squash export earnings. Watermelon and papaya exports were also significantly reduced than what was assessed in 1996. McGregor surmised that of all HTFA treated produce, breadfruit would most likely offer the best prospects for Tonga.

8.2.1 Bilateral Quarantine Agreement (BQA)

Produce that is known to be a host for risk quarantine pests may be imported into New Zealand only if a Bilateral Quarantine Agreement (BQA) has been negotiated between New Zealand and Tonga. A BQA is a mechanism by which offshore quarantine is guaranteed and refers to:

- The maximum pest limit set by New Zealand.
- The treatments to be undertaken by the exporting country (Tonga).
- Inspection levels on arrival in New Zealand.
- Contingency actions to be undertaken by the exporting country and New Zealand if fruit flies are found in the produce.

All imported produce must meet individual requirements according to its risk profile and accompanied by an International Phytosanitary Certificate issued by the relevant authorities. All produce is inspected at the New Zealand border and treated or destroyed if necessary. Documentation for each BQA treatment pathway will ensure trace back, monitoring and treatment security.

8.2.2 Sea containers

Sea containers from all countries must comply with "Import Health Standards for sea Containers", and must have the signed current International Phytosanitary Health Certificate (IPHC), a signed New Zealand MAF Biosecurity Quarantine Declaration which is: 'Declaration attesting to the interior and exterior cleanliness of the container and whether any restricted packing or packaging is used within the cargo or container'.

For details refer to www.maf.govt.nz/biosecurity/imports/nonorganic/standards/bmg-stdseaco.htm and http://www.biosecurity.govt.nz/border/transitional-facilities/sea-containers/container-declaration/tongan.pdf .

9 Discussion

Fruit production systems in Tonga are characterised as traditional, with mixed or tiered crop configurations, and with limited inputs of fertilisers and chemicals. The 'food gardens' comprise of crop varieties of selected traditional staples such as yams, taro, cassava, banana and breadfruit. Much of the production is consumed by the household and extended household and any surplus production sold at local domestic market centres.

Subsistence and small-scale production will continue to play a major role in Tonga, and support for Tongan householders to increase cash sales on local markets could contribute to meeting food security objectives. Commercial size horticulture enterprises on the other hand could generate greater income, supply the domestic market and surplus production may be exported. For the horticultural sector to grow and generate greater income however, export led production will need to be fostered. The latter can be achieved under a staged approach by focussing on aspects of production and postharvest technology, product quality and supply chain.

Land tenure in Tonga and the following factors were identified as significant for this study. The social factor (culture, customs, traditions, religion, demography), the political factor (legal framework, bureaucracy, village politic), the economic factor (livelihood, employment, semi-commercial farming, remittances), and the physical factor (land resource, availability, accessibility, usability) all impact on the level of application, continuation and maintenance of initiatives in Tonga.

Apart from this, the environment in which a modern efficient agribusiness sector in Tonga to thrive must be favourable and have the appropriate mix of incentives to attract investment. There were other considerable physical constraints and risks identified in the study. They included structural changes, infrastructure investments, and developments that involved significant capital inputs and required external cash mobilisation. It is beyond the scope of this study to comment on these aspects.

9.1 Climate

The temperature and rainfall data for the three main islands suggest that conditions are generally ideal for the production of tropical and sub tropical fruit crops. The annual mean maximum and minimum temperatures are around 27^{o}C and 15^{o}C, respectively. Rainfall is generally well distributed throughout the year although there can be periods of drought, and additional water supplies will be required during these periods. The soils of Tonga are derived from a combination of volcanic ash and coral, indicating generally highly productive, easily cultivated soils.

The lack of surface or ground water available for irrigation is potentially a constraint for large-scale commercial production that could affect the development of export markets, which demand high quality uniform product. Conversely, the well-distributed rainfall may be counter productive to the production of high quality fruit (e.g. mango and papaya) which prefers low or nil rainfall conditions but high soil moisture during fruit development for blemish-free fruit.

Despite the favourable climate for tropical and sub tropical fruit production, Tonga is susceptible to natural disasters. In particular, cyclones are experienced regularly during the wet season and they can have a destructive impact on fruit trees.

9.2 Production costs

The costs of imported inputs for farming are high, but unclear. With the exceptions of vehicles and trucks, imported inputs to agriculture are mostly exempted from tariffs and taxes. The duties and taxes substantially raise the costs of transporting farm produce in Tonga.

Nevertheless, prices for imported inputs such as fertilisers and chemicals are high, and these high prices are associated with purchasing inputs in relatively small amounts. Merchants are unwilling to buy and store these inputs in large amounts as this could affect their cash flow. Co-operative arrangements to jointly, bulk purchase could address this concern.

9.3 Markets, information and access

Local central markets are already established in Tongatapu, Vava'u and Ha'apai. These markets form the main channels for distribution and marketing and, could provide an incentive for farmers to increase food production hence improving food security and increase household earnings.

While product price largely determine purchasing choice and pattern, a market-oriented approach to production, and the capability and capacity to produce commodities that meet certain criteria or specifications could foster and promote a different production approach. Sale of surplus production is not envisaged as the mechanism for promoting economic improvement.

Growers and the private sector appear to be somewhat informed of domestic markets and requirements but had little or limited knowledge about the export opportunities, prices and market requirements. Overall, they seem dissatisfied. MAFFF staff however visited and had undertaken various information gathering activities overseas and relayed the market information back to growers and interested parties.

9.4 Export

The experience of New Zealand importers with Tongan exporters had been reported as disappointing, and this related mainly to volume, quality and coordination. Some steps to improve the situation could include the formation of growers' co-operatives and specialised marketing arms or linkages for the continued supply of large volumes of produce.

It may be pertinent to up-skill and provide education and training opportunities in horticultural systems and production techniques, improved supply chain and postharvest management to ensure supply of quality produce.

PITIC offers a free service and provides information to potential exporters on statistics, produce prices and other information on produce type, import and phytosanitary requirements, sources of packaging and potential buyers in order to successfully meet requirements of the New Zealand market.

While there were many factors that could determine whether a particular fruit commodity could be successfully exported to New Zealand, quality remains the critical constraint (Grandison, 2003). Sub-standard quality products receive lower

prices and smaller market share and in the long term damage the reputation of the exporting country.

The Bilateral Quarantine Agreement with New Zealand could provide a real opportunity for Tonga to increase exports for banana, papaya and mango while tropical fruits such as longan, lychee, mangosteen and rambutan present potential new commodities. Tropical fruits have a great potential with the increasing Asian and Pacific Island Countries populations and increasingly so with the sophisticated European shopper.

9.5 Fruit fly

The quality of fruits and vegetables are severely affected by fruit flies. Better quality produce attract higher prices in the domestic market, and could expand the economic base for export.

While the potential for horticultural exports exists and could be progressed in the future, and building upon their squash export trade and experience, the challenge would be dependent on their ability to meet product specifications, volume and fruit fly disinfestations.

The presence of fruit fly is a major obstacle in the development and growth of horticultural industries, for both local and export efforts. The expertise and technology to eradicate and control fruit fly is accessible (FAO/AusAid /SPC/UNDP Project on Regional Management of Fruit Flies in the Pacific) and Tonga's involvement started in 1990. Eradication of fruit fly was successfully achieved in Nauru and information about this project is available from http://www.spc.int/pacifly/Success_stories/Nauru_erad1.htm .

The Australian Centre for International Agriculture Research (ACIAR) began supporting regional fruit fly management surveys and projects, and protein bait spraying in the early 1990s in order to improve prospects for entering export markets. Forced hot air treatment technology was also developed and a HTFA plant was established in Tonga. Equipped with appropriate and improved fruit fly management tools, Tonga would have the capacity to export fruit and vegetables to markets which would otherwise have been closed and which could deliver considerable economic benefits.

Fruit fly quarantine surveillance and control however must be sustained to prevent future outbreaks and would be critical for its US$7million squash export industry to Japan. Information on Tonga's fruit fly profile can be found at http://www.spc.int/Pacifly/Country_profiles/Tonga.htm .

It may be pertinent to

- upgrade the technical knowledge and understanding of the impact of fruit flies on the production and export of fresh fruit
- reduce the levels of damage to fresh fruit caused by fruit flies during production and consider post harvest treatments
- strengthen the capacity of quarantine services and the private sector to overcome quarantine restrictions
- comply with protocols on the export of fresh fruit imposed by importing countries.

9.6 High temperature forced air

Significant resources have been devoted to developing the High Temperature Forced Air (HTFA) at Fua'amotu to facilitate export of fruit fly host commodities to New Zealand. With appropriate staff training, this could ensure the heat treatment process would be managed efficiently and effectively to cater to the range of potential and perhaps anticipated demands for agricultural export. The HTFA facility is a good investment strategy to increasing export earnings for those involved in primary production, particularly it should enable more accessibility to market opportunities in New Zealand.

The challenge now is to encourage the development of a grower/marketing cooperative who would take on the responsibility of organising production with regard to export orders and product specification, and who would control the supply of fruit/produce to the HTFA facility at a standard that allows product to be treated and packed. Another challenge is to support and advance farmers to grow 'commercially' in order to generate more revenues, and better use of this facility.

It was not possible to determine the operating costs and returns to restore the HTFA plant including ongoing running costs such as labour, power, maintenance and rent. There are currently no production nor arrangements to restore the facility. At the present time, it is not possible to identify who could devote the time and resources.

The reasons given as to why the HTFA is not operating included

- absence of available produce for export that required treatment through HTFA
- absence of reliable marketing arrangements to give confidence to growers to produce product for export
- high freight charges
- additional product specification costs related to quality control.

9.7 Land tenure and access

The complexity of the land tenure system in Tonga can dissuade use for commercial agricultural production. While the land tenure system provided Tongan households with access to land for subsistence and semi-commercial agricultural production, the grant of up to 8.25 acres of agricultural land however, may become an increasingly important constraint for use for commercial farming. Moreover, there are a finite number of available tax allotments and the tax allotments cannot be sold in Tonga, complicating the financing and re-sourcing of agricultural and agri-business activities.

Although up to 10 allotments of land however may be leased for periods of up to 20 years, a large majority of land allotments are not being used (effectively) for agricultural purposes to generate higher revenues. The high-risk nature of the activity, low expected returns from agricultural activities, issues on security of tenure and lease arrangements remain complex concerns for investors. Subsistence and semi-commercial farming however, is a limited source of economic development.

Improved process for accessing land is considered a high priority both for small semi-commercial and larger commercial projects.

9.8 Technology

The agricultural sector is still dominated by subsistence production and is unlikely to enhance economic growth. While about 250 growers consider themselves as commercial farmers, still they operate on a small scale, and are not sufficiently large enough to drive and activate future growth. Knowledge and adoption of more efficient production techniques and investment to maintain sustainable productivity would be important considerations for the long-term future of the agricultural sector and economy.

While the Tongan agricultural sector seems to face few constraints, there is little commercial horticultural production, or rather what we regard as commercial production. Tongan producers require encouragement to be more market-oriented and to plan to produce for future export markets if the horticultural or agricultural sector is expected to be the mechanism for economic growth, given the small domestic market. The reasons why past activities have not progressed are unclear.

Export performance to date however had been inadequate as exports are overwhelmingly in raw material form, and mainly from squash with a few months of concentrated activity. Other exports are the more traditional root crops and which did not require additional protocols. These crops are considerably more robust or durable compared with fresh fruits and the produce has less demanding postharvest and handling requirements.

With the exception of certain heavy root vegetables, for example, taro and pumpkin squash, that which required little post harvest handling, post harvest handling of fruit seems to be non-existent and the quality of produce markedly poor.

Commercial horticultural enterprises must adopt more efficient and superior technology in order to produce superior produce for export, minimise production costs and be able to compete successfully on the world market. Adoption of more productive farming systems and techniques, and the use of improved varieties and planting materials can enhance productivity of horticultural producers.

The diversification of the primary export base is also considered important in terms of reducing the high level of risk associated with a narrow range of export commodities. Access to agricultural information, extension activities and services program delivery may be formally targeted to meet farmers' needs.

Dissemination of technical information and establishing links with clients through the Information and Extension staff of MAFFF, including closer involvement and participation of the private sector and clients in the planning and implementation of agricultural programs are contributing factors to a participatory approach in the training and transfer of appropriate horticultural technologies.

9.8.1 Horticulture expansion

Specific horticultural crop development aimed at encouraging farmers to increase the planting of key crops (citrus, bananas, papaya) and providing the necessary support through the development of viable technologies to minimize production costs and maximize yields could assist in raising household incomes and minimise reliance on remittances.

These could include research to identify suitable varieties, introduction of new varieties to increase the product base and availability, fertilizer research trials, improved cultural practices, pest and disease management and production systems.

Demonstration collections could be established on two to three farms on each of the major islands (Tongatapu, Vava'u, Ha'apai and Eua). These collections should be utilised for local extension and fruit promotional activities, education and training, and as sources of propagation material.

9.8.2 Germplasm collections

Germplasm collections exist at the MAFFF Vani Research Station, Tongatapu and Ene'io Botanical Gardens in Vava'u island. The collection at Vani is overgrown and a good part of it may no longer be available to the research station. There are no planting plans available, and hence access to material at Vani would be unreliable.

The collection at Ene'io Botanical Gardens is part of a private collection managed by the ex CEO of MAFFF, Mr Haniteli Fa'anunu. The garden operates as an agro-tourist complex and is a good potential source of germplasm material. Ene'io Gardens staff also have propagation experience which would be important for multiplication and future distribution of germplasm and planting material.

In a recent Tongan National biodiversity strategy and action plan (Folaumoetu'I, 2006) the suggestion was made to establish gene conservation stand/seed orchards and botanical gardens in the main island centres on Tonga for *ex situ* conservation of priority species including Heilala (*Garcinia cessilis),* Tava *(Pometia pinnata),* Moli *(Citrus spp)* and fekika *(Syzygium malaccense).* Future germplasm type projects could potentially cooperate with this initiative and ensure a range of species of horticultural importance is also represented in these collections. The key issue will be continued maintenance of these gardens to ensure that material of horticultural significance remains correctly identified and is available for propagation and distribution to growers.

Improvements in germplasm of the well-known fruits as well as importing germplasm of currently unknown fruits will do much to improve the output of the current subsistence production system in Tonga. New germplasm will invigorate the current subsistence based bartering and market system as well as contribute to improved fruit choice and nutrition outcomes for Tongan citizens.

9.9 Freight

Tonga appears to be reasonably well serviced by international air and sea freight. Shipping between the main islands is somewhat adequate however, the smaller islands are poorly serviced.

The high cost of both air and sea freight space could considerably limit export activities.

Mechanisms to ensure sustainability of new initiatives would require the provision of adequate numbers of trained personnel and financial support. In particular, quarantine surveillance, maintenance of fruit fly programs and HTFA operations would be critical in ensuring markets remain open for Tongan produce.

Improvements are also needed on links with larger neighbouring destinations and source markets, particularly Australia and New Zealand. The improvements discussed should include freight space if Tonga is to improve her economic position.

10 Conclusions and recommendations

While Tonga horticulture remains in the home garden phase, household incomes will remain largely unchanged and reliance on remittances would continue. The reasons for the lack of continuation of recent agricultural programmes and infrastructure projects however, e.g. HTFA and continuing export of banana and papaya to New Zealand, are unclear. One explanation could be the little support for the recurrent costs of managing and maintaining these early public services.

Tonga's many islands and many cultural and natural assets are the basis for a strong tourist trade, and Tonga has the capacity to supply and replace many of the fruit and vegetable imports. With successful increases in fruit produced there is also a concomitant need for improvements in air and sea access, flight frequency, routes, services and development of a much improved network of regional routes and inter-island routes within the kingdom.

Import replacement possibilities could include increased citrus and mango production and diversifying into other tropical exotics. This could build on current local expertise while improved horticultural and supply chain training could progress further opportunities.

Essentially the study shows that the predominant objective in developing a tropical fruit industry first would be to raise incomes and provide employment, and production surplus to consumption could be sold in markets. Export opportunities are currently unachievable in light of the issues in meeting product specifications, fruit fly compliance, and other production and supply chain issues.

The likelihood of establishing a successful tropical fruit industry could be developed by improving the capacity of resources through mentoring, training and capacity-building activities given that other projects, for example, fruit fly management, high temperature forced air treatment and bilateral trade agreement would be exploited in future partnerships.

In view of the traditional and social patterns at work of the Tongan people and some insight of how Tongan society functions, it appears that change is even more essential in building a more resilient economic horticultural base, that is, exploit their human resources to maximize economic returns. Suites of projects and programs carried out in Tonga over the past 20 years have made considerable impact in Tonga. The following activities identified by the project team are aimed at achieving staged improvements in Tonga's tropical fruit industry include;

1. Horticulture

- Sustainable production and improvement through training and mentoring, improved production technologies, postharvest technologies and understanding of the supply chain. An introduction to tropical fruit production in far north Queensland to key MAFFF staff and growers.
- The traditional production systems currently practised by producers are applicable for the marketing structure that exist in Tonga, however will need to be expanded if Tonga is determined about developing their horticulture industry.

- Introduce research/extension staff and Tongan fruit growers to tropical fruit enterprises in north Queensland. Expose and educate the Tongan contingent to the different tropical fruits, view the fruits and taste them. Compile a list of genetic material they favour and would like to import and trial.
- Improvement of services in the horticulture sector. Key and enthusiastic MAFFF staff and key growers could be trained in aspects of horticultural production, e.g. plant propagation, pest scout, disease management, etc. and in turn become trainers and or provide consultancy services.
- Address and provide in-house training in Tonga regional centres, on fruit agronomy and production. MAFFF staff to coordinate with overview/guidance from Australian project staff. Involvement from MAFFF staff could ensure more effective linkages between stakeholders and service providers at the local level. The local districts will also have to take on more responsibilities in providing services. Such assistance would enhance the productivity and efficiency of their farming practices. It is also expected that this method could aim to improve women's involvement in food production.
- Development of information and information access for producers. Brief information fact sheets developed covering production practices, disease and pest facts, post harvest practices, etc. for growers by local staff. Fact sheets, posters and information resources should be largely visual, including practical training and procedures. (Fact sheets could be similar to the Pacific Gardener Newsletter ACIAR Project Samoa and Cape York communities).
- Diversifying into other tropical fruit species and growing improved varieties of mango (KP, R2E2, Keitt) and tropical citrus varieties identified as suitable for production in Tonga.
- Australian staff to monitor training and milestones.
- Technology transfer in training Tonga for commercial HTFA quarantine export operations. This should include education and training of staff in the procedures given the increased complexity of HTFA treatment.

2. Marketing

- For the domestic market, develop promotional and educational material for each Central Market, for example, product descriptions, uses, etc. including information targeted at the tourist sector in Vava'u, e.g. Tropical Tastes Tonga.
- Key growers and/or co-operative to visit Queensland markets and to learn about the supply chain.
- Market information. For the domestic market, distribution of central market prices and throughput via media i.e. radio, paper, etc.
- For the export market, develop an investment package suitable for external investors (e.g. HTFA operation).
- Investigate processing opportunities, by engaging food technology support for existing processing operations.

3. Economics

- Export opportunities. The operating costs and returns of running the currently idle HTFA plant, including costs of treating fruit should be undertaken at some point. These estimates are important should the Tongan government wish to assist by kick starting and to promote export performance.

- This can assist current and new projects to have the twin impact of reducing imports, which can be produced locally such as fruit and vegetables, and lifting Tonga's export capacity by improving the export supply-chain simultaneously.
- Domestic – development of mixed enterprise gross margins.
- Mentoring economics staff members.

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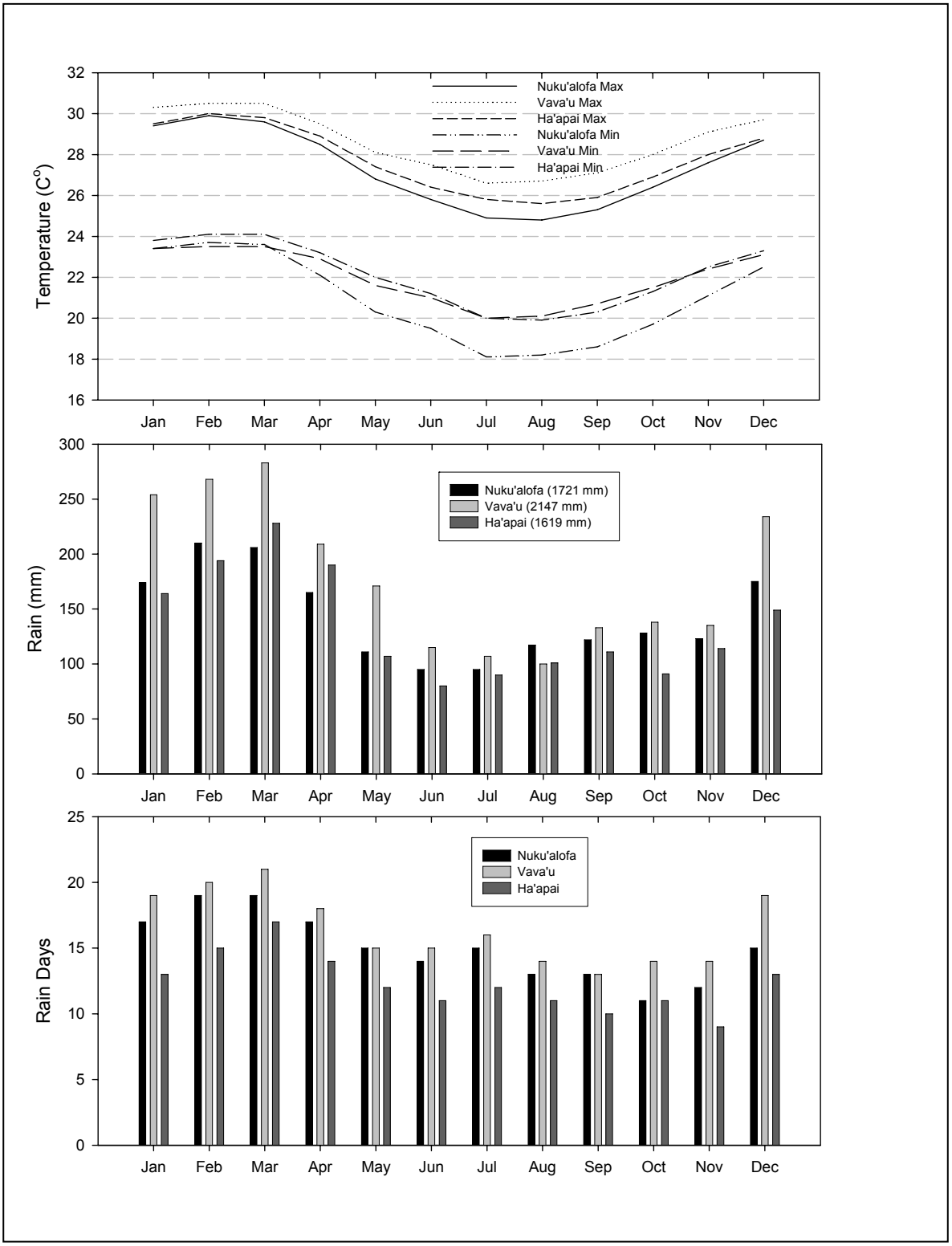
12 Appendixes

12.1 Appendix 1 Climate graphs of Tonga: mean monthly minimum and maximum temperatures, mean monthly rainfall and mean number of rain days per month for Nuku'alofa, Vava'u and Ha'apai.



12.2 Appendix 2 Tonga meteorological service: cyclone frequency report

Tonga Meteorological Service – Ministry of Civil Aviation

A report on the

LIST OF TROPICAL CYCLONES
THAT HAS AFFECTED AT LEAST A PART OF TONGA FROM 1960 TO PRESENT

No	NAME	DATE	YEAR	AREA AFFECTED	CLASSIFICATION
1.	Unnamed	17-19 Jan	1960	Northern and Central	Storm
2.	Unnamed	14-19 Mar	1961	Central and Southern	Severe Hurricane
3.	Unnamed	22-23 Nov	1964	Southern	Gale
4.	Unnamed	25-26 Feb	1969	Central and Southern	Gale
5.	Unnamed	11-17 Jan	1969	Northern and Central	Gale
6.	Dolly	11-25 Feb	1970	Northern	Hurricane
7.	Gillian	08-11 Apr	1970	Central	Hurricane
8.	Helen	13-16 Apr	1970	Northern	Storm
9.	Bebe	19-28 Oct	1972	Southern	Hurricane
10.	Collete	02-03 Nov	1972	Northern	Storm
11.	Eleanor	31-07Feb	1973	Northern	Hurricane
12.	Juliet	03-04 Apr	1973	Central	Severe Hurricane
13.	Tina	23-28 Apr	1973	Central	Storm
14.	Lottie	05-12 Dec	1974	Southern	Hurricane
15.	Val	29-05 Feb	1975	Northern	Hurricane
16.	Pat	15-18 Mar	1977	Central	Storm
17.	Anne	25-31 Dec	1977	Central	Storm
18.	Ernie	16-23 Feb	1978	Central and Southern	Storm
19.	Leslie	21-23 Feb	1979	Central	Storm
20.	Meli	24-23 Mar	1979	Northern and Southern	Hurricane
21.	Ofa	10-15 Dec	1979	Northern	Storm
22.	Tia	21-27 Mar	1980	Central	Storm
23.	Peni	01-06 Jan	1980	Southern	Storm
24.	Val	24-29 Mar	1980	Northern	Storm
25.	Betsy	30-03 Feb	1981	Central and Southern	Gale
26.	Cliff	08-15 Feb	1981	Central	Storm
27.	Daman	20-24 Feb	1981	Northern	Storm

1

12.3 Appendix 2 Tonga meteorological service: cyclone frequency report (contd.)

No	NAME	DATE	YEAR	AREA AFFECTED	CLASSIFICATION
28.	Isaac	27-05 Mar	1982	Central and Southern	Severe Hurricane
29.	Lance	03-08 Apr	1984	Northern	Storm
30.	Drena	11-14 Jan	1985	Northern	Storm
31.	Eric	14-20 Jan	1985	Central and Southern	Hurricane
32.	Keli	08-12 Feb	1986	Southern	Gale
33.	Martin	10-14 Apr	1986	Central	Storm
34.	Kerry	29-03 Apr	1989	Northern and Southern	Storm
35.	Ofa	30-10 Feb	1990	Northern	Severe Hurricane
36.	Sina	24-04 Dec	1990	Central and Southern	Hurricane
37.	Val	04-13 Dec	1991	Northern	Hurricane
38.	Joni	06-13 Dec	1992	Southern	Storm
39.	Nina	23-05 Jan	1993	Northern and Central	Hurricane
40.	Kina	26-05 Jan	1993	Southern	Hurricane
41.	Mick	05-09 Feb	1993	Central	Storm
42.	Hina	12 -21Mar	1997	Southern	Hurricane
43.	Keli	10-15 Jun	1997	Northern	Hurricane
44.	Ron	01-08 Jan	1998	Northern	Severe Hurricane
45.	Cora	23-30 Dec	1998	Central and Southern	Hurricane
46.	Mona	08-10 Mar	2000	Central and Southern	Storm
47.	Paula	26-08 Mar	2001	Central and Southern	Storm
48.	Waka	29-01 Jan	2001	Northern and Central	Severe Hurricane
49.	Yolande	03-05 Dec	2002	Central	Gale
50.	Ami	10-15 Jan	2003	Southern	Storm
51.	Cilla	27-28 Jan	2003	Central	Gale
52.	Eseta	13-14 Mar	2003	Central and Southern	Gale
53.	Fili	14-15 Apr	2003	Central	Gale
54.	Heta	05-06 Jan	2004	Northern	Severe Hurricane
55.	Lola	30-01 Feb	2005	Southern	Gale
56.	Tam	12-13 Jan	2006	Northern	Gale
57.	Urmil	14-15 Jan	2006	Northern	Gale
58.	Vaianu	11-15 Feb	2006	Southern	Gale

Northern = Niuafo'ou and Niuatoputapu, Central = Vava'u and Ha'apai, Southern = Tongatapu and Eua
Gale means average winds of 34 to 47knots; Storm means average winds of 48 to 63 knots,
Hurricane means average winds of 64 to 100 knots; Severe Hurricane means average winds of >100 knots

2

12.4 Appendix 3 Tropical fruit presentation

Tropical fruit review - Tonga

Mr. Viliami Kami and Lamipeti Havea
MAFFF
&
Yan Diczbalis, Vic O'Keefe
and Rod Strahan
Queensland Department of Primary Industries and Fisheries

Delivery ACIAR

- Adapted quote from the Pacific Gardener
  - Horticulture can make a significant contribution to community health and nutrition as well as to incomes in remote regions. However, fostering sustainable horticulture development is often difficult to achieve because of limited access to genetic material and information on production and appropriate use at both an individual, enterprise and community level.

Delivery

Tonga ACIAR Project

- Objectives
  - Overview of current industry and markets
  - Marketing and economic study of current and new tropical fruits for;
    - Domestic production (food security)
    - Import replacement
    - Export market
  - Identify risk factors, project impact, resource requirements and potential collaborators
  - Develop recommendations for further work eg.,
    - Introduction and evaluation of fruit trees
    - Production training

Delivery

Questions

- What fruits do you grow?
- Major production problems
  - Pests?
  - Diseases?
  - Input supplies?
  - Harvesting?
- Markets?
  - Packaging
  - Transport
  - Market information
- Horticulture skills
  - Propagation
  - Irrigation
  - Fertiliser management (fertigation)
- Financial aspects
- What fruits are you interested in?

Delivery

Tropical Fruit production and marketing in Queensland

Yan Diczbalis and Vic O'Keefe
Queensland Department of Primary Industries and Fisheries

Delivery

Tropical fruit production areas

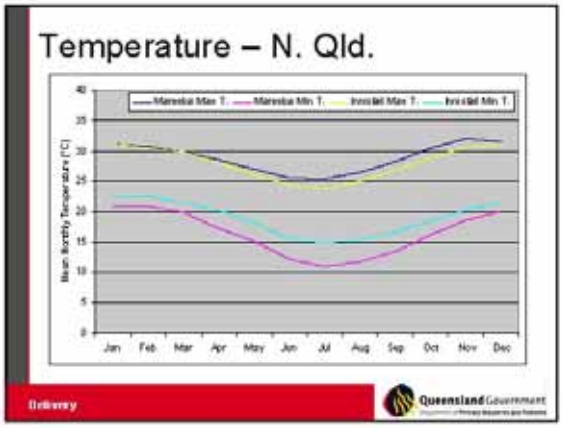
Delivery

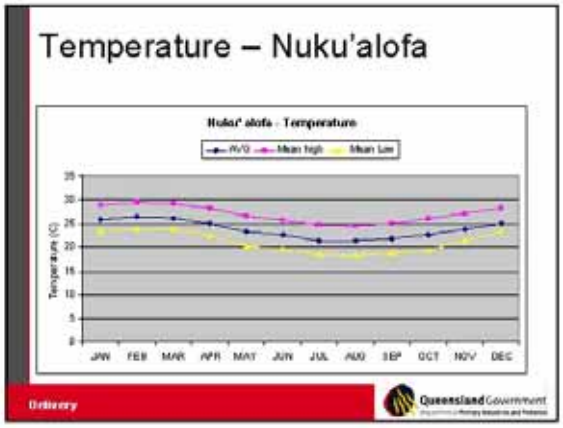

Delivery
Queensland Government


Delivery
Queensland Government


Delivery
Queensland Government


Delivery
Queensland Government


Temperature – N. Qld.
Mareeba Max T.
Mareeba Min T.
Innisfail Max T.
Innisfail Min T.
Mean Monthly Temperature (°C)
0
5
10
15
20
25
30
35
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Delivery
Queensland Government


Temperature – Nuku'alofa
Nuku' alofa - Temperature
AVG
Mean high
Mean Low
Temperature (C)
0
5
10
15
20
25
30
35
JAN
FEB
MAR
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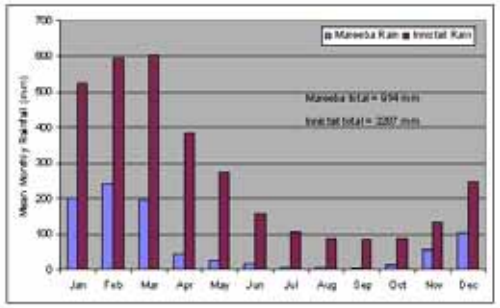
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Delivery
Queensland Government

Rainfall – N. Qld.



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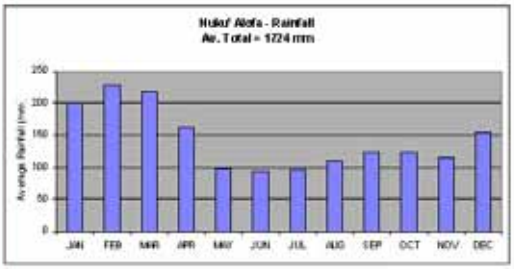
Queensland Government

Rainfall – Nuku'alofa



Delivery

Queensland Government

Fruits

- Carambola
- Citrus
- Durian
- Jakfruit
- Langsat (Duku)
- Longan
- Lychee
- Mango
- Mangosteen
- Marang (Tarap)
- Persimmon
- Pulasan
- Rambutan
- Salak
- Tarap

Delivery

Fruits

- Abiu
- Black Sapote
- Custard Apple/
- Guava
- Jaboticaba
- Mammey Sapote
- Monstera
- Papaya (Pupaw)
- Passionfruit
- Pitaya
- Pineapple
- Rollonia
- Sapodilla
- Star Apple (Cainito)
- Soursop

Delivery

Delivery

Queensland Government

Major Fruits

- Banana
- Mango
- Pineapple
- Lychee
- Papaya (Papaw)

Delivery

Queensland Government

Banana Research

- Nutrition and irrigation management
- Pest and disease management
  - Yellow Sigatoka
  - Nematodes
  - Bunch pests
- Soil Health
- Crop forecasting
- Varieties

Delivery

Banana varieties

- Cavindish represents 95% of production
- Other commercial varieties
  - Lady Finger
  - Ducasse
  - Red Dacca
  - Sucrier
  - Plantains
- Interest in promoting use of high Vitamin A varieties (Red Dacca or Sucrier)

Delivery

Mango

Industry based on Australian seedling selection;

- Kensington Pride (Bowen) 80% of trees and 90% of production

Other cultivars include;

- R2E2, Honey Gold, B74
- Keitt, Palmer
- Nam Doc Mai, Khiew Sawoey, Chok Anan

Delivery

Mango Production (tonnes)

Region	2002/2003
Queensland	32937
Northern Territory	12600
Western Australia	3094
Total Fresh	48631
Processing	13544
TOTAL	62175

Value $120M

Delivery

DPI's Prime Research Activity - Breeding

Delivery

Queensland Government

Pineapple

- QLD
  - 5,000 ha
  - 128,000 tonnes
  - $36M

Delivery

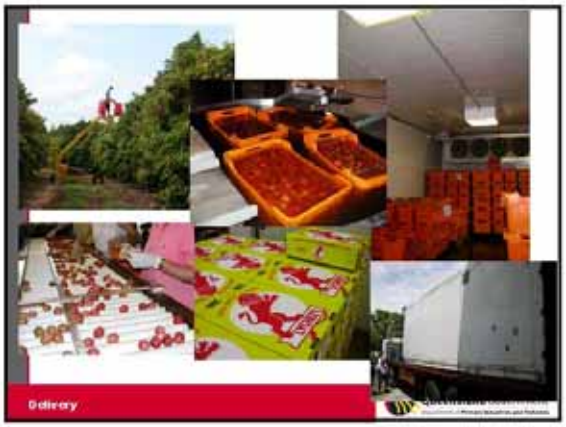
Queensland Government

Lychee

- Industry spread from north Queensland to northern NSW
- 3,500 to 4,000 tonnes
- Values at $18-20M

Delivery

Queensland Government



Delivery

Papaya (Papaw)

- 400 hectares
- valued at $18 million

Delivery

Queensland Government

Papaya Research

- Nutrition and irrigation management
- Papaya breeding
- Pest and disease management
- Propagation

Delivery

Minor Tropical Fruits

- **Commercial**
  - **Rambutan** - *Nephelium lappaceum*
  - **Longan** - *Dimocarpus longan*
  - **Mangosteen** - *Garcinia mangostana*
  - **Durian** - *Durio zibethinus*

Delivery

Longan industry profile

- 75,000 trees; $10M Industry spread along the east coast of Australia
  - Major production area on the Tablelands
  - 1000 – 2000 tonnes/annum
  - Domestic market supply
  - Cultivars; Kohala, Homestead, Biew Kew, Chompoo

Delivery

Delivery

Rambutan industry profile

- 30,000 trees $4.3M. Main industry located in far north Queensland (300-600 tonnes/annum)
  - Smaller (50-100 tonnes/annum) but lucrative industry based in Darwin (Northern Territory)
  - Primarily domestic market supply
  - Active efforts to develop export markets
  - Main cultivars; R9, R134, R156-red, R162, R167, Binjai, Jitlee, Rongrien

Delivery

Delivery

Issues - rambutan and longan

- bird and bat problems
- canopy management
- IPM of pests and diseases
- Marketing groups
  - Domestic market profile
  - fruit quality standards
  - new market opportunities
  - packaging

Delivery

Durian industry profile

- 13,000 trees, from Cooktown to Tully (≈35 t/annum)
  - Smaller industry in NT
  - Domestic market
  - Cultivars, Monthong, Kan Yao, Luang, Hepe, D. macrantha, D175 (red prawn)
  - Major issues
    - tree die back
    - Imports

Delivery

P. palmivora diseases of durian

Delivery

Mangosteen

- 14,000 trees, Cooktown to Tully valued at $0.75M
  - Smaller industry in NT
- Issues
  - Long juvenile period
  - Crop management
  - Detecting internal disorders
  - Thai imports recently approved by BioSecurity Australia

Delivery

Delivery

Tropical Citrus

Delivery

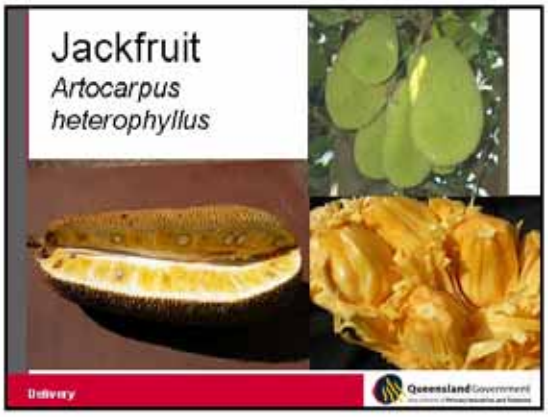

VITO'S EXOTIC FRUITS
Delivery
Queensland Government


Minor Tropical Fruits
• With excellent tourist market potential
Delivery
Queensland Government


Abiu – Pouteria caimito
Delivery
Queensland Government


Carambola
Averrhoa carambola
Delivery
Queensland Government


Guava – Psidium guajava
Delivery
Queensland Government


Jackfruit
Artocarpus heterophyllus
Delivery
Queensland Government

Marketing Section

- Document existing Supply Chain for Tongan horticulture products.
- Domestic and Export
- Eg complex export supply chain
  - Grower > Packer / Consolidator > Exporter > Importer > Wholesaler > Retailer > Consumer
- Australia domestic focus (90-95%) – competition
- Increase domestic consumption.
- Go for 2&5 campaign.

Delivery
Queensland Government


Questions
• What fruits do you grow?
• Major production problems
– Pests?
– Diseases?
– Climate?
– Input supplies?
• Markets?
– Packaging
– Transport
– Market information
• Horticulture skills
– Propagation
– Irrigation
– Fertiliser management (fertigation)
• Financial aspects
• What fruits are you interested in?
Delivery
Queensland Government

12.5 Appendix 4 Tropical fruit and nut species with a common and Tongan name

TONGAN NAME	COMMON NAME	SCIENTIFIC NAME	Sited in Tonga
Tuitui	Candlenut	*Aleurites moluccana*	Yes, Ene'io Bot. Gardens (2 var)
Telie pælangi	Cashewnut	*Anacardium occidentale*	Yes, Ene'io Bot. Gardens
Fainaa	Pineapple (all varieties)	*Ananas comosus*	Yes, Ene'io Bot. Gardens (3 var)
ˇApele tonga	Custard apple (rough skin)	*Annona cherimolia*	Yes
ˇApele ˇinitia	Soursop	*Annona muricata*	Yes (common); Ene'io Bot. Gardens
ˇApele mafu	Bullock's heart (reddish smooth skin)	*Annona reticulata*	Yes, Ene'io Bot. Gardens
ˇApele tonga	Sugar apple (smooth skin)	*Annona squamosa*	Ene'io Bot. Gardens
Mei	Breadfruit	*Artocarpus altilis*	Yes, Ene'io Bot. Gardens (5 var)
Vahivahi	Breadfruit var. vahivahi	*Artocarpus altilis*	Yes
Kea kulufau - Mei	Breadfruit var. kea kulufau	*Artocarpus altilis* var. kea kulufau	Yes
Kea maˇamaˇa - Mei	Breadfruit var. kea maˇamaˇa	*Artocarpus altilis* var. kea ma'ama'a	Yes
Mei ˇinitia	Jackfruit	*Artocarpus heterophyllus*	Yes, Vani Research Stn.
Tapanima	Carambola	*Averrhoa carambola*	Yes, Vani Research Stn., Ene'io Bot. Gardens (2 vra)
'Ai	ˇAi	*Canarium harveyi*	Ene'io Gardens
Makai	Makai	*Canarium samoense*	Not seen
Lesi	Pawpaw (all varieties) / papaya	*Carica papaya*	Yes (common), Ene'io Bot. Gardens (5 var)
	White sapote	*Casimora edulis*	Yes
ˇApele fetuˇu	Star apple	*Chrysophyllum cainito*	Yes, Vani Research Stn.
Sinamoni	Cinnamon	*Cinnamomum zeylanicum*	Not seen
Meleni	Water Melon	*Citrullus vulgaris*	Yes
Laimi	?	*Citrus aurantifolia*	Ene'io Bot. Gardens (2 var)
Kola	Sour Orange	*Citrus aurantium*	Ene'io Bot. Gardens
Pomelo	Pommelo / Pummelo	*Citrus grandis syn C. maxima**	Yes, Ha'apai; Ene'io Bot. Gardens
L˚mani kili petepete	Rough skin lemon	*Citrus jambhiri*	Not seen
L˚mani kili molemole	Smooth skin lemon	*Citrus limon*	Ene'io Bot. Gardens (4 var)
Moli tonga (Moli uku)	Pummelo	*Citrus maxima* (see *C. grandis* above)*	Ene'io Bot. Gardens (3 var); Ha'apai
Moli kælepi	Grapefruit	*Citrus paradise* (or *Citrus grandis*)	
Molipeli	Mandarin	*Citrus reticulata*	Ene'io Bot. Gardens

TONGAN NAME	COMMON NAME	SCIENTIFIC NAME	Sited in Tonga
Moli foiiki	Moli foiiki	*Citrus reticulata* var. molifoiiki	Not seen or identified
Molimahi	Sour mandarin	*Citrus reticulata* var. molimahi	Not seen or identified
Moli vaikeli	Tangelo	*Citrus reticulata* var. Paradisi x reticulata	Not seen or identified
Moli kai	Sweet Orange	*Citrus sinensis*	Ene'io Bot. Gardens (2 var)
Situlumelo	Citrumello	*Citrus volkameriana*	Not seen or identified
	Wampi	*Clausena lansium*	Yes (Vani research stn)
Niu	Coconut	*Cocos nucifera*	Yes (common), Ene'io Bot. Gardens (10 var)
Kofi	Kofi	*Coffea arabica*	Not seen
	Longan	*Dimocarpus longa*	Yes (Vani research stn; Ha'apai backyard) Ene'io Bot. Gardens
Pesimoni	Black sapote	*Diospyros digyna*	Yes (Vani research stn)
Tulieni	Durian	*Durio zibethinus*	Not seen
Lœketi	Loquat	*Eriobotrya japonica*	Not seen
Polokænite	Surinum cherry	*Eugenia uniflora*	Not seen
Kuava	Pineapple guava	*Feigoa sellowiana*	Not seen
Fiki kai	Edible fig	*Ficus carica*	Not seen
Kamikuati	Kumquat	*Fortunella margarita*	Not seen
Situloapeli	Strawberry	*Fragaria vesca*	Not seen
Fetoˇomaka	Fetoˇomaka	*Garcinia myrtifolia*	Not seen
Moˇonia	Mo'onia	*Garcinia pseudoguttifera*	Not seen
Ifi	Tahitian chestnut	*Inocarpus edulis or Inocarpus fagifer*	Yes (common), Ene'io Bot. Gardens (4 var)
Tava pælangi	Lychee	*Litchi chinensis*	Yes (Ene'io Bot. Gardens) reports of fruiting tree in Nuku'alofa
Nati	Macademia nut	*Macademia integrifolia*	Yes (Ha'apai backyard), Ene'io Bot. Gardens
Nati	Macademia nut	*Macademia tetraphylla* (pink/purple flowers)	Not seen
ˇAselola	Acerola	*Malpighia urens (glabra)*	Yes (Ene'io Bot. Gardens)
ˇApele pælangi	Apple	*Malus domestica*	Not seen, Unlikely crop
Mango	Mango (all varieties)	*Mangifera indica*	Yes (common; Vani research stn; Ene'io Bot. Gardens (11 var)
Kuinisi	Quince	*Mangifera odorata*	Not seen
Sapotila	Sapodilla	*Manilkara zapota*	Yes, Ene'io Bot. Gardens
Monesitela	Monstera	*Monstera deliciosa*	Ene'io Bot. Gardens

TONGAN NAME	COMMON NAME	SCIENTIFIC NAME	Sited in Tonga
Nonu	Noni (Indian Mulberry)	*Morinda citrifolia*	Ene'io Bot. Gardens (2 var)
Fuamelie	Black mulberry	*Morus alba*	Not seen; Unlikely crop
Fuamelie	Red mulberry	*Morus rubra*	Not seen, Unlikely crop
Feta˘ukula	Banana var. feta˘ukula	*Musa paradisiaca*	Banana in particular plantain types are commonly available.
Fetau˘lu˘ikuma	Banana var. fetau˘lu˘ikuma	*Musa paradisiaca*	"
Hopa	Plantain	*Musa paradisiaca*	Ene'io Bot. Gardens (5 var)
Mahimahi	Mahimahi	*Musa paradisiaca*	Banana in particular plantain types are commonly available.
Mamae	Mamae	*Musa paradisiaca*	"
Pata	Cooking banana	*Musa paradisiaca*	"
Pata lahelahe	Cooking banana var. lahelahe	*Musa paradisiaca*	"
Pata tonga	Cooking banana var. tonga	*Musa paradisiaca*	"
Pikipiki hina	Banana var. pikipiki hina	*Musa paradisiaca*	"
Putalinga kula	Banana var.putalinga kula	*Musa paradisiaca*	"
Putalinga puka	Banana var.putalinga puka	*Musa paradisiaca*	"
Tateau	Banana var.tateau	*Musa paradisiaca*	"
Tokoni vai	Banana var. tokoni vai	*Musa paradisiaca*	"
Tu˘utu˘ukautala	Banana var. Tu˘utu˘ukautala	*Musa paradisiaca*	"
Uhotaha	Banana var. uhotaha	*Musa paradisiaca*	"
Vaivai hako	Banana var. vaivai hako	*Musa paradisiaca*	"
Vaivai puki	Banana var. vaivai puki	*Musa paradisiaca*	"
Siaine	Banana	*Musa sapentium*	"
Misipeka	Lady Finger	*Musa* spp.	"
Natimeki	Nutmeg	*Myristica fragrans*	Not seen
Kotone	Kotone	*Myristica hypargyraea*	Not seen
Tava fulufulua (Lamuputeni)	Rambutan	*Nephelium lappaceum*	Not seen; Ene'io Bot. Gardens
˘Olive (ngaahi kai)	Olive (edible)	*Olea europaea*	Not seen, Unlikely crop
Vaine pælangi	Vaine pælangi	*Passiflora edulis*	Not seen but recorded at growers meetings
Vaine mol˝	Yellow passionfruit – soft skin	*Passiflora edulis f. flavicarpa*	Not seen but recorded at growers meetings
Vaine-˘ae-kumæ	Vaine-˘ae-kumæ	*Passiflora foetida*	Not seen

TONGAN NAME	COMMON NAME	SCIENTIFIC NAME	Sited in Tonga
Vaine fefeka	Hard passionfruit	*Passiflora ligularis*	Not seen
Pæsione	Giant granadilla	*Passiflora quadrangularis*	Ene'io Bot. Gardens (3 var)
ˇAvoka	Avocado	*Persea americana*	Yes (Vani); Ene'io Botanic Gardens
Polokænite	Otaheite Gooseberry	*Phyllanthus acidus*	Not seen
Pepa	Pepper	*Piper nigrum*	Not seen
Tangato	Burdekin Plum	*Pleiogynium timorense*	Ene'io Bot. Gardens
Tava	Pacific lychee	*Pometia pinnata*	Yes (common), Ene'io Bot. Gardens (2 var)
Apiu	Abiu	*Pouteria caimito*	Ene'io Botanic Gardens
	Canistel	*Pouteria campechiana*	Yes (Vani research Stn)
	Mamey Sapote	*Pouteria sapota*	Yes (Vani research Stn), Ene'io Bot. gardens
Sapote?	Green Sapote	*Pouteria viride*	Ene'io Bot. Gardens
Nekitalini	Nectarine	*Prunus persica*	Not seen, Unlikely crop
Piisi	Peach	*Prunus persica*	Not seen, Unlikely crop
Kuava	Strawberry guava	*Psidium cattleianum*	Not seen
Kuava	Guava	*Psidium guajava*	Yes, Ene'io Bot. Gardens (3 var.)
Kuava guava	Yellow strawberry guava	*Psidium llitorale*	Not seen
Vi	Polynesian plum	*Spondias dulcis*	Yes, Ene'io Bot. Gardens
	Kepel	*Stelechocarpus burahol*	Yes (Vani Research Stn.)
H˚hea	H˚hea	*Syzygium corynocarpus*	Ene'io Bot. Gardens
Fekika vao	Fekika vao	*Syzygium dealatum*	Not seen or identified
Fekika pælangi	Rose apple	*Syzygium jambos*	Not seen or identified
Fekika kai	Malay apple	*Syzygium malaccense*	Yes (Ha'apai back yard), Ene'io Bot. Gardens (2 var)
Heavula	Heavula	*Syzygium richii*	Not seen or identified
Koli	Koli	*Syzygiunm neurocalyx*	Not seen or identified
Tamaline	Tamarind	*Tamarindus indica*	Yes (Vani research stn; Ene'io Bot. Gardens)
Telie	Tropical almond	*Terminalia catappa*	Ene'io Bot. Gardens (3 var)
Koko	Cocoa	*Theobroma cacao*	Not seen
Kælepi	Grapes	*Vitis vinifera*	Not seen, Unlikely crop

* *Citrus grandis* and *C. maxima* are both synonyms for Pommelo. Scora and Nicolson (1986) argue that although *C. grandis* is more prevalent in the literature, *C. maxima* is the correct scientific name under the International Code of Botanical Nomenclature.

12.6 Appendix 5 Gross margins analysis per acre

Gross Margin Budget of Banana (Ripe)

	1	acre

1.0 Production Parameters

	No.of unit	Unit		No.of unit	Unit		No.of unit
Plant spacing							
Between row	3.4	*m*	**Avg Price**			Rate ineffective area	7%
Between plant	2.7	*m*	Banana	0.57	*T$/kg*	Area of an acre	4047
Plant density	409	*pl*	Suckers	0.10	*T$/sucker*	Other loss	20%
Crop Duration	60	*mths*	Avg weight	11	*kg/bunch*		
Yield	3601	*kgs*	ıpport stakes	0.20	*T$/prop*		

2.0 Gross Income

		Stages of growth (mths)					
		Banana Crop	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
		1-12	13-21	22-30	31-39	40-48	49-57
Yield	*(in kg)*	8,500	8,000	7,500	7,000	6,500	6,000
Price	*(T$)*	0.57	0.57	0.57	0.57	0.57	0.57
Total Gross Income		**4,845**	**4,560**	**4,275**	**3,990**	**3,705**	**3,420**

3.0 Establishment Costs

						Stages of growth (mths)	
		Banana crop	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
Descriptions		1-12	13-21	22-30	31-39	40-48	49-57
Land Preparation							
Ploughing/Slashing		120.00					
Disc harrowing		40.00					
Planting Material							
600 suckers		66.00					
NPK 6:15:6		135.00	67.50	67.50	67.50	67.50	67.50
Urea		125.00	62.50	62.50	62.50		
Propping sticks		28.00	28.00	28.00	28.00	28.00	28.00
Mutriate of Potash			30.00				
Marketing cost		248.50	236.00	223.50	211.00	198.50	186.00
Total Variable Costs		762.50	424.00	381.50	369.00	294.00	281.50
4.0 Gross Margin		**4,082.50**	**4,136.00**	**3,893.50**	**3,621.00**	**3,411.00**	**3,138.50**
Return to Variable Cost		5.35	9.75	10.21	9.81	11.60	11.15

5.0 GM Returns to Labour

		Stages of growth (mths)					
		Banana crop	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
		1-12	13-21	22-30	31-39	40-48	49-57
Labour Inputs							
Prepare Planting Materials		40	0	0			
Planting/Replanting		70	0	0			
Fert. Application		15	10	5	5	5	5
Weeding		40	40	40	30	30	30
Propping		20	20	20	20	20	20
Harvesting		100	100	90	80	75	70
Total Labour Requirements		285	170	155	135	130	125
GM per hour of labour		11.32	21.33	22.12	23.82	23.24	22.11
Total labour cost		855.00	510.00	465.00	405.00	390.00	375.00
Margin after labour cost		**3,227.50**	**3,626.00**	**3,428.50**	**3,216.00**	**3,021.00**	**2,763.50**
Average margin after labour costs		3,213.75					

Gross Margin Budget of Plantain

1 acre

1.0 Production Parameters

	No.of unit	Unit		No.of unit	Unit		No.of unit	Unit
Plant spacing								
Between row	3.4	*m*	**Avg Price**			Rate ineffectiv	7%	
Between plant	2.7	*m*	Plantain	0.62	*T$/kg*	Area of an acr	4047	sq.m
Plant density	409	*pl*	Suckers	0.10	*T$/sucker*	Other loss	20%	
Crop Duration	60	*mths*	Avg weight	11	*kg/bunch*			
Yield	3601	*kgs*	Support stak	0.20	*T$/prop*			

2.0 Gross Income

		Stages of growth (mths)					
		Plantain Crop	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
		1-12	13-21	22-30	31-39	40-48	49-57
Yield	*(in kg)*	3,601	3,421	3,061	2,881	2,701	2,521
Price	*(T$)*	0.00	0.62	0.62	0.62	0.62	0.62
Total Gross Income		**0**	**2,121**	**1,898**	**1,786**	**1,674**	**1,563**

3.0 Establishment Costs

	Stages of growth (mths)					
	Plantain crop	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
Descriptions	1-12	13-21	22-30	31-39	40-48	49-57
Land Preparation						
Ploughing/Slashing	40.25					
Disc harrowing	40.25					
Planting Material						
600 suckers	409.21					
Propping sticks	28.00	28.00	28.00	28.00	28.00	28.00
Marketing cost	167.64	160.26	145.50	138.11	130.73	123.35
Total Variable Costs	685.35	188.26	173.50	166.11	158.73	151.35
4.0 Gross Margin	-685.35	1,932.75	1,724.25	1,620.00	1,515.75	1,411.50

5.0 GM Returns to Labour

	Stages of growth (mths)					
	Plantain crop	1st ratoon	2nd ratoon	3rd ratoon	4th ratoon	5th ratoon
	1-12	13-21	22-30	31-39	40-48	49-57
Labour Inputs						
Prepare Planting Materials	3	0	0			
Planting/Replanting	3	0	0			
Fert. Application	1	1	1	1	1	1
Weeding	3	3	3	3	3	3
Propping	2	2	2	2	2	2
Harvesting	2	2	2	2	2	2
Total Labour Requirements (hrs)	14	7	7	7	7	7
GM per hour of labour	-54.23	255.59	227.37	213.26	199.15	185.04
Total labour cost	85.25	44.33	44.33	44.33	44.33	44.33
Margin after labour cost	**-770.60**	**1,888.42**	**1,679.92**	**1,575.67**	**1,471.42**	**1,367.17**
Average margin after labour costs	1,202.00					

Gross Margin Budget of Papaya

			1		acre
1.0 Production Parameters					
	No.of unit	**Unit**		**No.of unit**	**Unit**
Plant spacing					
Plant spacing	3 x 2.1	*m*	**Avg Price**		
Plant density	600	*pl*	Papaya	**0.53**	*T$/kg*
Crop Duration	60	*mths*			
Yield	15 - 28	*t / acre*			
2.0 Gross Income					
			Stages of growth (mths)		
			Year 1	Year 2	Year 3
Yield	*(in kg)*		2,220	27,750	20,812
Price	*(T$)*		0.53	0.53	0.53
Total Gross Income			**1,177**	**14,708**	**11,030**
3.0 Establishment Costs					
			Stages of growth (mths)		
			Year 1	Year 2	Year 3
Descriptions			1-12	13-24	25-36
Land Preparation					
Ploughing/Slashing			120.00		
Disc harrowing			40.00		
Planting Material			120.00		
Thrive			52.50	52.50	52.50
NPK 6:15:6			101.25	33.75	33.75
Gramoxone			180.00	180.00	180.00
Manzate 200			52.00	52.00	52.00
Cusol			36.00	36.00	36.00
Punch			110.00		
Mistblower Operation			45.00	45.00	45.00
Marketing cost			91.50	573.50	559.75
Total Variable Costs			**948.25**	**972.75**	**959.00**
4.0 Gross Margin			**228.35**	**13,734.75**	**10,071.36**
5.0 GM Returns to Labour					
			Stages of growth (mths)		
			Banana crop	1st ratoon	2nd ratoon
			1-12	13-21	22-30
Labour Inputs					
Planting/Replanting			80	0	0
Fert. Application			30	20	20
Spraying			36	36	36
Weeding			40	40	30
Pruning / Thinning			2	4	4
Harvesting			25	400	300
Total Labour Requirements			213	500	390
GM per hour of labour			-1.93	24.47	22.82
Total labour cost			639.00	1,500.00	1,170.00
Margin after labour cost			**-410.65**	**12,234.75**	**8,901.36**
Average margin after labour costs			3,454.24		

Gross Margin Budget of Mango

1.0 Production Parameters

		1 acre					
Plant spacing	Size Unit	Plant den	24	*pl/ac*	**Avg. price**		
Between row	18.3 *m*	Other Los	20%		- fruit	1.96	T$
Between row	9.1 *m*	Avg yield/	1000	*fruit*	-pl/mater	1.00	T$
Economic Life	70 *yrs*	Avg. weig	0.44	*kg*			
Avg Mktable Yield	8,470 *kg*	Planting t	*All*	*year round*			

2.0 Gross Income

Years	1	2	3	4	5	6	7	8 +
Yield (kg\ac)	0	0	0	0	424	847	1,271	1,694
Price ($/kg)	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
Gross Income	0	0	0	0	830	1,660	2,490	3,320

3.0 Establishment Costs

	Qtn	
Clear land (hr)	16	96.00
Digging holes (number)	24	290.41
Cuttings (T$)	1.00	31.46
Total Establishment Costs		**417.87**

5.0 Labour Input

Economic Life *(in years)*	1	2	3	4	5	6	7	8 +
Tasks *(in hours)*								
Slashing	0	48	48	48	48	48	48	48
Planting	2	1						
Prunning	0	0	0	8	8	8	8	8
Picking fruits	0	0	0	0	8	8	8	8
Selling	0	0	0	0	8	8	8	8
Total labour requirement	2	49	48	56	72	72	72	72
Total labour cost	12	294	288	336	432	432	432	432
Margin after labour costs	**-430**	**-294**	**-288**	**-336**	**398**	**1,228**	**2,058**	**2,888**
Margin per tree after labour costs	-17.76	-12.15	-11.90	-13.88	16.45	50.75	85.05	119.35

Gross Margin Budget of Lemon / Lime

1.0 Production Parameters

Plant spacing	Size Unit	Plant density	24	*pl/ac*	Avg. price		
Between row	18.3 *m*	Other Loss	20%		- fruit	1.93	T$
Between row	9.1 *m*	Avg yield/pla	400	*fruit*	-pl/material	1.00	T$
Economic Life	30 *yrs*	Avg. weight/f	0.14	*kg*			
Avg Mktable Yield	1,065 *kg*	Planting time	*All*	*year round*			

2.0 Gross Income

Years	1	2	3	4	5	6	7 +
Yield (kg\ac)	0	0	0	266	532	799	1,065
Price ($/kg)	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Gross Income	0	0	0	513.38	1,026.76	1,542.07	2,055.45

3.0 Establishment Costs	Qtn	0
Clear land (hr)	16	96.00
Digging holes (number)	24	290.41
Cuttings (T$)	1.00	31.46
Total Establishment Costs		**417.87**

5.0 Labour Input

	1	2	3	4	5	6	7 +
Tasks *(in hours)*							
Slashing	0	8	8	8	8	8	8
Planting	2	1					
Prunning	0	0	0	8	8	8	8
Picking fruits	0	0	0	8	12	16	20
Selling	0	0	0	8	8	10	10
Total labour requirement	2	9	8	32	36	42	46
Total labour cost	12	54	48	192	216	252	276
Margin after labour costs	**-420**	**-54**	**-48**	**321**	**811**	**1,290**	**1,779**
Margin per tree after labour costs	-17.35	-2.23	-1.98	13.28	33.50	53.31	73.53

Gross Margin Budget of Orange

1.0 Production Parameters

Plant spacing	Size Unit	Plant density	24 *pl/ac*	Avg. price			
Between row	18.3 *m*	Other Loss	20%	- fruit	1.96 T$		
Between row	9.1 *m*	Avg yield/plant	400 *fruit*	-pl/material	1.00 T$		
Economic Life	30 *yrs*	Avg. weight/fru	0.14 *kg*				
Avg Mktable Yield	1,065 *kg*	Planting time	*All year round*				

2.0 Gross Income

Years	1	2	3	4	5	6	7	8 +
Yield (kg\ac)	0	0	0	0	266	532	799	1,065
Price ($/kg)	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
Gross Income	0	0	0	0	521.76	1,044	1,565	2,087

3.0 Establishment Costs	Qtn	0
Clear land (hr)	16	96.00
Digging holes (number)	24	290.41
Cuttings (T$)	1.00	31.46
Total Establishment Costs		**417.87**

5.0 Labour Input

Economic Life *(in years)*	1	2	3	4	5	6	7	8 +
Tasks *(in hours)*								
Slashing	0	8	8	8	8	8	8	8
Planting	2	1						
Prunning	0	0	0	0	8	8	8	8
Picking fruits	0	0	0	0	8	12	16	20
Selling	0	0	0	0	8	8	10	10
Total labour requirement	2	9	8	8	32	36	42	46
Total labour cost	12	54	48	48	192	216	252	276
Margin after labour costs	**-430**	**-54**	**-48**	**-48**	**330**	**828**	**1,313**	**1,811**
Margin per tree after labour costs	-17.76	-2.23	-1.98	-1.98	13.63	34.19	54.27	74.84

12.7 Appendix 6 Contacts

Tongan Government

Name	Position	Contact Details
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Tongan Private Industry

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Mr Haniteli 'O. Fa'anunu	Managing Director "Ene" I O Enterprises Co. Ltd.	PO Box 3 Tu'anekivale Neifu, Vav'u Kingdom of Tonga Phone: (676) 71048 Mobile: 56 169 or 15 350 Email: eneiobg@hotmail.com
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New Zealand Government		
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12.8 Appendix 7 Summary of individual meetings

1. Chief Executive Officer of MAFFF

A meeting was held with Mr Penisimani Vea, CEO of MAFFF to discuss the project and to seek the CEO's inputs.

Points of interest included;

- MAFFF has a strong interest in the development of a tree fruit project.
- Aim primarily to ensure local food security and diversity.
- The health benefits of fruit consumption are of primary interest to Tonga.
- MAFFF is interested in obtaining capacity building and training opportunities for staff with specific reference to fruit tree propagation, orchard management and post harvest care.
- The CEO referred to an import of Mango (cv. Kensington Pride) by a resort owner on Vava'u.
- Propagation facilities are available at the Forestry nurseries on Tongatapu and Ha'apai.
- There is a current Youth Development Program being run in association with the Vava'u training nursery.
- There is a strong MAFFF interest in investigating the feasibility of fruit processing facilities.
- Potential development of limes, oranges, mango, avocado, breadfruit and banana.
- There is the need to determine agronomic characteristics of imported varieties.
- Establish costs associated with producing locally versus imported product; cost must be comparable. Origin of produce has little bearing on purchasing pattern of Tongans. Price is the major factor.

2. MAFFF Quarantine (Silitoni Tupou and Sione Foliaki)

- Discussion on plant quarantine issues with particular reference to plant imports.
- Currently, there are no prescribed quarantine arrangements for imports of plant cuttings, seedlings or grafted trees.
- Quarantine management would welcome and appreciate a list of any intended imports so that they can review any quarantine measures that may have to be put in place.
- There are limited (secure quarantine shade/glasshouse) quarantine facilities and quarantine staff are keen to have such facilities in place.
- Fruit tree imports, e.g. mango have occurred recently without any quarantine period required. Plants were inspected on import for pest and disease.
- Discussions regarding HTFT facilities and arrangements made for an inspection.

3. Vani Research station

- Inspected the fruit tree collection. The collection was overgrown with grass and weeds, and sections were used for grazing cattle. Approximately half of the collection was established on land that has since been resumed by a Noble member of the Tongan Royal family. Access to the plant material may be unavailable.
- A request was made for a map of the collection and its history.
- A list of trees identified at the Vani Research Station is documented in Appendix 3.

4. Ene'io Botanical Gardens, a private enterprise. A meeting with the owner/operator, Mr Haniteli Fa'anunu (past CEO of MAFFF)

- 22 acres established with 520 plant species.
- A list of tropical fruit and nut species in the Ene'io collection was provided and incorporated into Appendix 3.
- Mr. Haniteli reported that the Vani Research Station collection commenced in the 1980's.
- Grant Vinning of Asian Market Research conducted a study of the export potential for fruit to Japan and the USA.
- Informed that avocado exports to NZ were approved at a higher temperature protocol. This would need to be verified.
- *Citrus tristeza* virus was a problem on lime and sweet orange plantings. Tristeza represents one of the biggest threats to citrus production around the world.
- Solo papaya has good potential.
- Strong winds can be a problem.
- Breadfruit has good market prospects in New Zealand.
- Good prospects for processed product e.g. taro chips or frozen fruit product. Mr Alan Bowe, a resort owner was interested in developing a fruit drying facility.
- Groundwater studies suggested that there was insufficient water for commercial irrigation.
- Dry conditions in Vava'u could extend for three months.
- Mr Haniteli would like to promote greater use of dwarf coconuts and believed the islands' coconut plantings would need replacing systematically.
- Lychee has been reported to fruit in Nuku'alofa.
- Ene'io would be prepared to run propagation courses of fruit trees.

5. Vava'u Tonga Visitors Bureau, with Mr Bruno Toke
6. A young producer from Vava'u, Mr Kali

- Owns four acres of land and is using approximately two acres.
- Growing cassava, taro (*Colocasia* and *Alocasia* spp), yam, pineapple, papaya and breadfruit.
- The income from his plot is a second income as Mr Kali is a tradesman with the local phone company.
- A lot of the production exchanged with family members for other crops and services.

7. Vava'u Vanilla Producers

- The producers own eight acres of land and lease an additional four acres.
- Growing kava, vanilla, cassava, taro (*Colocasia* and *Alocasia* spp), yam, pineapple, papaya, breadfruit and banana.
- The vanilla crop was poorly maintained, as current prices were low.
- Good returns were achieved for pineapples, these were exported to the main island of Tongatapu; income was approximately T$10 000 per annum
  - 12 containers @ T$80/each for transport/lease cost
  - Out of season pineapples in Nuku'alofa sell for T$6 each
  - 130 pineapples per container, T$800-900 per container.

- No external inputs, fertiliser or herbicide used in production.
- Use whipper snipper for grass control.
- The major costs are fuel and transport.

8. Officer in Charge Ha'apai, MAFFF economist, Mr Manuelle Moale

- Container freight costs T$3800- T$4000 per 20ft container.
- Lack of equipment to move containers for loading the barge.
- Three tourist resorts in Ha'apai that could be potential purchasers of locally produced fruit and vegetables.
- Shortage of vegetables, leafy salads, etc. but no one yet targeting the demand.

9. Friendly Islands Marketing Co-operative (FIMCO), Mr David

10. MAFFF High Temperature Forced Air Plant, with Quarantine staff

- The HTFA plant based at Fua'amotu airport was currently not operational.
- In 1998, 7.5 tonnes of papaya (value of NZ $47 000) were exported to New Zealand, using the forced hot air treatment.
- The Tonga HTFA facility was accredited by NZMAF in October 2004 for export of breadfruit, chilli, eggplant, mango, papaya, tomato and avocado under a Bilateral Quarantine Agreement (BQA) with NZ.
- Exports were only active when MAFFF coordinated the fruit and export.
- The HTFA facility had been un-staffed for the past year as the only skilled operator was on long service leave.
- Ideally, industry or an industry appointed coordinator would need to develop a cooperative of grower suppliers to ensure the supply of product to the HTFA facility on an ongoing basis.
- MAFFF imposed a 50c/kg charge for treatment at the facility.
- The facility would need re-accreditation prior to reinstatement.

11. Ministry of Agriculture and Forestry, New Zealand (MAF, NZ)

- Inspectors highlighted a range of problems with incoming product from Tonga
  - Product arrived without the correct paper work.
  - Product poorly packaged.
  - Product dirty and or did not meet product specifications and protocols.

12. New Zealand importers (wholesalers)

- Two importers were interviewed and both importers raised several issues in regard to Tongan product
  - Lack of consistency in product and supply.
  - Packaging is a problem.
  - Product is unreliable.
  - Tongan product is no more competitive than product from other Pacific Island countries.