



Pacific Island Breadfruit Market and Marketing Study with a focus on FIJI and SAMOA

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Acronym List

ACIAR	Australian Centre for International Agricultural Research
AMA	Agromarketing Authority of Fiji
BAF	Biosecurity Authority of Fiji
BQA	Bilateral Quarantine Agreement
CTA	Technical Centre for Agricultural and Rural Cooperation ACP-EU
FAO	Food and Agricultural Organization for the United Nations
FBS	Fiji Bureau of Statistics
FJD	Fiji Dollar
FODMAP	Fermentable Oligosaccharides
FOB	Free on Board
GI	Glycaemic Index
GOS	Galacto- Oligosaccharides
HBK	Hot Bread Kitchen
HTFA	High Temperature Forced Air Treatment
IBS	Irritable Bowel Syndrome
IHME	Institute for Health Metrics and Evaluation
MAFFM	Ministry of Agriculture Forests Fisheries and Meteorology of Samoa
MPI	Ministry of Primary Industries, Fiji
NCD	Non-Communicable Diseases
NWC	Natures Way Cooperative (Fiji) Ltd.
NZMFAT	New Zealand Ministry of Foreign Affairs and Trade
PBP	Pacific Breadfruit Project
PICs	Pacific Island Countries
PIFON	Pacific Island Farmer Organization Network
SPC	Secretariat of the Pacific Community
SROS	Scientific Research Organization of Samoa
TC	Tropical Cyclone
TRTC	Tutu Rural Training Centre
USD	US Dollars
VC	Value Chain
WHO	World Health Organization

Exchange rates*

	<u>USD</u>	<u>AUD</u>	<u>NZD</u>
Fijian (FJD)	0.50	0.64	0.69
Samoaan (Tala)	0.39	0.50	0.54

*Buying rate March 17th 2018 –Source:
<http://www.xe.com/currencyconverter/>

1 Summary

The focus of this breadfruit market and marketing study has been on Fiji and to some extent Samoa. However, the findings are relevant to the commercialization of breadfruit in all Pacific island countries.

Breadfruit (*Artocarpus altilis*), is widely grown in the Pacific islands where it is often an integral part of traditional agroforestry systems. For more than a decade Fiji, Tonga and Samoa have been permitted to export fresh breadfruit to New Zealand, treated by the approved High Temperature Force Air (HTFA) quarantine treatment for fruit flies. The quantities exported have been small and well below market demand. Larger quantities of frozen breadfruit are exported to Australia, New Zealand and the United States. There are substantial and immediate market opportunities to expand fresh and frozen breadfruit export markets – however, significant marketing constraints remain.

For the future, there are major opportunities in supplying processed breadfruit products to export markets. These markets are divided in two broad segments: the gluten/grain-free product market; and, the market based on processing advantages potentially offered by breadfruit. However, for these markets to be realised, raw material supply constraints have to be overcome and there needs to be substantial capital investment and private sector involvement.

The study identifies more immediate market opportunities for processed breadfruit products on local markets. A particular opportunity is for breadfruit flour as a substitute for imported grains, particularly wheat flour. This large domestic market is expected to be driven by non-communicable disease (NCD) health concerns, together with the future impact of climate increasing the relative price of imported grains.

The market opportunities for breadfruit created by health and nutrition considerations

The Pacific islands have undergone a ‘nutrition’ transition from diets largely based on locally grown food to those primarily based on processed, imported, foods. Current diets are generally considered as nutritionally-inferior to traditional diets. This has been a major contributor to non-communicable diseases (NCDs) which are now prevalent throughout the Pacific islands region. Diabetes is particularly relevant, with the region now ranking highest in the world in terms of the prevalence. As a result the share of public health expenditure is growing, raising questions about long-term financial sustainability.

Diets based on traditional Pacific food staples, including breadfruit, can mitigate the prevalence of type II diabetes. The three (3) key positive nutritional features of breadfruit food products in contributing to an overall reduction in NCDs:

- 1) gluten free and low in FODMAP elements;
- 2) a moderate glycemic index; and,
- 3) a high non-digestible carbohydrate context (high amylose content).

Conclusion: A substantial increase in breadfruit consumption can make a significant contribution to the reduction of NCDs and thus have large social and economic benefits.

Market opportunities created by processing characteristics

Initial work undertaken in collaboration with this market study, demonstrated that breadfruit offers several processing advantages compared with substitute products such as cassava and corn starch. This

work identified a particularly valuable natural thickener that can be derived from breadfruit flour by simply adding water. It is not necessary to heat the liquid (as is the case with cornstarch) or to add chemical derivatives (as required for cassava starch). Thus, breadfruit flour offers the prospect of producing a variety of gluten free mixes without heating or the addition of chemical additives.

Conclusion: Support for practical applied research in developing custard mix products from breadfruit flour focusing on the domestic market would now be fully justified.

Breadfruit flour as a partial substitute for wheat flour in making bread products for local markets

In all the PICs wheat flour bread and buns is a major mainstream consumer item with large volumes of wheat and wheat flour imported annually. It is not realistic, for the foreseeable future, to expect 100% substitution of breadfruit flour in mainstream bakery products. However, only a partial substitution of wheat flour with breadfruit flour offers a sizable market opportunity and could make a significant contribution to the NCD crisis and bring with it substantial economic and social benefits.

Future opportunities for breadfruit created by Climate Change

Breadfruit has been identified as a key crop for food security in the Pacific islands, due to the crop's:

- ability to secure food energy from the atmosphere, thanks to its large leaves and canopy and being relatively undemanding on the soil;
- high tolerance to climate change and climate extremes;
- compatibility to intercropping within agroforestry systems; and,
- ability to sequester carbon

The forecast situation for breadfruit in the face of climate change contrasts markedly to that for grain crops, where climate change is expected to have a significant negative impact. This has major negative economic implications for the PICs, where imported grains already represent more than half of their food imports and already exceed the value of their total exports. Thus, for a number of traditional staples, including breadfruit, climate change creates a major market opportunity with the real price of imported grains increasing. The challenge for Pacific island farmers, agribusiness and policy makers is to be able to take advantage of this opportunity.

Commercial breadfruit industry development over the last two decades

The large Samoan diaspora living in New Zealand, Australia, and the United States, together with other Pacific islands communities, has long been identified as a substantial market for fresh breadfruit. This is in addition to the Indian, Malaysian and Sri Lankan consumers who also use breadfruit in curry dishes.

Fiji

Fiji, in 1997, was the first PIC to receive approval to export fresh breadfruit exports to New Zealand using the HTFA quarantine treatment – with the first exports made in 2001. Nature's Way Cooperative (Fiji) Ltd (NWC), the quarantine treatment business projected, in its first Strategic Plan, fresh exports to New Zealand of 400 tonnes by 2006. These projections were regarded as conservative

based on an in-depth market study. The Plan also made somewhat smaller projections for the Australian and US markets – assuming market access would soon be in place.

Actual fresh breadfruit exports fell far short of projections, peaking with only 40 tonnes exported in 2008. It had become clear that if anywhere near market potential was to be realized the transition had to be made from “wild harvest” to growing breadfruit as an orchard crop. The “wild harvest” cropping system and value chain could not provide sufficient supply of produce of consistently good quality for market development. Thus, the development of breadfruit orchards was deemed an essential requirement to support breadfruit exports (both fresh frozen) and eventually commercial processing.

To facilitate the transition from “wild harvest” to orchard breadfruit the Pacific Breadfruit Project (PBP) was designed. This four year PBP, with the Australian Centre for International Agriculture Research (ACIAR) funding, commenced implementation in 2011, with a key objective of establishing a commercial small- holder based orchard industry in Fiji. As a result of the PBP nearly 2,000 breadfruit trees have been planted in orchards, of which approximately half have begun to bear fruit.

Fiji currently has six (6) active exporters of breadfruit products (fresh, frozen and cooked). The breadfruit orchard development program has yet to have a significant impact on fresh and frozen breadfruit exports, although the first two months of 2018 recorded over 8,474 kgs of fresh breadfruit exported to New Zealand, this is higher than total annual exports for the past 9 years. This increase can be attributed to the substantial investment in research and commercial breadfruit production over the past six years led by Nature’s Way Cooperative through the ACIAR funded Pacific Breadfruit Project.

Fiji has also been a leader in cottage industry scale processing work at the Tutu Rural Training on Taveuni. However, overall, Fiji’s significant agro-progressing industry has yet to become involved with breadfruit processing.

Recommendation: Marketing linkages between the newly established breadfruit orchards and Fiji’s agro-processing enterprises and fresh and frozen product exporters need now to be developed.

Samoa

Breadfruit is one of Samoa’s most important traditional food staples, with over 80% of all households having breadfruit as a permanent crop and there are significant fresh breadfruit sales in the main municipal markets during the breadfruit season.

Samoa has a long tradition of staple crop processing – including breadfruit. In more recent times the emphasis has been chips (crisps), largely made by micro enterprises. More recently, the Scientific Research Organization of Samoa (SROS) has been involved in the production of breadfruit flour which is now being sold through a local supermarket.

Samoa began exporting fresh HTFA treated breadfruit to New Zealand in 2004 utilizing the small research HTFA facility operated by the Ministry of Agriculture. However, in spite of the encouraging initial progress, Samoa’s fresh exports subsequently ceased. As with Fiji, the bilateral quarantine agreement (BQA) and in particular the required bait-spray regime, has proven to be a major constraint. For Samoa, this has proven to be an even more binding constraint to fresh export development due to the absence of breadfruit orchards. Frozen exports have continued to grow over the last decade and now exceed 350 tonnes annually – although well below the level achieved in the 1980s.

Samoa was an early pioneer of breadfruit orchard development in the Pacific islands, with the Ministry of Agriculture established a small orchard at Atele. Some twenty years on, this orchard continues to be well maintained and represents a valuable resource for a commercial breadfruit industry. However, it was expected that the Atele orchard would serve as a demonstration that would lead to the proliferation of small holder commercial orchards. This is yet to occur and raw material supply remains a constraint to the Samoan breadfruit industry preventing it reaching anywhere near its full commercial potential.

Samoa has been the Pacific's pioneer in breadfruit processing research. This dates back to the 1980s, with the University of the South Pacific Alafua Food Processing Facility. In more recent years, it has been the Scientific Research Organization of Samoa (SROS), which has been at the forefront of applied breadfruit processing research. The focus has been on commercial scale breadfruit processing of four products (breadfruit flour, peeled frozen breadfruit, frozen breadfruit fries; and, precooked breadfruit pieces).

Revisiting the Australian and New Zealand market in 2017/18

The Australian and New Zealand breadfruit market were re-visited as part of this study. This involved meetings with importers, retailers and processors and covered fresh, frozen and processed breadfruit. It was the first specific breadfruit market visit since 2004. The Auckland visit was particularly timely as it coincided with the peak breadfruit season and was the first occasion when breadfruit from the PBP orchard's was being exported.

The market interviews conducted revealed that the market had clearly grown over the last decade or so with population growth. However, the basic structure of the market has changed little and remains driven by Pacific islanders and the Samoan diaspora in particular. The emerging interest in breadfruit flour as a health food product in the wider community was confirmed – however, there was not sufficient time and resources available in this study to explore this emerging market segment adequately.

Recommendation: A specific study now be undertaken to determine the place for breadfruit in Australia and New Zealand's emerging gluten and grain free market.

The Australian and New Zealand market visits confirmed the ongoing need for marketing improvements if identified market demand for fresh and frozen breadfruit was to be anywhere near realized. These include, improved:

- quality (variety, maturity, handling);
- consistency of supply and extended season;
- bio-security related market access (for New Zealand a more viable bait spray regime; for Australia still after more than 15 years no market access for fresh HTFA treated breadfruit);
- higher volumes per consignment to reduce fixed biosecurity and other clearance costs; and
- pricing to compete with imported root crops and other substitutes.

The high and increasing cost of airfreight was identified by buyers as a major constraint to market development.

Overall demand for breadfruit and requirements to meet market

The demand for breadfruit, as for any product, is driven by a combination of the following variables:

- The price of the product and the price of competing substitutes

- Population growth
- Income growth and the income elasticity of demand for the product.
- Consumer tastes and preferences

The study analysed these variables in terms of both domestic and export markets and for fresh and processed breadfruit products.

Domestic markets

Price: For most PICs, fresh breadfruit is a minor product sold on domestic markets – with Samoa being an important exception. Over the last two decades the price of breadfruit in Samoa has essentially doubled in real terms. This price situation is unlikely to change for the foreseeable unless breadfruit starts to be grown as an orchard crop. For Fiji, the domestic market price for fresh breadfruit has started to fall as orchard production comes on stream. For breadfruit sold in fresh produce markets the main substitutes are the traditional staple crop and imported potatoes. To this has to be added the broader product substitution by imported grains (rice and wheat products).

In Fiji, breadfruit was found to be relatively price competitive with dalo and can be expected to become increasingly so as more breadfruit sourced from the orchards enters the market. Furthermore, breadfruit is expected to be better able adapt to climate change than dalo. If domestic fresh market sales of breadfruit reach 5% of the value of dalo and cassava sales, it would represent a market approaching FJD 10 m.

For fresh breadfruit consumption, the major substituted fresh product is imported potatoes. Potatoes are also seen as the main imported substitute for frozen breadfruit. Fiji imports nearly 35,000 tonnes of potatoes annually. Due to environmental and climatic considerations locally grown potatoes are seen to be increasingly unsustainable without substantial government subsidies. Orchard produced fresh breadfruit is already price competitive with imported potatoes. However, the major disadvantage for fresh breadfruit relative to potatoes is its short shelf life. This disadvantage is largely overcome by frozen breadfruit pieces – however, such a product is yet to be readily available on the Fiji domestic market, and when it becomes available its price is likely to be significantly higher than that of imported potatoes. It is projected that the price of imported potatoes will also increase relative to breadfruit due to the impact of climate change.

As yet, there is no commercial processing of breadfruit flour in the PICs. Thus it is difficult to get data on actual prices for breadfruit flour. However, it can be expected to be significantly higher than the price of imported wheat flour. Fiji imports around 135,000 tonnes of wheat annually with a landed value of some FJD 105 m. Breadfruit flour is currently a long way from being price competitive as a substitute for wheat flour in its general use.

The more immediate direct market for breadfruit flour is in the niche gluten free bakery market. Here the competition is with rice, cassava, maize and millet flour. These imported gluten free flours are still significantly cheaper than the current price for breadfruit flour. It is expected that this price difference could be bridged somewhat with the further development of breadfruit orchards and commercial processing. However, if breadfruit flour is to compete it will need to differentiate itself from other gluten free ingredients. It has a strong basis for doing so in terms of wider nutritional benefits and superior processing attributes.

The initial processing work undertaken at the Tutu Rural Training Centre suggests significant processing advantages for breadfruit starch and starch derivatives compared with mainstream cassava and corn starch, which are also duty free. However, in this preliminary stage, it is far beyond the scope

of this study to explore the pricing requirements of this product on domestic markets or eventually on export markets.

Recommendation: A detailed investigation of the processing advantages offered by breadfruit is now needed to take advantage of this promising marketing opportunity.

The domestic markets for chips and other snack food is large – albeit much smaller than the flour market. The long experience of Samoa with breadfruit (and root crop) chips, and the more recent experience with Tutu in Fiji, indicates that these products have little difficulty in being price competitive with locally made potato and cassava chips. Unfortunately, chips don't offer the same processing advantages as other breadfruit products.

Population: For Fiji, increasing urbanization (now around 56% of the population live in urban areas) means a higher percentage of the population are not in a position to grow their own food and have to purchase it. This increases the demand for all agricultural products – both domestically grown and imports. Even higher rates of urbanization are being experienced in the other Melanesian countries – but somewhat lower rates in Samoa and Tonga.

Income: If Fiji can maintain its current per capita income growth over the next decade there will be steady growth in demand for breadfruit products – particularly now that an increasing majority of the population live in urban areas. The processed breadfruit products might be expected to have higher income elasticity than fresh breadfruit given that these products are initially targeting niche markets.

Consumers and marketing enterprises throughout the PICs are not generally aware of the health and nutritional benefits breadfruit and breadfruit products offer.

Recommendation: Major effort to create consumer and enterprise awareness of the health and nutritional benefits offered by breadfruit and breadfruit products. A significant allocation of public sector funds (both donor and government) would be justified for this purpose given the huge cost that NCDs are increasingly incurring on PIC economies and communities.

Export markets

In evaluating short and medium-term export markets for breadfruit and breadfruit products the focus was on the Australian and New Zealand markets. A sufficient supply base and the necessary large investment in processing capacity have yet to be established to warrant consideration of broader global markets. Some consideration is made, however, of the US fresh and frozen market given the sizable Samoan population residing there.

Some 15- years ago there was much optimism regarding exporting fresh breadfruit to New Zealand, Australia and the United States. However, to this day New Zealand remains the only country to which fresh breadfruit is permitted utilizing HTFA quarantine treatment facilities in Fiji, Tonga and Samoa. Despite long pending market access requests to Australia and United States it is unlikely that this situation will change in the foreseeable future, unless breadfruit becomes a high priority of the Quarantine Authorities in both the importing and PIC exporting countries.

Pacific Islander population: The main drivers of demand are the Pacific Islander population, particularly the Samoan population. Samoans now, numbering around 153,000, make about half on the New Zealand Pacific islander population and has been growing at around 1.4% annually (compared with 0.75% for the population at large). The Breadfruit Profile, prepared by the Samoan Ministry Agriculture in 2002 “conservatively” estimated the market for fresh breadfruit in New Zealand to be around 400 tonnes in 2002 based on Samoan population of 115,000. To Pacific islander population has to be added

increasing numbers of Indian, Malaysian and Sri Lankan people who live in New Zealand who use breadfruit in curry dishes. Australia has a smaller, but still significant, Samoan population. Australia, however, has a much larger population of people from India, Malaysia and Sri Lanka.

In these high-income countries, it could be expected that a small but increasing percentage of the general population will have become interested in consuming fresh breadfruit given the increasing publicity and interest in gluten free products.

The Pacific island communities, who constitute the main market for breadfruit are generally found in the lower income segment. Price wise breadfruit cannot compete with wheat flour, rice and potatoes in every-day consumption. However, the income elasticity of the demand for breadfruit amongst the Samoan and other Pacific islander communities could be expected to be high and demand will increase significantly as incomes rise.

The gluten free market: Much is being made of the huge gluten free market – with estimates of the current global annual demand ranging from USD 3 billion to USD 15 billion and forecast to grow to USD 50 billion over the next decade. However, for the medium term at least, it is highly unlikely that breadfruit could obtain a share of this broad gluten free market. Not only is available breadfruit supply minuscule compared with demand – there are substantial supplies of much lower priced substitutes (rice, corn and cassava flour) already available. Over the next decade or so the price relativities of breadfruit flour could well change as the impact of climate change is increasingly felt on grain crops.

Conclusion: It is unlikely, for the medium term at least, that breadfruit could obtain a share of the broad gluten free market

Niche markets: For the foreseeable future, export market prospects for processed breadfruit products, apart from frozen and cooked breadfruit, lies in high value niche markets, where breadfruit can differentiate in terms of non-price factors.

Conclusion: The study identified two promising, but yet to be developed, niche market opportunities based on:

- The superior processing characteristics of breadfruit
- Unique health and fitness characteristics of breadfruit

Indicative estimates of the demand for Fiji's breadfruit products

Estimates are made for both current and medium term (5 to 10 years) demand. Ideally such demand estimates should be based on statistical analysis, utilizing historical data. However, with breadfruit being a small, new commercial industry, the necessary data required for such statistical analysis is not available. Furthermore, recent technological and consumer preference changes have been such that these would not be captured by standard econometric analysis. Thus, the estimates made are more qualitative in nature based on the information that is available. As such, they should be seen as a guide for private sector to invest in breadfruit production and processing opportunities and for public sector support in term of policy, investment in infrastructure and technical assistance. The conclusions from the analysis are:

- The identified markets for breadfruit and breadfruit products far exceeds the readily available supply and this is expected to be increasingly so in the medium term.
- The challenge is to create the necessary linkages between breadfruit supply and identified markets.
- There are significant weaknesses in the breadfruit value chain that need to be addressed if the opportunities identified are to be anywhere near realised.

Domestic market

The focus of this report is on the domestic market – where the most immediate and accessible opportunities lie. **For Fiji, the indicative current annual demand for breadfruit is estimated to be around 8,000 tonnes annually, valued at nearly FJD 5 million.** The key considerations the demand estimate are:

- The volume and value of root crops sold on domestic market (demand for breadfruit on the staple market is put at 1% of taro sales)
- The volume and value of potatoes imported (demand for breadfruit as a substitute for imported potatoes put at 1% of potato imports)
- The volume and value of wheat imports (demand for breadfruit flour put at 0.1% of wheat imports).
- The high volume of potato chip consumption (demand for bread fruit chips is set at a minuscule fraction of this volume).
- The high cost to individuals and society from NCDs and the emerging awareness of the role that products such as breadfruit can play in addressing this health issue.

The indicative medium-term demand for breadfruit is estimated to be some 35,000 tonnes per annum, valued at around FJD 20 million. To put these estimates in prospective: i) the fresh market demand estimate is equivalent to only 2% of current sales of taro and 2% of current potato imports; and, ii) breadfruit flour demand estimate is only 0.5% of current flour imports. The key variables driving this growth in estimated demand are:

- A continuing high rate of urbanization in Fiji, coupled with increasing per capita income
- Price relatives increasingly moving in favour of breadfruit compared with dalo and imported grains and potatoes. This is due to the impact of climate change and existing breadfruit orchards coming into full production and new breadfruit orchards being established.
- Price relativities in favour of breadfruit flour will be further enhanced by the expected investment in breadfruit processing and technological advances in processing
- Increasing public awareness of the costs and consequences of NCDs, together with the nutritional and health benefits of consuming breadfruit and breadfruit products.
- The increasing availability of breadfruit products. For new innovative products increasing availability and promotion can be expected to generate its own demand.

Export market

The indicative current export demand for Fiji's breadfruit and breadfruit products is estimated to be some 1,500 tonnes per annum, with a fob value of approximately FJD 6.5 million. This export market is shared with Samoa and Tonga. **In the medium term, this demand is projected to increase to some 2,500 tonnes, doubling in value to approximately \$12.5 million.** These estimates are based on the following considerations:

New Zealand

- The previous in-depth market studies of the New Zealand fresh breadfruit market were confirmed in this market study still to be valid. These estimates have been adjusted to allow for growth in the New Zealand Pacific Islander population – particularly the Samoan community.
- Market interviews with exporters and importers.
- There is currently no realistic market for breadfruit flour in New Zealand – however, it can be expected to develop in the medium term as viable processing capability develops in Pacific islands and the market becomes aware of the health benefits accruing to the consumption of

breadfruit flour. A notional medium-term market of 200 tonnes of breadfruit flour has been allowed for.

Australia

- Estimated size of the Australian fresh breadfruit market is based on the relative size of the Samoan community relative to New Zealand. However, any realization of this market is not possible while Fiji's market access request remains pending.
- The demand estimates for frozen and cooked breadfruit in New Zealand based on discussion with the main exporter and importer, which is the same company.
- A notional demand estimate for Fijian breadfruit flour has been allowed for Australia.

Other markets

- Currently there are no realistic export markets for Fiji fresh breadfruit outside New Zealand. In the medium term a notional market of 100 tonnes is allowed for in the US market, given the size of the Samoan community. However, this assumes that Fiji will be able secure market access for fresh breadfruit in the next few years.
- The frozen and cooked market estimates for the US are based on selling to the sizable Samoan community. These estimates are based on the previous experience of the major exporter.
- Exceptionally large markets have been identified in the US, and elsewhere, for gluten free flour products. However, it could not be expected that Fiji breadfruit flour could be competitive on these markets for the foreseeable future – except for very narrow niche markets. A notional medium-term demand projection for other markets of 200 tonnes has been allowed for.

Requirements to realise identified demand for breadfruit products

Sizable demand, for both domestic consumption and export, has been estimated for breadfruit products. These markets can be expected to increase significantly in the medium term (next 5 to 10 years). However, Fiji as well as Samoa and Tonga, currently fall far short of meeting this demand.

The absence of breadfruit orchards and thus the dependency on “wild harvest” is a major weakness in the breadfruit value chain. In Fiji, considerable progress has been addressing this constraint – although more work is still required. However, despite the importance of planting breadfruit orchards for commercial market development, this alone is not sufficient to allow underlying demand to be anywhere near satisfied. There are other weaknesses in the breadfruit value chain, both for domestic markets and export, which now need to be addressed. These include:

- **The reform of the BQA for breadfruit exports to New Zealand and obtaining market access for fresh breadfruit to the Australian and United States markets.**
- **Addressing the inadequate local knowledge in the processing of domestically grown food, including breadfruit.**
- **The need for a substantial applied research effort directed at breadfruit processing.**
- **The need to link local processors and exporting companies to the newly established breadfruit orchards.**
- **Assistance in product development, labelling and in developing consumer awareness.**

2 Background

2.1 Breadfruit the archetypal Pacific island food tree

Breadfruit (*Artocarpus altilis*), is widely cultivated in the Pacific islands where it is often an integral part of traditional agroforestry systems. The tree is believed to be native to a vast area extending from New Guinea through the Indo-Malayan Archipelago to Western Micronesia. Morton (1987), reports that breadfruit was spread through the Pacific by migrating Polynesians.

Breadfruit can be cooked and eaten at all stages of maturity. It is high in complex carbohydrates, rich in fibre and low in fat. In some Pacific island countries (PICs), such as Samoa, breadfruit is a major food staple. In other PICs, such as Fiji and Vanuatu, breadfruit overall is regarded as a minor food staple. However, even in these countries there are some areas, such as Natewa Bay in Fiji and Malo island in Vanuatu, where breadfruit is an important food staple.

2.2 Efforts to commercialise breadfruit production

For more than a decade Fiji, Tonga and Samoa have been permitted to export fresh breadfruit to New Zealand if it is treated for fruit flies by a certified high temperature forced air (HTFA) quarantine treatment facility. However, the quantities exported have been small and well below market demand. Larger quantities of frozen breadfruit are exported to Australia, New Zealand and the United States.

There are substantial and immediate market opportunities to expand fresh and frozen breadfruit export markets – however, there remain significant marketing constraints. These opportunities and the requirements to satisfy these markets are explored in this market study.

For the future, there are major breadfruit market opportunities in supplying processed breadfruit products to export markets. These markets are divided in two broad and sometimes interrelated segments. These are: gluten-free product market; and, markets based on the processing advantages being increasingly offered by breadfruit flour and paste. However, for these markets to be realised, raw material supply constraints have to be overcome and there needs to be substantial capital investment and private sector involvement which as yet, has not been forthcoming.

The study identifies more immediate market opportunities for processed breadfruit products sold on local markets. A particular opportunity is for breadfruit flour and starch as a substitute for imported grains, particularly wheat flour. This large domestic market is expected to be driven by non-communicable diseases (NCDs) health concerns, together with the impact of climate change increasing the relative price of imported grains. The nutritional, processing advantages and climate change drivers of breadfruit demand are discussed briefly below.



Figure 1: Typical village breadfruit planting in Nth. West Upolu, Samoa



Figure 2: A typically well maintained *Ma'afala* variety in a Samoan village



Figure 3: Collecting *Bale kana ni Samoa* root sucker in Natewa Bay village – the Fiji breadfruit “hot spot”



Figure 4: A breadfruit based agro forest on Malo island, Vanuatu



Figure 5: Fresh breadfruit being prepared for HTFA quarantine treatment and Natures Way Cooperative in Fiji



Figure 6: Fresh breadfruit being quarantine treated in Samoa in 2001 in the HTFA research unit at the Alele Horticulture Centre



Figure 7: Breadfruit being prepared for freezing prior to export to New Zealand in 2017 at the Atele Horticulture Centre



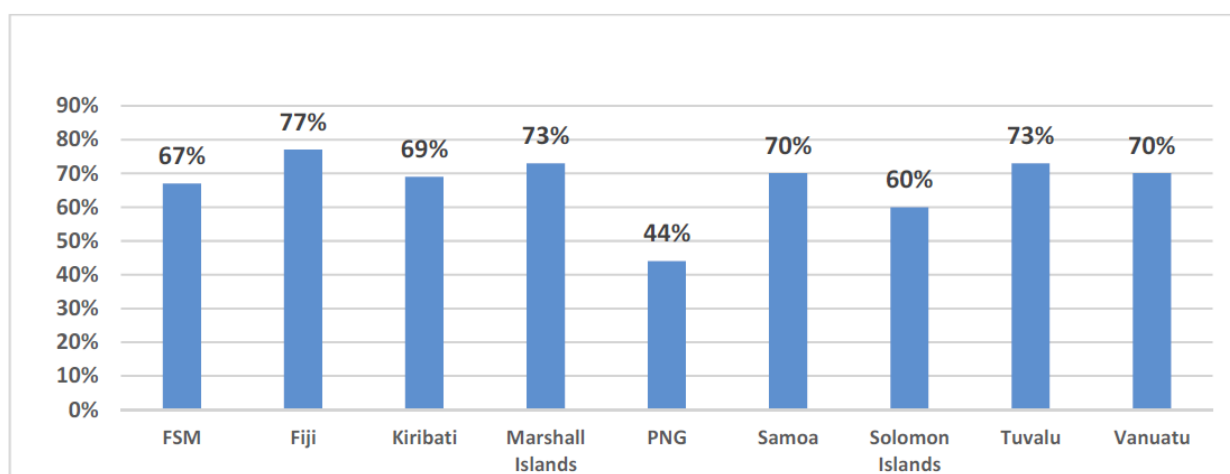
Figure 8: Samoan frozen breadfruit ready for export

2.3 The market opportunities for breadfruit created by health and nutrition considerations

2.3.1 The Pacific island nutrition and NCD crisis

The Pacific islands are undergoing a ‘nutrition’ transition from diets largely based on locally grown food to those primarily based on processed, imported, foods. Current diets are generally considered as nutritionally-inferior and have been identified as a major contributor to two types of malnutrition (under-nutrition and over-nutrition) that are prevalent throughout the region (Taylor 2017, PIFON 2017, FAO, 2014). The prevalence of overweight adults in the PICs is among the highest in the world. Adult obesity rates are at or above 60 per cent, in Tonga and the Cook Islands and above 45 per cent in Kiribati, the Republic of the Marshall Islands and Samoa. Non-communicable diseases (NCDs) are now the leading cause of death in most countries in the Pacific, ranging from an estimated 60 per cent of deaths in Solomon Islands to 77 per cent of deaths in Fiji as shown in figure 10 (Xu et.al).

Figure 9: Estimated percentage of total deaths caused by NCDs in PICs*



*Xu et.al (2016)

Diabetes is particularly relevant in the Pacific islands and has increased steadily over the last four (4) decades. The PICs now rank the highest in the world in terms of the prevalence of diabetes – with 7 PICs ranked in the top 10 countries in the world in terms of diabetes prevalence (table 1).

Table 1: Top ten countries/territories for diabetes prevalence in the world*

Country/Territory	2013 – Prevalence (%) of diabetes (20–79 years)
Tokelau	37.5
Federated States of Micronesia	35.0
Republic of the Marshall Islands	34.9
Kiribati	28.8
Cook Islands	25.7
Vanuatu	24.0
Saudi Arabia	24.0
Nauru	23.3
Kuwait	23.1
Qatar	22.9

*International Diabetes Federation (2013)

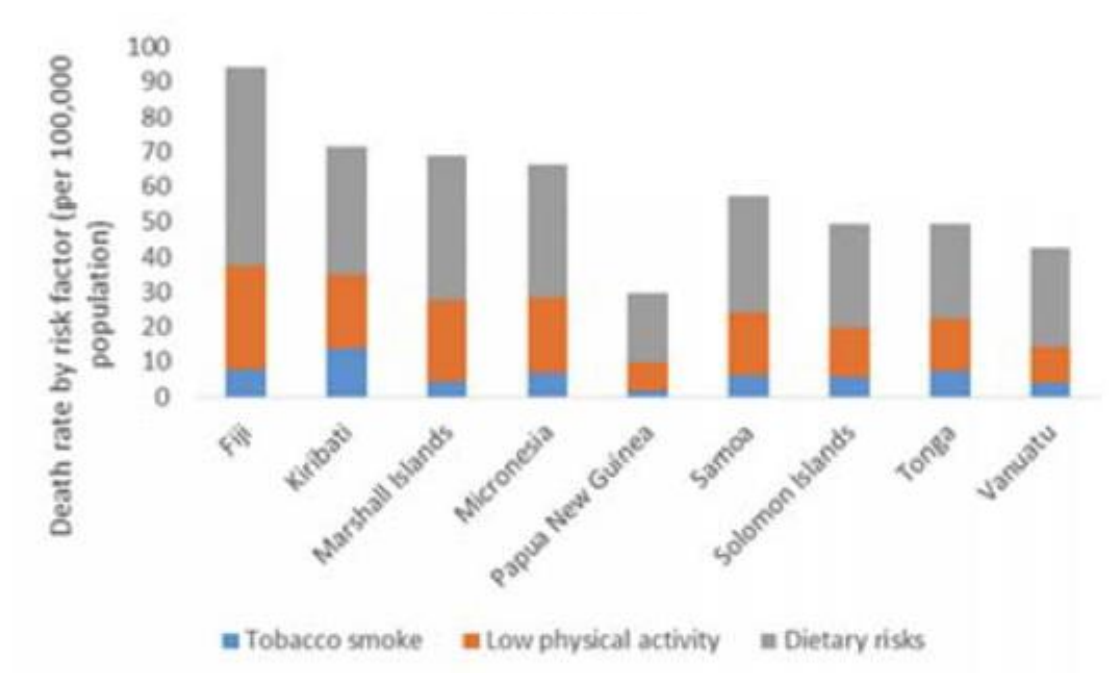
In 2011, Pacific leaders declared the NCD epidemic a health and economic crisis and a threat to sustainable human development (WHO/SPC, 2011). A report released at the Pacific NCDs Summit in Nuku'alofa, Tonga (June, 2016) further highlighted the economic threat posed by NCDs in the Pacific Islands. In particular, there are major public health costs incurred.¹ The share of public health expenditure is growing for most countries in the Pacific, raising questions about long-term financial sustainability (World Bank 2016).

While many social and economic factors have contributed to the increase in diabetes, an overall greater consumption of westernized foods and neglect for the traditional diet by Pacific Island communities has undoubtedly played the pivotal role (Chan et al., 2014; Ragone & Raynor, 2009; WHO, 2010; World Bank 2016). A combination of behaviour factors (tobacco smoking, low physical activity, and poor diet) are the major contributors to diabetes. Of these factors, diet is seen as the dominant contributor as

¹ In Vanuatu, where diabetes prevalence is overwhelmingly high (24%), the average cost to treat a type 2 diabetes patient is five (newly diagnosed) and twelve times (progressed) the average per capita domestically resourced government expenditure on health (Anderson, 2013).

indicated by research conducted by the Institute for Health Metrics and Evaluation, (IHME) (World Bank 2016).

Figure 10: Diabetes mortality rates attributed to risk factors*

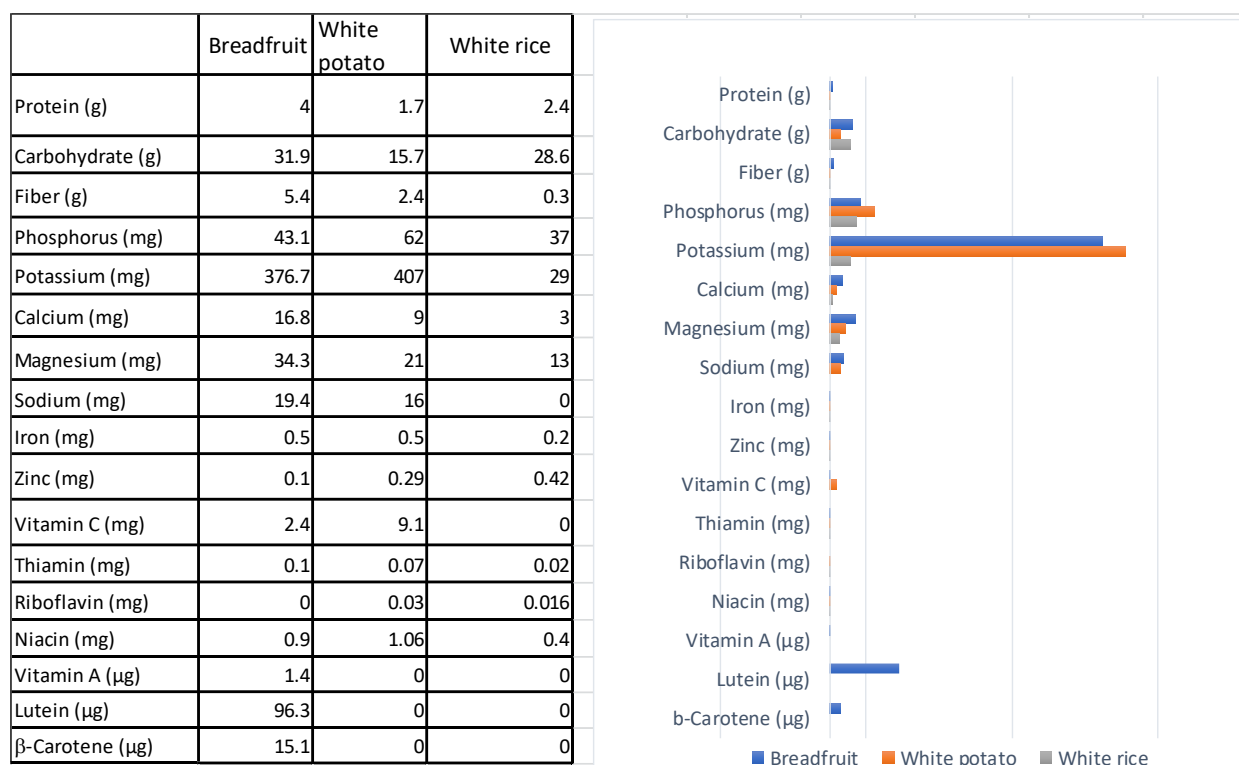


Source: World Bank 2016 p, 3.

2.3.2 Nutritional benefits offered by breadfruit

Turi et al. (2015) refer to a number of studies that indicate that diets based on breadfruit and other traditional Pacific staples can mitigate the prevalence of type II diabetes. This conclusion is based on a combination of field observations, ethno botanical reports and medical records. The nutritional advantages offered by breadfruit and breadfruit products are summarised below.

Breadfruit is high in complex carbohydrates, rich in fiber, low in fat, and cholesterol and gluten free. It has a moderate glycemic index (blood sugar shock) compared to that of white potato, white rice, white bread, and cassava (table 2). However, protein, fat and crude fiber varies significantly between varieties and stage of maturity as shown in pioneer breadfruit processing research undertaken in Samoa in the early 1980s by Wooten and Tumaalii (1984) (table 3). The popular Samoan variety *Ma'afala*, and the equivalent Fijian variety *Bale kana ni Samoa*, scores particularly well in this respect.

Table 2: A “typical” nutritional comparison of breadfruit with potato and white (per 100 g serving)*

*Source: Elevitch, Ragone and Cole, Breadfruit Production Guide: Recommended Practices for Growing and Harvesting 2nd Edition 2014

Table 3: Composition of flour from pulp of Samoan breadfruit varieties at different stages of maturity*

Variety	Maturity stage	% (dry weight basis) of						
		Moisture content (%)	Crude protein	Crude fat	Crude fibre	Ash	Total sugar	Starch
ma'opo	immature	8.6	4.60	1.33	6.56	2.99	15.1	66.7
	mature	6.17	3.34	1.93	5.01	2.55	15.6	71.3
	very mature	4.83	4.34	1.57	4.73	3.08	31.5	53.4
puou	immature	11.22	4.72	0.77	4.70	3.09	19.7	65.4
	mature	11.66	4.76	0.80	3.83	2.94	14.8	72.1
	very mature	13.73	4.46	0.96	3.75	2.84	11.5	73.1
ma'afala	immature	3.61	3.57	1.11	3.20	1.69	21.7	66.2
	mature	2.84	3.70	1.36	2.87	1.90	22.1	58.7
	very mature	2.55	4.00	1.25	2.84	2.41	31.8	56.1
tala	immature	21.01	4.77	1.29	6.86	4.08	18.6	62.7
	mature	19.03	5.00	1.35	5.27	2.48	22.7	61.5
	very mature	15.45	5.08	1.45	5.19	2.59	27.9	53.9
gutufagu	immature	14.42	4.52	0.84	4.67	3.54	10.0	75.7
	very mature	14.91	4.00	0.80	4.15	3.91	14.6	67.9
ma'a	immature	3.40	3.79	1.25	4.14	2.86	14.8	70.7
	mature	8.84	2.90	0.90	4.12	3.18	17.0	71.4

aveloaloa	mature	9.29	3.26	1.68	4.49	2.54	18.7	67.7
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* Source: Wooten and Tumaalii (1984)

The three (3) key positive nutritional features of breadfruit food products that can contribute to an overall reduction in NCDs are:

- 1) being gluten free and low in FODMAP elements;
- 2) having a moderate glycemic index; and,
- 3) a high non-digestible carbohydrate context (high amylose content).

These features are analyzed below.

Gluten free and being low in FODMAP elements

Gluten is found in grain products such wheat, rye, maize and barley – however, it is not found in rice. Fruit and vegetables including breadfruit do not contain gluten. Gluten is the key ingredient in bakery products facilitating their ability to rise when baked.

Gluten intolerance can bring with it serious health consequences through celiac disease which results in destruction of the bowel lining (Asiata, Viali 2017). Celiac disease is a genetic disorder which affects about 1% of the population worldwide (Green, 2007). This disease is much more common amongst ethnic Caucasians and particularly people who originated from the Middle East and North Africa's Fertile Crescent. A low prevalence of celiac disease is found in the Pacific Islands, South-East Asia and eastern China, but higher rates are found countries west of India and China (figure 11).

Celiac disease is not the only consequence of “gluten intolerance”. Irritable Bowel Syndrome (IBS), is thought to be related to gluten intolerance. The incidence of IBS is far greater than celiac disease, impacting on up to 20% of the population in some Western countries such as Australia (<http://www.ibis-australia.org>). It was initially thought that IBS was solely related to gluten intolerance but without the potentially deadly true coeliac effects. However, more recent research has shown that although IBS sufferers benefit from a gluten free diet, it is not gluten per se, that is the real issue but something else, known as FODMAP elements, that co-exist in gluten containing foods such as wheat, barley, rye (<http://cart.gesa.org.au/membes/files/Consumer%20Information/Low%20FODMAP%20Diet.pdf>)² Breadfruit is not only gluten-free, but importantly it is also low FODMAP (<https://www.ibsdiets.org/fodmap-diet/fodmap-food-list/>).

² FODMAPs are a large group of dietary sugars found in many common foods such as specific dairy products, wheat and other grains, and fruits and vegetables. FODMAPs are found in many foods we commonly eat and is an acronym for: Fermentable Oligosaccharides – Fructans and galacto- oligosaccharides (GOS) Disaccharides – Lactose Monosaccharides And – Fructose in excess of glucose Polyols – Sorbitol, Mannitol, Maltitol, Xylitol and Isomalt FODMAPs can be classified into two groups:

- Those FODMAPs that are partly absorbed (fructose, lactose, polyols)
- Those FODMAPs that are not absorbed in anyone (fructans and GOS)

Figure 11: Estimated global distribution of celiac disease*



* Source: <http://www.dr-schaer-institute.com/us/professional-articles/a-global-map-of-celiac-disease-1229.html>

Gluten free products are now widely perceived as health foods, even though being gluten free in itself is only of significant health benefit for a small percentage of the population. It can be expected that the low FODMAP 'market' will far overshadow the gluten free celiac disease 'market'.

Dr. Fusi Avegalio, Head of the Pacific Business School, University of Hawaii, noted in his presentation to the Pacific Breadfruit Roundtable held in Tonga in 2016 “The global demand for gluten free products was estimated to be USD 13 billion in 2013. Today (2016), the market is worth USD 15 Billion and continues to grow” (PIFON, 2016). Adrian Kirton, food industry consultant from Barbados, in his presentation to the 2017 Samoan Breadfruit Summit, provided somewhat more conservative estimates of the gluten free product market (Kirton, 2017). Quoting Transparency Market Research, he projected the gluten free food market to reach USD 5 billion by 2021 up from USD 2.8 billion in 2014, with the gluten-free bakery products making up the largest market share. If Pacific island breadfruit products were to capture just 1% of this more conservative gluten free market forecast, it would represent a market of USD 50 million – which far exceeds the current PICs capacity to supply. The absence of gluten however reduces its functionality since gluten is necessary for the open texture of bread and other wheat-based products. This does not limit its use however since it has excellent thickening properties at low temperature and gelling features at high concentrations (see Section 1.4.1) –suggesting that use in the processing industry will emerge as private sector interest gains momentum.

To gain market share in the gluten-free bakery market, breadfruit has to compete with other currently lower priced gluten-free products such as rice and cassava flour. Over time, the price of breadfruit flour is expected to become increasingly more competitive in the face of climate change as is discussed in some detail below. However, to be able to compete in the short to medium term, breadfruit products will need to be able to differentiate themselves in the market in terms of non-price factors. These factors include: overall improved nutrition, product origin and image and superior processing characteristics.

The availability of raw material supply and the large capital investment requirements means that the initial focus for processed breadfruit products needs to be on domestic and not export markets. For domestic Pacific island markets being gluten free is probably of only limited benefit from a health perspective – although “gluten free” labeling can expect to be a marketing advantage for higher income market segments. However, there are other substantial health benefits that breadfruit offers and that need to be promoted in domestic Pacific island markets. These have been identified as and are discussed briefly below:

- A moderate glycemic index (rate of rise in blood sugar); and,
- a high fiber high non-digestible carbohydrate context (high amylose content).

Moderate glycemic index (GI)

Breadfruit has a moderate glycemic index compared with substitute carbohydrates such as potatoes, white rice, white bread, taro and cassava. Lower GI diets result in the body more slowly converting food into energy and keeping blood sugar levels more stable. A lower glycemic diet is regarded as effective in the control of diabetes particularly when in food with a higher carbohydrate content (Diabetes.co.uk). Breadfruit is such a food.

High fibre and non-digestible carbohydrate context (high amylose content).

Breadfruit starch, in contrast to products made up of simple sugars, is slow to digest. This capacity to resist digestion reduces the propensity of consumers to feel hungry and thus to over eat, which in turn raises blood sugar levels and insulin sensitivity contributing to diabetes. Breadfruit products or other products fortified with breadfruit have thus been identified as a means of regulating blood sugar levels and insulin sensitivity (Akanbi et al., 2009 ; Nwokocha & Williams, 2011).

The combination of moderate GI and high amylose content in breadfruit products

In the fight against NCDs, obesity and in particular diabetes, there is increased interest in processed food products that combine a low GI and high fiber content (Lafiandra et. al, 2014). Breadfruit flour and paste is such a food. Breadfruit is also seen as a useful source of vitamin C, potassium, magnesium, and calcium, with small amounts of thiamin, riboflavin, niacin and iron. The actual level of these additional benefits will vary with variety and how the breadfruit is processed.

The overall conclusion from the above analysis is that: A substantial increase in breadfruit consumption can be expected to make a significant contribution to the reduction of NCDs and thus have large social and economic benefits.

2.4 Market opportunities created by processing characteristics

2.4.1 Natural starch based products

Food technologist Dr. Richard Beyer provided technical assistance to the Taveuni based Tutu Rural Training Centre (TRTC) in the processing of breadfruit flour for bakery products. This work was undertaken as part of this study with funding provided by the Pacific Island Farmer Organization

Network (PIFON) and is discussed in Chapter 7 of this report. Dr. Beyer also experimented with making breadfruit starch-based products such as custard mixes. This initial work demonstrated that in addition to nutritional benefits, breadfruit starch offers particular processing advantages compared with substitute products such as cassava and cornstarch. Dr. Beyer in his presentation the 2017 Breadfruit Summit in Samoa noted:

Hydrocolloids that are commonly used as thickening are starch, xanthan, guar gum, locust bean gum, gum karaya, gum tragacanth, gum Arabic and cellulose derivatives. The gelling type hydrocolloids are alginate, pectin, carrageenan, and agar. Polysaccharides [Greek *poly* = many; *sacchar* = [sugar](#)] are complex [carbohydrates](#), composed of from 10 to up to several thousand [monosaccharides](#) arranged in chains. The most common monosaccharides that appear as parts of polysaccharides are [glucose](#), [fructose](#), [galactose](#) and [mannose](#). Breadfruit starch compared with the likes of cassava and corn starch have “longer” (more elastic) gels – with a larger strain at failure. This increases the viscosity of products that use breadfruit starch.

Richard Beyer’s work identifies breadfruit starch as a particularly valuable natural thickener for food processing. A thickener from breadfruit flour can be derived, without the particles disaggregating, by simply adding water. It is not necessary to heat the liquid (as is the case with cornstarch) or to add chemical derivatives (as required for cassava starch). Thus, breadfruit flour offers the prospect of producing a variety of gluten free mixes without heating or the addition of chemical additives. These include high value products such as: custard and Bisto™ sauce mixes, blancmange³ and a variety of dips. Richard Beyer’s work at Tutu successfully demonstrated this on a cottage industry scale (figure 12). He is of the view that this could be readily scaled up to larger processing operations.

The conclusions drawn from Dr Beyer’s work at Tutu:

- Breadfruit flour is instantly dispersible in cold water at low concentrations (1% w/v unheated) and being highly viscous.
- At high concentrations, this breadfruit product will form a gel.



Figure 12: Tutu Rural Training Centre flour dissolved in cold water and used as a thickener for custard gel

³ Blancmange is a sweet dessert commonly made with milk or cream and sugar thickened with gelatin, cornstarch or Irish moss, and often flavoured with almonds. It is usually set in a mould and served cold.

The overall conclusion from the work at Tutu: Support for more practical applied work in developing custard mix products from breadfruit flour focusing on the domestic market would now be fully justified. This is one of the key recommendations for realizing identified demand for processed breadfruit products.

2.5 Breadfruit flour as a partial substitute for wheat flour used in mainstream market bread and buns

In all Pacific island countries wheat flour bread and buns is a major mainstream consumer item for all income classes in both rural and urban areas. Large volumes of wheat and wheat flour are imported by all PICs. Fiji, for example, over the period 2012-2016 imported an annual average of 135,500 tonnes of wheat products (table 4). These had a landed value of FJD 106.5 million.

Table 4: Fiji wheat imports 2012-2016

Wheat	2012	2013	2014	2015	2016	Annual average 2012-2016
Volume (kg)	139,169,685	157,180,420	97,747,750	114,306,926	169,169,020	135,514,760
Value (FJD)	97,886,204	123,906,183	113,851,455	106,396,487	90,936,150	106,595,296
Land price per kg (FJD)	0.70	0.79	1.16	0.93	0.54	0.82
Source: Fiji Bureau of Statistics						

It is not realistic, for the foreseeable future, to expect 100% substitution of breadfruit flour in mainstream bakery products (bread and buns). However, the Tutu experience has demonstrated that breadfruit flour (made from the *Bale kana ni Samoa* variety) can be mixed with wheat flour up to a maximum ratio of one third and can produce more than satisfactory conventional bread and bun products for local consumers. Work undertaken by the University of the West Indies, Trinidad and Tobago presented at the 2017 Pacific & Global Breadfruit Summit in Samoa found similar results.

Only a partial substitution of wheat flour with breadfruit flour offers a sizable market opportunity and could make a significant contribution to the NCD crisis in the PICs by increasing the percentage of food consumed with lower blood sugar levels (lower GI) and high fiber (amylose content). If Fiji was to substitute only 10% of wheat product imports with breadfruit flour this would represent a market of over 12,000 tonnes of flour (approx. 60,000 tonnes of fresh breadfruit) valued at some FJD 10 million at current prices. This would bring with it large economic and social benefits in terms of improved public health and foreign exchange saved. Such volumes represent a market well in excess of the capacity to supply for the foreseeable future.

2.6 Future opportunities for breadfruit created by Climate Change

Breadfruit, as identified in the SPC published book “Vulnerability of Pacific agriculture and forestry to climate change”, is one of a number of traditional Pacific island staple food crops expected to adapt well to climate change (Taylor et.al 2016, Chpt. 4).

The optimum climatic conditions for breadfruit production are temperatures ranging from 21-32 °C and an annual rainfall of 1500-2500 mm (Ragone, 1997, 2006). Breadfruit trees are prone to

damage from high winds, however trees are seldom uprooted by cyclones, with damage usually confined to outer branches⁴. Breadfruit requires relatively high levels of rainfall to thrive but can survive droughts of 3-4 months after the tree is established (<http://www.spc.int/lrd/cepactacc/breadfruit.php>). It is unlikely that the increasing temperature will have too much impact on breadfruit production, at least to a 2 °C increase (Taylor et.al 2016 p 188). Breadfruit has been identified as a key crop for the future food security of the Pacific islands because of the crop's:

- ability to secure food energy from the atmosphere, thanks to its large leaves and canopy and being relatively undemanding on the soil;
- high tolerance to climate change and climate extremes;
- compatibility to intercropping within agroforestry systems;
- ability to sequester carbon; and

The forecast situation for breadfruit in the face of climate change contrasts markedly to that for grain crops. Climate change is expected to have a significant negative impact on global grain production, and in particular, Asian rice production. This means that the real price of imported grains for the Pacific islands is projected to increase significantly in coming decades (Taylor et al, Chpt 9). This has major negative economic implications for the PICs, where imported grains already represent more than half of their food imports and where food imports for many of these countries already far exceeds the value of their total exports (McGregor et al 2009). Thus, for a number of traditional staples, including breadfruit, climate change creates a major market opportunity with the real price of imported grains increasing.

The challenge for Pacific island farmers, agribusiness and policy makers is to be able to take advantage of this opportunity. To take advantage of this opportunity a significant transition is required from what is essentially a highly perishable fresh “wild” harvest fruit to an orchard grown tree crop that is processed into products that can be substituted for imported grains. The first initial steps have been made in breadfruit orchard development in Fiji and with breadfruit processing development in Fiji, Samoa and Tonga. The purpose of this market and marketing study is to investigate the short and medium term opportunities and requirements to take this product development process forward.

⁴ The NWC Breadfruit Research and Extension Officer (Kaitu Erasitu) reports the following damage from category 5 Cyclone Winston that severely impacted western Viti Levu:

- At the time of TC Winston, the 10 leading breadfruit orchards had approximately 1430 breadfruit trees established.
- 3 trees were broken (1 tree was broken right at the base which later had side shoot and is now growing well again). The other two trees were at Prakash and Shan Ali breadfruit orchards in Johnston Rd Lautoka. They just had the top terminal broken. The rest of the branches recovered well in less than two months. Whereby new leaf, new side shoots have started to grow bigger into new branches and new shoots.
- Fruit production at the time was severely impacted. The main production season for both *Uto Dina* and *Balekana* variety is January, February and March. At the time we expecting at least 4 tonnes from our orchards and this would have been their first significant production.
- It was 3 months for next fruiting season and the breadfruit trees to recover before they could yield again – which they all did.
- For the *Uto Dina* variety the fruit loss was higher (around 70 %) compared with that for the *Bale Kana* variety. It was higher for Uto Dina because there were lots of tall trees and more broken branches which with heavy fruiting were easily broken.

3 Commercial breadfruit industry development over the last two decades

3.1 Fiji

3.1.1 Identified export markets

The findings of previous market studies

The large Samoan diaspora living in New Zealand, Australia, and the United States has long been identified as a substantial market for fresh breadfruit, together with other Pacific island communities. This is has to be added Indian, Malaysian and Sri Lankan consumers who also use breadfruit in curry dishes.

In Samoa, breadfruit is a major traditional food staple so there is a significant domestic market for fresh breadfruit. A study carried out in Apia's Fugalei Market in 2001 found that annual breadfruit sales were 40% more than that of taro (Samoa MAFFM (2002 p, 19). At that time, Fiji's taro exports to New Zealand were around 4,000 tonnes and the Samoan population was some 115,000. On this basis the upper limit of the fresh breadfruit market was estimated to be around 4,000 tonnes annually – with a more conservative estimate being 500 tonnes (Nature Way Cooperative, 2005). These estimates were consistent with an in-depth market study by Gordon Grandison conducted in 2004 that found importers could readily sell 4 tonnes of fresh breadfruit per week if available. On the same basis similar, albeit smaller, markets were identified in Australia and the United States. However, without market access for high temperature forced airfare (HTFA) quarantine treated breadfruit, these markets were not relevant when these studies were undertaken. Unfortunately, this remains the case today, despite long pending market access applications being in place.

The Grandison study identified similar market demand for frozen breadfruit with the consumer base extending to the Asian community. For some 20 years Fiji has been exporting small volumes of frozen breadfruit to New Zealand, Australia and the United States. These frozen breadfruit markets have not been constrained by quarantine barriers but faced similar supply constraints as fresh breadfruit exports.

Table 5 below, presents data supplied by the Fiji Bureau of Statistics (FBS) for export of breadfruit products over the period 2006 to 2016. The data is divided into four categories: fresh, frozen, other breadfruit products and total breadfruit products. Other breadfruit products are made up of canned, brined and breadfruit pieces. Total breadfruit exports peaked in 2008, with 40 tonnes exported. They reached 37 tonnes in 2016, despite Cyclone Winston that occurred at the beginning of that year. The fresh exports figures provided by the FBS appear to be inflated when compared with treatment throughput data for the same period provided by Natures Way Cooperative (NWC) who operates the HTFA quarantine treatment facility (table 6). It would seem that some frozen breadfruit exports have been mistakenly inserted into the wrong HS code category and is shown as fresh exports.

Table 5: Fiji's breadfruit product exports (2006-2016)

Fiji breadfruit product exports: 2006-2016											
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fresh breadfruit											
Quantity (kgs)	10,097	23,894	15,863	2,822	1,808	9,984	5,772	8,112	16,442	19,582	6,296
Value (FJD \$ fob)	29,155	43,014	33,740	19,240	9,044	33,070	15,787	32,628	48,293	59,445	46,568
Frozen breadfruit											
Quantity (kgs)	225	0	404	3,573	8,149	7,549	2,916	4,478	9,977	5,343	26,821
Value (FJD \$ fob)	829	0	915	23,365	64,612	31,428	4,163	18,475	34,913	33,163	131,071
Other breadfruit products											
Quantity (kgs)	1,525	5,119	24,120	3,272	8,148	5,026	10,296	3,289	6,853	2,223	4,209
Value (FJD \$ fob)	10,464	30,124	92,042	49,982	45,019	51,909	80,777	9,212	20,741	12,558	24,470
Total breadfruit products											
Quantity (kgs)	11,847	29,013	40,387	9,667	18,105	22,559	18,984	15,879	33,272	27,148	37,326
Value (FJD \$ fob)	40,448	73,138	126,697	92,587	118,675	116,407	100,727	60,315	103,947	105,166	202,109

Source: Fiji Bureau of Statistics

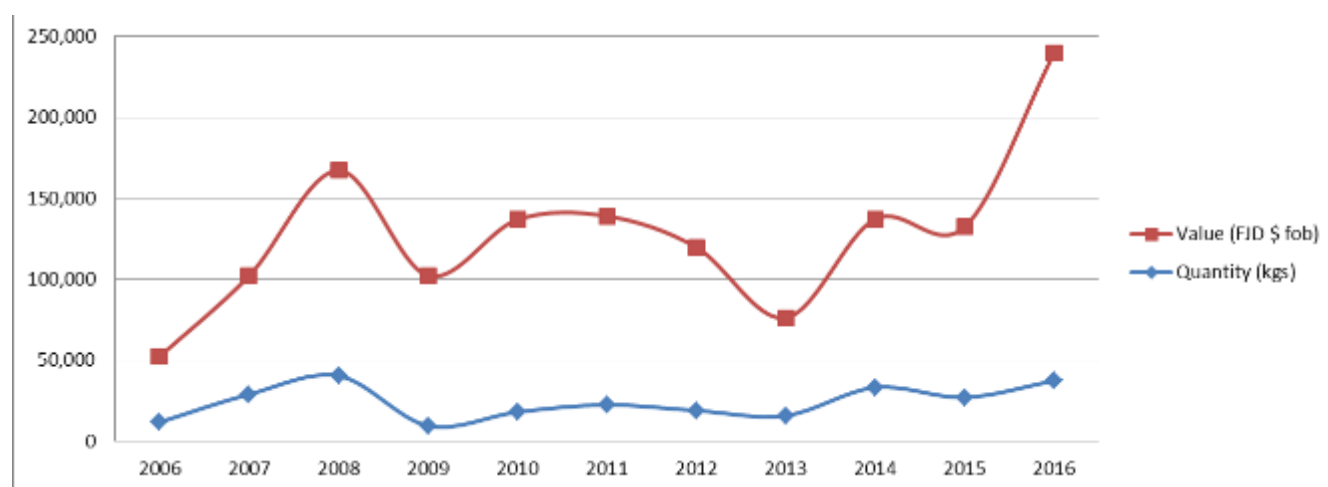


Table 6: Fresh breadfruit treated by the Natures Way Cooperative HTFA treatment facility (tonnes) 2001-2017)*

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Quantity (kgs)	2,063	5,454	6,823	9,936	12,109	4,678	12,804	11,442	2,961	4,368	1,812	1,761	-	2,581	-	-	1,329	80,121

Year	Quantity (kgs)
2001	2,063
2002	5,454
2003	6,823
2004	9,936
2005	12,109
2006	4,678
2007	12,804
2008	11,442
2009	2,961
2010	4,368
2011	1,812
2012	1,761
2013	-
2014	2,581
2015	-
2016	-
2017	1,329

* Natures Way Cooperative (Fiji) Ltd.

3.1.2 Breadfruit orchard development

Fiji began exporting fresh HTFA treated breadfruit to New Zealand in October 2001 – with one tonne shipped that year (table 7). The NWC 5-year Strategic Plan (2002 – 2006), encouraged by the estimated size of the New Zealand fresh breadfruit market discussed above, made optimistic projections for breadfruit treatments: 20 tonnes (2002); 100 tonnes (2003, 2004 and 2005) and 150 tonnes (2006). The projections were based on a combination of positive indicators:

- proven suitability of breadfruit for HTFA treatment;
- the large identified market in New Zealand; and,
- the expected market access to Australia and the United States – which also had a significant identified market.

There was steady growth in breadfruit exports which reached 15 tonnes in 2005. However, this fell far short of the Strategic Plan projection of 100 tonnes in that year. It had become clear that if anywhere near market potential was to be realized the transition had to be made from “wild harvest” to growing breadfruit as an orchard crop. The fresh export breadfruit “wild harvest” value chain is shown in figure 14. This cropping system and value chain could not provide sufficient supply of produce of consistently good quality for market development. With “wild harvest” fruit it was also very difficult to meet the bait spraying requirement under the bilateral quarantine agreement (BQA) for export of fresh breadfruit to New Zealand. The same consistent supply constraint applied to both fresh and frozen breadfruit exports. Thus, the development of breadfruit orchards was deemed an essential requirement to support breadfruit exports (both fresh and frozen) and eventually commercial processing (McGregor et al 2014).

To facilitate the transition from “wild harvest” to orchard breadfruit production NWC prepared a project proposal that was submitted the Australian Centre for International Agricultural Research (ACIAR) for funding. The basis for this proposal is schematically represented in figure 13. This project was further designed to become a Pacific Breadfruit Project (PBP), which commenced implementation in 2011 with ACIAR funding. The key objective of the four (4) year PBP was to establish breadfruit as a commercial small- holder based orchard industry in Fiji.

Figure 13: The “wild” harvest fresh breadfruit export value chain 2004



Figure 14: The PBP poster schematically illustrating the transformation from “wild harvest” breadfruit production and harvesting to breadfruit orchard production and harvesting

The PBP involved concerted applied research effort in three (3) inter-related areas, presented below:

1. Identifying varieties that will extend the fruiting season and develop systems for propagating them (figures 15 & 16).



Figure 15: PBP Extension Officer Kaitu Erasito providing training on breadfruit marcotting for planting material production



Figure 16: PBP planting material nursery at Natalau in the Sabeto Valley, Nadi

2. Developing best practices for the establishment and management of small scale commercial breadfruit orchards (figures 17 and 18).



Figure 17: Intercropping breadfruit orchard with pineapples at Tui's orchard opposite Nadi Int. Airport



Figure 18: Intercropping papaya with breadfruit orchard at Prakash's orchard (Johnson Rd, Lautoka)

3. Establishing harvesting and post-harvest systems to meet export market requirements (figures 19 and 20).



Figure 19: Fruit fly baitspray breadfruit for fresh export to New Zealand under the Bilateral Quarantine Agreement (BQA) at Sahn Ali orchard (Buabua, Lautoka)



Figure 20: Properly packed breadfruit after HTFA treatment and ready for export to New Zealand

The original NWC proposal to ACIAR also included a significant processing/value adding component. However, this component was deleted by ACIAR, suggesting that this be delayed until a later stage when the orchard production base had been established. A small amount of processing work has, nevertheless, been undertaken under the PBP utilizing a different funding source. However, major applied breadfruit research is still required.

As result of the PBP it was projected that by 2020, 20,000 breadfruit trees would be planted in orchards, which would be capable of producing 4,500 tonnes of marketable fruit for export (fresh and frozen) and domestic processing. While considerable progress has been made in establishing breadfruit orchards actual plantings have been substantially less than the initial projections of the PBP. As a result of the PBP nearly 2,000 breadfruit trees have been planted in orchards, of which approximately half of which begun bearing fruit (table 7). There have been 36 farmers on nearly 16 hectares of land. All but one of these farms are located in western Viti Levu with ready access to the NWC quarantine treatment facility at the Nadi International Airport. The exception was the TRTC on Taveuni, which has led the way in small breadfruit processing development.

Table 7: Fiji Breadfruit Orchard Planting of March 2017*

Location	Number of farmers	Number of trees planted trees	Area planted to breadfruit orchards (ha)
Nadi	15	799	6.5
Lautoka	9	340	2.8
Sigatoka	4	145	1.2
Ba	6	125	1.1
Tavua	2	80	0.64
Taveuni (Tutu Rural Training Centre)	1	550	4.0
Total	36	1959	15.6

*Source: Kaitu Erasito Natures Way Cooperative Research and Extension Committee Meeting March 17, 2017

3.1.3 Performance and constraints in realizing export market opportunities

Fresh, frozen and cooked breadfruit exports

Fiji's fresh and frozen breadfruit exports since 2005 were shown in tables 6 and 7 above. Fiji currently has six (6) active exporters of breadfruit products.

- **Mahens Exports** (fresh HTFA treated breadfruit to New Zealand). Mahens Exports, based in the Sigatoka Valley, was one of the pioneer fresh breadfruit exporters, making their first shipment in 2001. The company's exports peaked in 2007 – with some 8 tonnes shipped. For the reasons discussed above there was then a steady decline in exports with no exports made in 2013, 2015 and 2016. With encouragement from the PBP exports commenced again in 2017, with 1.3 tonnes shipped despite the fruit loss incurred by TC Winston in January 2016. Mahen Exports made the first export of fruit sourced from the PBP orchards in February 2018 and steady growth in exports is then anticipated. However, issues remain regarding the viability of the current bait spray regime under the current bilateral quarantine agreement (BQA) discussed below.
- **Viti Fresh Exports** (fresh HTFA treated breadfruit to New Zealand). Viti Fresh is a new export company that was formed in late 2017. Viti Fresh sources a range of fresh fruits and vegetables from the Ba area for export to New Zealand. Viti Fresh has sent three commercial breadfruit consignments via airfreight from December – February 2018.
- **Sai Yee Foods** (frozen and cooked breadfruit to Australia). The Suva based company currently ships around 10 tonnes of frozen breadfruit a month during the breadfruit season (40 tonnes per year) to Sydney as part of a mixed product consignment. Estimates are that the market would be 40 to 45 tonnes a week if a "consistent supply was available at a reasonable price". The company is now transitioning from frozen breadfruit sent by sea to cooked breadfruit sent by air. Cooked breadfruit is seen by the company as a more viable option due to the much lower storage costs. In February Sai Yee Food will be linked the PBP orchards to enhance the company's supply base. An order has been placed for 15 tonnes of fresh breadfruit.
- **Unique Exports** (frozen breadfruit to Australia). The Nadi based company began operations in 2011. Around 2 tonnes of frozen breadfruit are shipped annually with mixed consignments of frozen root crops and vegetables. The company is yet to be linked to the PBP Orchards.
- **Agro Marketing Authority (AMA)**. The Nausori based parastatal marketing company exports an average of 100 – 300 kgs of breadfruit a week New Zealand with mixed consignments of frozen root crops. This breadfruit is sourced from the Central Division and islands of the Eastern Division. The Marketing Manager believes sales to New Zealand could be increased ten (10) fold if they had a consistent reliable supply. They have also received enquiries from buyers in Australia. A meeting with the AMA Marketing Manager and the lead PBP orchards has been arranged for February 2018.
- **Taveuni Kava and Dalo Dealers**. Taveuni Kava and Dalo dealers are large suppliers of frozen dalo and breadfruit to the New Zealand market. The company sources its raw materials from Taveuni but carries out most of the processing (peeling and freezing) just outside of Suva.

The breadfruit orchard development program has yet to have a significant impact on fresh and frozen breadfruit exports. Although the export data for the first 2-months of 2018 – suggest that this starting to change – with over 8,474 kgs of fresh breadfruit exported to New Zealand, this is higher than total

annual exports for the past 9 years. This increase can be attributed to the substantial investment in research and commercial breadfruit production over the past six years led by Nature's Way Cooperative through the ACIAR funded Pacific Breadfruit Project.

The slower than expected impact can be explained by three (3) mitigating factors: the closure of the leading breadfruit export business; the impact of severe Cyclone Winston; and, the unnecessarily excessive bait-spray requirements for fresh breadfruit exports to New Zealand under the BQA. These are discussed briefly below:

- **The loss from the industry of the leading breadfruit exporter.** The Lautoka based National Exports, closed as an exporting business 2014 after the death of company's Managing Director. National was the leading breadfruit product exporter. The company pioneered the development of frozen breadfruit exports to the United States in the 1990s and was one of two companies exporting fresh breadfruit to New Zealand. The gap left by the departure of National has yet to be filled. Although it encouraging to note that the Mahen's Exports, the other long standing fresh breadfruit exporter, recommenced exports to New Zealand in 2017 and the company's first exports in 2018 was largely sourced from breadfruit orchards that were developed by the PBP. This shipment was followed into the market as part of this market study as reported below. The NWC's Board has approved the Cooperative becoming involved in fresh breadfruit exports, if necessary, as a "proof of concept" to encourage private exporter involvement. There has been increasing private exporter involvement in frozen/cooked breadfruit, with Sai Yee Foods exports to Australia. For more than a decade this company has not been able to secure sufficient breadfruit supply to meet the immediate demand in Australia. In January 2018, Managing Director Ken Yee, met with the leading breadfruit orchard farmers to source their supplies for coming season – with the expectation of placing an order of 10 to 15 tonnes depending on price. Meetings have also been arranged with the AMA Marketing Manager.
- **TC Winston.** This category 5 cyclone struck in January 2016 – with western Viti Levu provinces of Ba and Ra being amongst the worst affected areas. While very few breadfruit orchard trees were destroyed, the cyclone severely setback the emerging breadfruit fruiting by more than a year (see section 1.6 above for the impact of climate change on breadfruit).
- **The BQA bait spray requirements.** The bilateral quarantine agreement (BQA) for the export of fresh breadfruit from Fiji to New Zealand requires that the fruit must be sprayed with protein bait for six weeks before shipping. The fruit is then HTFA treated prior to shipment (figures 21 & 22)⁵.

⁵ The purpose of bait spraying is to kill female fruit flies before they lay their eggs. Fruit flies must ingest protein before they can lay eggs. Thus protein yeast with an added pesticide is sprayed on fruit as trap for fruit flies (<https://lrd.spc.int/project/protein-bait-spraying>)



Figure 21: Baitspaying at Prakash's orchard (Johnson Rd. Lautoka)



Figure 22: Baitspaying at Sahn Ali's breadfruit orchard (Buabau, Lautoka)

This particular BQA been in place since 1999 when it was developed jointly by Fiji Quarantine (then located in Ministry of Agriculture) and New Zealand MPI. Breadfruit is a significant host for the two economic species of fruit fly found in Fiji [(*Bactrocera xanthodes* (the Pacific fruit fly) and *B. passiflorae* (Fijian fruit fly)] (http://www.pestnet.org/fact_sheets/fruit_flies__fiji_170.htm). Thus, a bait spraying requirement in the BQA is certainly justified. However, the current requirement of six weeks of bait spraying prior to HTFA undermines the commercial viability of fresh breadfruit exports. It makes the timing of HTFA treated breadfruit exports problematic. The quality of breadfruit exports are very sensitive to the stage of ripeness – needing to be harvested at slightly less than full maturity (mature green)⁶. Consequently, at the time of the booking of an airfreight shipment a significant quantity of fruit that has already reached the mature green stage of maturity and cannot be shipped because it has not met the six weeks

⁶ The optimum stage of breadfruit maturity for domestic breadfruit consumption allows for no more than 2 days before it must be consumed, in Fiji's warm conditions, before it goes soft and is inedible. This would not be sufficient time to allow for export. For export maturity, a breadfruit must have a sufficiently long life to reach the port (or umu/lovo) of the overseas consumer and still taste good. From the time a breadfruit is picked it must have a minimum of six days storage life, calculated as follows:

- Picking and delivery to the exporters shed for sorting, grading and Fiji Quarantine inspection 1 day
- Delivery to NWC for treatment and packing 1 day
- Air freight, quarantine clearance by importing country, delivery 1 day
- Warehouse to retailer 1 day
- Retailer's shelf life 1 day
- Consumer's storage prior to cooking 1 day

Breadfruit for export has to be harvested at slightly less than full maturity, to achieve the necessary balance between shelf-life and acceptable eating quality. Such fruit is best described as mature green. Small (< 100 mm radius for dark green fruit are not acceptable. The eating quality of such fruit will not be acceptable, either in umu, boiled or curried. NWC will also reject such fruit because it has unacceptable heat transfer properties for HTFA quarantine treatment. (see NWC (2005) A Manual for the Growing and Marketing of Breadfruit for Export.

of bait spraying requirement. However, by the time the next shipment can be made it has passed the green mature stage and cannot be shipped, and thus needs to be written off. Even worse, this over mature fruit needs to be removed from the field and disposed of or it becomes a serious fruit fly host. Thus, substantial costs are incurred, well in excess of the cost of bait-spraying itself. All indications are that reducing the bait spray period before treatment to four (4), or even three (3) weeks, would still provide a more than adequate reduction in the incidence of fruit fly infestation. Furthermore, the NWC facility has now been in operation for over twenty (20) years. Over this period over 10,000 tonnes of fruit have been treated and not a single live fruit fly egg, larvae or adult has ever been found. This exemplary track record was not at hand at the time the original and unchanged BQA bait spray regime was put in place. The original bait spray BQA protocols are currently under review as part of NWC Research and Extension Support Project funded by NZMAT. It is hoped that the necessary reforms will be forthcoming to ensure the long-term financial viability of fresh breadfruit exports to New Zealand and in the future Australia and the United States. Should these reforms not be forthcoming it doubtful the large identified market potential for fresh breadfruit exports can ever be realised.

The challenge now is to link the existing breadfruit marketing enterprises with the breadfruit orchards established under the PBP. Mahen's Exports, in February 2018, made the first export for fresh breadfruit sourced from PBP orchards. Kyle Stice accompanied the shipment through its entire value chain. Their visit was sponsored by NWC (with funding by NZ MFAT) as part of their contribution to this Market and Marketing Study. Their findings are presented briefly below. Also, under the auspices of this study, on farm meetings were arranged between frozen breadfruit exporters (Sai Yee Foods and the AMA Marketing Manager) and the leading breadfruit orchards. Creating these marketing links is now an essential step for a steady expansion in fresh/frozen/cooked breadfruit exports.

3.1.4 Breadfruit processing development

While Fiji leads the region in breadfruit orchard development it lags well behind Samoa in breadfruit processing research and development (section 3.2.4). Applied breadfruit processing, was initially expected to be a major part of the ACIAR funded PBP. ACIAR, however, decided that their funding of the processing work should be delayed until the orchard production base was established. Nevertheless, the PBP, using PIFON funding and support from this study, was able to undertake cottage industry scale processing work with its partner organization, the TRTC. This work utilised the expertise of food processing expert Dr. Richard Beyer. This involved the production of breadfruit flour, chips and paste and is reported briefly below and in more detail in annex 3 of this report.

In the past, some breadfruit processing had been conducted by Foods Pacific. Foods Pacific, based in Lami, is one of Fiji's leading food processing companies (www.foodspacific.com). Fresh breadfruit was included in their "minimally" processed pouched product line. However, this venture was discontinued in the face of insufficient and erratic raw material supply. However, during interviews held with the Managing Director, George Patel, as a part of this study, he was briefed on the PBP orchard development program. Mr. Patel expressed interest in meeting with the orchard suppliers and in particular receiving breadfruit samples with the view of reestablishing his processed breadfruit production line. It would be major breakthrough for breadfruit processing development in Fiji to have the active involvement of such a company.

Recommendation: More technical support be provided to move this development forward.

As part of this Market and Marketing Study meetings were also held with Atela Yee, Managing Director of Raiwaqa Bakery, to discuss the prospect of using breadfruit flour as an ingredient in the company's "gluten free" product line. Raiwaqa Bakery currently uses imported rice and cassava flour, with the

addition of xanthan gum, to produce gluten free puddings, cookies and wraps (figure 23). A 2 kg sample of Tutu's breadfruit flour was provided to Raiwaqa Bakery, together with technical assistance from Dr. Richard Beyer. The work with Raiwaqa Bakery remains a work in progress. As would be expected there were issues faced with the first batch of blends made with breadfruit flour. Further consultations with Richard Beyer are required. Funding to support this sort of ongoing technical input is needed.

What Is Gluten?
Gluten refers to the proteins found in cereal grains' endosperm. Gluten both nourishes plant embryos during germination and later affects the elasticity of dough.

THE BIG THREE
Wheat, Barley, Rye

Grain Cross Section
Grain, Endosperm, Germ, Bran

14 Signs You Are GLUTEN INTOLERANT

- ▲ Hair Loss
- ▲ Irritability
- ▲ Dermatitis or Eczema
- ▲ Headaches
- ▲ Weight Loss or Gain
- ▲ Brain Fog
- ▲ Tiredness
- ▲ IBS
- ▲ Autoimmune Diseases
- ▲ Digestive Issues
- ▲ Joint or Bone Pain
- ▲ Lack of Vitamins
- ▲ Abdominal Pain
- ▲ Anxiety or Depression

Raiwaqa Bakery
Gluten Free Products

★ *Gluten-free* ★

Gluten Free Banana Pudding
Ingredients: Rice Flour, Tapioka Flour, Egg, Milk, Margarine, Sugar, Banana
\$1.95 each

Gluten Free Cookies
Ingredients: Rice Flour, Egg, Margarine, Sugar
\$1.99 pack

Gluten Free Wrap
Ingredients: Rice Flour, Tapioka Flour, Egg, Margarine, Sugar
\$1.25 each

Figure 23: Gluten Free product currently on offer at Raiwaqa Bakery

Fiji's leading bakery, Hot Bread Kitchen (HBK), now offers a range of gluten free breads and pastry products. These are made from imported white rice and cassava flour. These niche market products are available three days a week in HBK outlets at Lami, Harbour Point, LIC, Damodar City, RB Patel Centrepoint, Nausori, and Tebara (Fiji Times July 31, 2015). There was not sufficient time and resources available under this study to engage with HBK on breadfruit flour and to provide them with samples from Tutu.

Conclusion: Introducing Fiji bakeries to breadfruit flour and linking them to suppliers remains a priority if significant demand for breadfruit is to be created.

As discussed above the marketing linkages between the newly established breadfruit orchards and Fiji's agro-processing enterprises and fresh and frozen product exporters needs to be significantly enhanced. In the meantime, the breadfruit orchards are securing worthwhile returns from the sale of fresh breadfruit on local markets. The orchards have been established with the *bale kana* variety, sourced from Natewa Bay, Vanua Levu. This variety has attracted a high degree of consumer preference in Viti

Levu municipal markets. For example, as of December 2017, the value of sales on the Lautoka market for two Johnston Rd. orchards was ⁷:

- Prakash – 1600kg @ \$1.50 per fruit = \$2400
- Sahn Ali – 1800kg @ 2.00 per fruit = \$3600

3.2 Samoa

Breadfruit, known as ulu, is one of Samoa's most important traditional food staples and is an integral part of the landscape in almost all Samoan villages (figure 24). It is reported that over 80% of all households have breadfruit as a permanent crop (table 8) and there are significant fresh breadfruit sales on the main municipal markets during the breadfruit season⁸. Samoa has more known varieties of breadfruit than any other PIC⁹. Surveys of the Fugalei market, however, indicate that there are four main varieties *maopo*, *puou*, *ma'afala* and *moamoalega*.

Table 8: Number of Samoan households with breadfruit as a permanent crop*

Region	Puou variety	Ma'afala variety	Other varieties
Samoa (whole country)	20, 685 (74% of households)	18, 238 (65% of households)	14, 594 (52% of households)
Apia Urban	3,047	2,788	1,730
North West Upolu	6,864	5,967	5,089
Rest of Upolu	5,088	6,423	3,057
Savaii	5,658	5,058	4,717

*Source: 2015 Agricultural Survey

⁷ Source Kaitu Erasito, NWC Breadfruit Research and Extension Officer

⁸ Estimated annual sales of breadfruit on Apia's Fugalei market

	tonnes
1997	121
1998	131
1999	117
2000	60
2001	75

Source: Samoa MAFFM (2002)

⁹ The SPC 1966 breadfruit survey identified 166 named breadfruit types in Samoa (Parham 1966).



Figure 24: Typical village breadfruit groves of breadfruit on Upolu in October 2017



The breadfruit fruiting season varies with location and variety. Breadfruit grown at higher altitudes tends to come into production later than breadfruit grown at sea level (Raynor, 1989). This together with Samoa's range of breadfruit varieties mean there is longer seasonal fruit availability than other PICs. The conclusion that can be drawn from Fugalei market surveys is that some breadfruit is available at most times of the year (figure 25). This should give Samoa a significant competitive advantage in the development of a commercial breadfruit industry. For example in Fiji, the fruiting season for production areas that have ready access to the HTFA facility at Nadi airport extends for only 4 to 5 months (Nov/Dec. through until May).

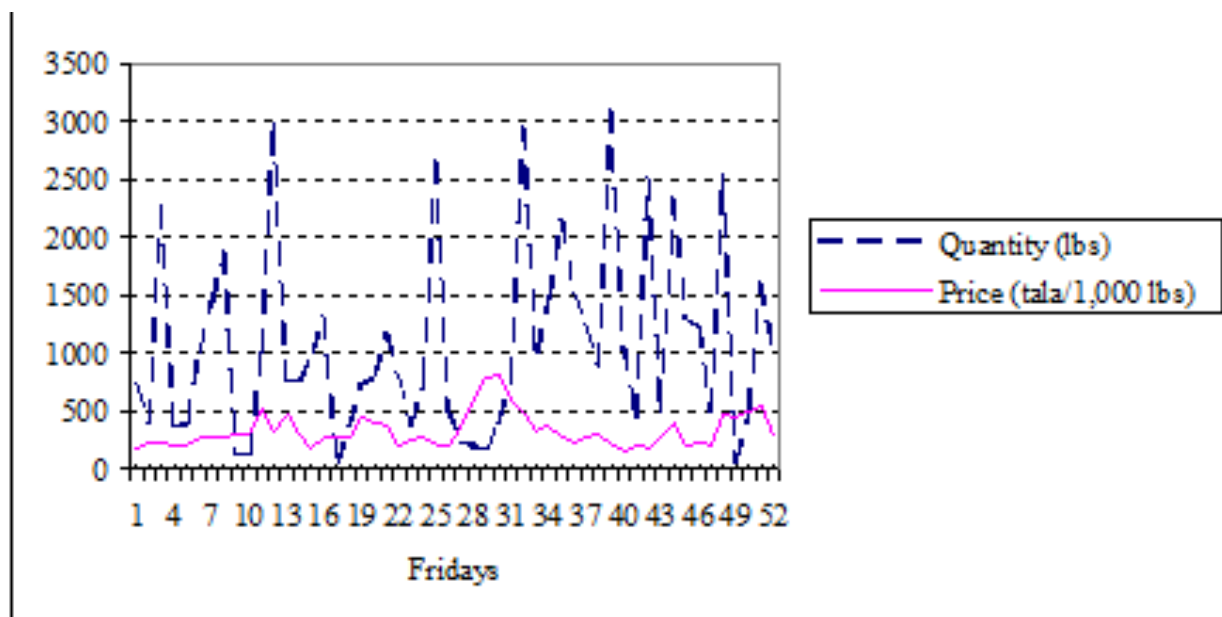


Figure 25: Breadfruit availability at the Apia Fugalei Market derived from the Friday market survey (Source: MAFFM Fruit Tree Development Project: Breadfruit Profile 2002)

3.2.1 Domestic market development of breadfruit in Samoa

Samoa, apart from substantial sales of breadfruit at municipal markets, has led the way in domestic market commercialization of breadfruit. Samoa has a long tradition of staple crop processing – including breadfruit. “Biscuits” (*masi ulu*) were traditionally made from fermented breadfruit and *masi saina* from ripe breadfruit (Cox 1980). However, these products are rarely made today. In more recent times the emphasis has been chips (crisps), largely made by micro enterprises – some of these have also produced breadfruit chips. Two larger enterprises (Tony Howman - T.H. Plantation) and Grant Percival (Natural Foods Int. Ltd) first became involved in breadfruit chip production in the 1990s (figure 26). Both companies have shown that exceptionally high-quality breadfruit chips can be manufactured in Samoa which is a more than acceptable substitute for imported snack foods.



Figure 26: T.H Plantation breadfruit chips being packed back in 2002



Figure 27: SROS manufactured breadfruit flour being sold at Farmer Joes supermarket.

More recently the Scientific Research Organization of Samoa (SROS) has been involved in the production of breadfruit flour which is now being sold through Farmer Joes supermarket stores (figure 27).

3.2.2 Export market development

Fresh breadfruit exports

Samoa began exporting fresh HTFA treated breadfruit to New Zealand in 2004 utilizing the small research scale HTFA facility operated by the Ministry of Agriculture's Atele Horticulture Centre (Figure 24). The fruit was harvested from the Centre's own breadfruit orchard that had been established several years earlier. In that year two consignments totalling 213 fruit (192.35 kg) were exported to New Zealand (Tuivavalagi, 2016). Tuivavalagi reports HTFA treated fresh exports peaked in 2006, when nearly 39,000 fruit (43.6 tonnes) were shipped. This is more than three (3) times the maximum exports that Fiji was able to achieve in 2007. This was despite Samoa only having an experimental scale HTFA

unit. However, in spite of this encouraging initial progress Samoa's fresh exports subsequently decreased and then ceased as reported by Tuivavalagi:

Issues with the Quarantine pathway and bait spraying became cumbersome for Samoan farmers that proved destructive to continue fresh exports of breadfruit to New Zealand. Efforts and meetings have continued with New Zealand but the momentum of exporting is now lost on farmers who have moved on to other crops for their livelihood (p, 13).



Figure 28: Packing breadfruit for testing in the Atele research scale HTFA facility at the Atele Horticulture Centre

Thus, as with Fiji, the BQA, particularly the bait-spray regime, has proven to be a major constraint in taking advantage of the identified fresh breadfruit export markets. For Samoa this has proven to be an even more binding constraint to fresh export development due to the absence of breadfruit orchards.

Frozen and processed breadfruit exports

Despite the cessation of fresh breadfruit exports to New Zealand, frozen exports have continued utilizing the Atele packing facilities. According to data supplied by the Ministry of Agriculture's Quarantine Department, 354.7 tonnes of frozen and cooked breadfruit were exported in 2017, of which 191.8 tonnes was shipped to New Zealand and 162.2 tonnes to Australia. There were five (5) separate exporting companies involved in these exports. The exports in 2017 represent a substantial increase in exports over the last decade, with only 19.9 tonnes exported in 2007.



Figure 29: Preparing breadfruit for freezing at the Altele in October 2017



Figure 30: Breadfruit flour sourced from Samoa is available in Auckland and online through <http://www.glutenfreestore.co.nz/>

The current volumes of frozen breadfruit products are well below those exported by Samoa in the 1980s. Papalii Grant Percival in his presentation to the October 2017 Pacific & Global Breadfruit in Apia noted:

In the 1980s breadfruit was plentiful and cheap. It cost less than US 0.01c per fruit. Natural Foods was set up to process taro, breadfruit and banana into products that could be sold.

- Fried as snacks
- Frozen for the markets
- Dried and turned into flour

These foods were intended for our diaspora however we also produced to order. New equipment was purchased and a new factory built with concessional interest loans.

This is not a short process and finally production started. SPARTECA had been formalized and we were able to get product into New Zealand at zero tariff. Transportation was not an issue as there were weekly freight services to New Zealand and USA. There were also daily services to the other Pacific Island Countries and twice weekly services to Hawaii and 4 times weekly to New Zealand. So, we were able to use sea and air freight.

NFIL exported 14 containers (approx. 140 tonnes) of frozen breadfruit to New Zealand in August of 1989. The product was peeled, cored, sliced into 200gr sizes, blanched, coconut cream added, vacuum packed and then blast frozen for the market. We offered two years shelf life. The coconut cream was later packed in a sachet with the breadfruit rather than in the packet with the ulu. Packaging had to be sourced capable of handling the process.

Our vulnerability to weather events was then revealed and we were badly damaged. We lost all sources of raw materials. We had extensive damage to the factory. We had minimal insurance. That was used to develop new product lines for some of our machinery and to try and survive. We repaid our loan and kept going until an IMF review recommended that the concessional long-term loans be adjusted to market conditions and interest rates increased overnight to 12% from 6%, our market was opened up and the high tariff borders removed. The high investment in production meant repayments sky rocketed and the reduction in the margins between imports and local production meant we had to really tighten our belts.

We are in the process of developing our new factory and have ordered the components needed and submitted our second request for tariff concessions. At present, wheat flour is tariff free as is most of the bulk foods we import for distribution whereas all our inputs are taxed. It is an additional cost on top of the high cost of transportation to and from Samoa. Our business plan indicates we will need to absorb a fair cost to develop this product. Currently breadfruit in season is down to 0.40c a kg and out of season can be up to \$2 a kg. As SROS showed yesterday this translates to a raw material cost to finished product of \$3.60 to \$18 per kg.

3.2.3 Samoan breadfruit orchard development

Samoa was an early pioneer of breadfruit orchard development in the Pacific islands. The Research Division of the Ministry of Agriculture established a small breadfruit orchard at the Atele Horticultural Centre in 1996. This was expanded to over 300 trees in 2001 under the auspices of the UNDP Fruit Tree Development Project (MAFFM 2002 (figures 31, 32, 33)). A range of popular varieties were planted at the Atele orchard¹⁰ – utilizing root suckers and aerial layered (marcotts) as planting material. This demonstration orchard had a number of applied research objectives, including:

- the selection of the best varieties for fresh export and processing;
- nursery practice to rapidly multiply selected varieties;
- an appropriate package of practices for breadfruit grown in small orchards – with particular attention given to yield potential, pruning, disease control, and the economic returns from fertilizer application;
- the most efficient methods of bait spraying;
- facilitating the local commercial manufacture of protein bait in collaboration with the Vailima Brewery;
- the optimum harvesting time for shelf life, taste and quality; and
- harvesting methods and equipment to minimize damage to fruit.

Some twenty years on, the Atele Horticulture Centre orchard continues to be well maintained and represents a valuable resource for the development of the Samoan commercial breadfruit industry. However, it was expected that the Atele orchard would serve as demonstration that would lead to the proliferation of small holder commercial orchards. This is yet to occur and raw material supply remains a constraint to the Samoan breadfruit industry reaching anywhere near its full commercial potential as outlined above by Papalii Grant Percival.

¹⁰ *Ulu Uea; Ulu Hawaii, Ulu Puou, Ulu Maafala, Ulu Manu'a, Ulu Fagufagu, Ulu Sina, Ulu Aveloloa, Ulu Kala, Maopo, Ulu Maa; Ulu Momolega.*



Figure 31: *ma'afala* root sucker planted at Atele Horticulture Centre Orchard in 2002



Figure 32: A flowering *ma'afala* marcott in 2002 one year after planting at Atele orchard



Figure 33: The well maintained Atele Horticulture Centre breadfruit orchard in October 2017

3.2.4 Samoan breadfruit processing research and product development

Samoa has been the Pacific's pioneer in breadfruit processing research. This dates back to the work in the 1980s at the University of the South Pacific's Alafua Food Processing Facility:

- Wooten, M. and Tumallii F. Breadfruit production, utilization and composition: A Review. *Food Technology in Australia* 36 (10): 464-465.
- Michael Wooten and Faale Tumaali (1984). Composition of Flours from Samoan Breadfruit: A Research Note. *Journal of Food Sciences* Volume 49. This flour was manufactured for 7 breadfruit varieties at various stages of maturity (see table 3).

USP Alafua has continued to undertake breadfruit processing research and product development. USP Food Technologist Professor Lut. Palomar in her presentation to the October 2017 Samoa Breadfruit Summit presented a range of mainly cottage industry breadfruit products her unit is currently working on. This included (figure 34):

- from fresh unripe/half ripe fruit (chips, instant juice, dip, pickles)
- from breadfruit flour (pan cake mix, pan cake, cookies, chiffon cake, cake roll)
- from ripe flour (quench drink, breadfruit flavoured home-made honey, pan cake syrup and jam, marmalade)



Figure 34. Cottage industry scale processed breadfruit products displayed by USP at the 2017 Breadfruit Summit

It has been the Scientific Research Organization of Samoa (SROS) at the forefront of more recent applied breadfruit processing research. The focus has been on commercial scale breadfruit processing of four products: 1) breadfruit flour, 2) peeled frozen breadfruit, 3) frozen breadfruit fries; and, 4) precooked breadfruit pieces. The work in the four areas is summarized below:

Commercial scale breadfruit flour

The SROS Report to the Breadfruit Summit concluded the following regarding breadfruit flour:

- Technical research for the breadfruit flour process has been completed and final product quality has been completed.
- SROS has embarked on promotional activities with samples sent to local restaurants and potential clients in New Zealand and Japan. The breadfruit flour is now being sold through Famer Joes supermarkets in Apia (figure 27 above)
- SROS has developed a business case for 72 tonne annual capacity processing facility for breadfruit flour.
- The major production cost identified are drying and the cost of fruit – both need to be substantially reduced to achieve sustainable commercial viability.
- The yeast by-product from manufacturing flour has been supplied to Vailima Breweries for making natural beer¹¹ and as an animal feed.

¹¹ Vailima has temporarily the commercial manufacture of breadfruit beer but indicated that it will again manufacture the product in the near future.



Figure 35: Sliced breadfruit being dried at SROS.

The main conclusions from the SROS 72 tonne/year breadfruit facility feasibility study were:

- Total investment USD 750.000 (capital USD 300,000 operating for first 14 months operation) this is for two chip drying units (one on Upolu and one on Savaii)
- Break-even in about 4 years after nearly 230 tonnes of flour and been produced and sold (based on a 30% margin over production costs)

Such a venture would require an investor with access to substantial capital and a long term vision.

Peeled frozen breadfruit

The SROS Report to the Breadfruit Summit discusses the process of peeling, washing, blanching and freezing breadfruit (figure 36)



Figure 36. The SROS process of peeling, washing, blanching and freezing breadfruit

The SROS applied research investigated the optimum set of stepwise procedures to produce quality frozen breadfruit products shown schematically below in the SROS Breadfruit Summit presentation (figure 37).

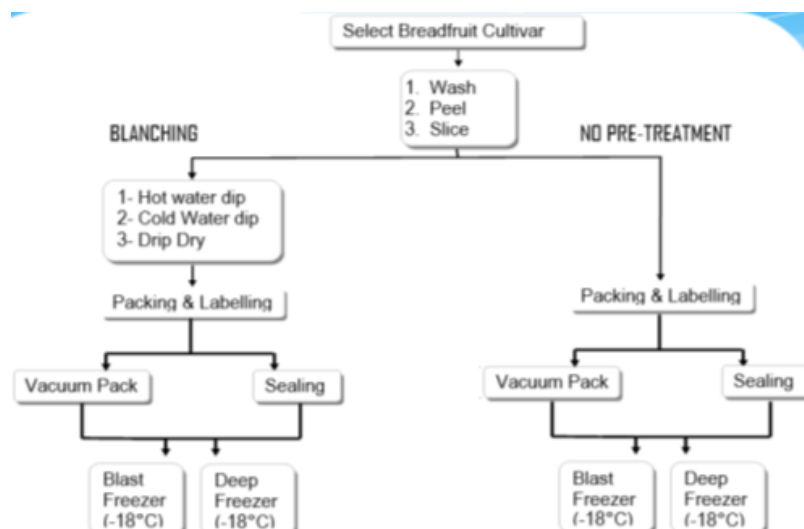


Figure 37: The SROS stepwise procedures for producing quality breadfruit products

This ready to cook product is already being exported by Samoan enterprises to Australia and New Zealand and has been shown to be viable for reasonably small-scale enterprises.

Frozen breadfruit fries

This product has been developed by SROS as a substitute for imported potato fries. Samples have been sent to local restaurants and bars and to contacts in New Zealand and Japan – which is reported to have received a positive response. SROS sees this product as being suitable for micro enterprises in the same way breadfruit chips have been – although greater capital investment is required with access to freezing capacity being necessary.



Figure 38: Ready to use breadfruit fries now available in local restaurants

Pre-cooked packaged breadfruit pieces.

This has been developed by SROS targeting both domestic and export markets. For the local market this product would be sold in the off season. In the past Samoa had exported whole Umu cooked breadfruit. However, this trade was shut down when New Zealand Quarantine found fresh whole uncooked and untreated breadfruit included hidden in a consignment. This is seen as a product for micro enterprises, with SROS providing training for youth and women's groups.

3.3 Revisiting the Australian and New Zealand market in 2017/18

The Australian and New Zealand Market were visited as part of this market study. Detailed reports from these market visits are presented in Annex 1 and Annex 2 and are summarised below.

3.3.1 Summary of Australia Breadfruit market visit

The Australian component of the 'Breadfruit Market and Marketing Study' comprised visits to Melbourne, Canberra and Sydney. This was undertaken by Kyle Stice and involved meetings with importers, retailers and processors. In advance of the Australia field visit, meetings were also conducted with Fiji based exporters.

Support for the Australian field visit was provided by the Pacific Trade and Invest (PT&I). PT&I also provide some coordination support through Mr. Jeremy Grennel (Coordinator- Export and Enterprise Development, Sydney Office). Over the course of the Australian Market visit, consultations were held with: 5 importers, 10 retailers and 1 processor.

Discussions with importers, retailers and processors of breadfruit in Australia confirmed that the primary consumers of breadfruit in Australia are:

- The Pacific island community – particularly Samoans
- Certain segments of the Asian community
- Potentially, gluten and grain free buyers

Discussions with importers, retailers and processors of breadfruit in Australia confirmed the following regarding sources, pricing and availability of breadfruit products in Australia:

- All fresh breadfruit is currently supplied through domestic production
- Domestic fresh breadfruit supply is very erratic and expensive due to the lack of commercial production
- Frozen breadfruit supply is coming exclusively from the Pacific Islands
- Fresh breadfruit imports are currently not permitted for any country however the Pacific is in the pipeline for market access

Regarding market demand, the market visit revealed the following conclusions:

- **Fresh breadfruit** – With the current scenario of domestic supply, which is reportedly sporadic and expensive, the market for fresh breadfruit is very limited – around 20 tonnes per year as is currently supplied from North Queensland .

With the prospect of market access for Pacific breadfruit a wholesale price of AUD \$7/kg for fresh breadfruit was calculated (using the NZ market as a comparison but factoring in real freight and clearance costs for the Australian market, which tend to be higher). This wholesale price was used in discussions with importers and retailers in Australia to determine the potential market. Based on feedback from importers and retailers, it is estimated that the immediate demand in Melbourne and Sydney would be around 9 tonnes per week. An additional 3 tonnes per week is estimated as the potential demand from Brisbane. If six months of supply can be achieved this would be a total annual volume of some 300 tonnes from all suppliers and to all markets.



Figure 39: Fresh breadfruit from Nth. Qld. available in Melbourne at a retail cost of AUD \$19.99/kg.



Figure 40: In the absence of fresh breadfruit, Pacific Islanders living in Australia have access to frozen breadfruit along with other frozen root crops.

- **Frozen breadfruit** – Based on feedback from importers and retailers the overall estimated demand for frozen breadfruit at current pricing would be around 4 tonnes per week over a 12 month period from all suppliers to all markets which is 240 tonnes per annum. Frozen breadfruit market demand will always be linked to other root crops such as taro and cassava and if supply/prices fluctuate significantly this will affect the demand for breadfruit.
- **Breadfruit flour** – Only one potential buyer of breadfruit flour was visited in the market with a requirement of 400 kg of breadfruit flour every month or a total of around 5 tonnes of breadfruit flour per year. It can be assumed that there are at least 3 additional potential buyers of breadfruit flour from the gluten/grain free market in Australia which could result in a market demand of around 15 tonnes per year. However, more specific detailed market research is required.

Consultations with exporters, importers and retailers identified a number of key requirements for the Pacific Island to meet the identified market demand for breadfruit in Australia including:

- Market access achieved for fresh breadfruit
- Consistency of supply and extended season
- Careful attention to quality (variety, maturity, handling)
- High volumes per consignment to spread out the high clearance costs in Australia

3.3.2 Summary of New Zealand Breadfruit market visit

A breadfruit market and marketing study visit was conducted in Auckland, NZ from February 14th – 18th, 2018. The market study covered fresh breadfruit, frozen breadfruit and breadfruit flour. The market visit coincided with the peak breadfruit season and thus captured a number of valuable insights into the value chains for fresh and frozen breadfruit from Fiji to NZ.

The market visit included discussions with 4 importers, 6 retailers and one processor. Discussions with importers, retailers and processors of breadfruit in New Zealand confirmed the following information about the buyers of breadfruit:

- **Primarily Pacific Islanders for fresh and frozen breadfruit** – The main buyers of fresh and frozen breadfruit in New Zealand are Pacific Islanders. New Zealanders of Samoan decent represent the largest segment of Pacific Islanders who buy breadfruit followed by Tongans and then Fijians.
- **Some segments of the New Zealand Asian community buy breadfruit but in relatively small volumes** - There exists a very large Indian and Asian community across New Zealand with a significant concentration in Auckland. Indians and Asians will purchase breadfruit when it is available however the fruit is generally cooked as a curry and served as an accompaniment and not the main meal and thus the volume purchased per household is much lower compared to the Pacific Island consumer.
- **Price is an important factor and breadfruit will compete with other root crops** - The Pacific Islanders living in Auckland are generally price conscious consumers however the large number of family and community island functions results in high purchasing of Pacific foods including breadfruit. It is very common for most members of the Samoan and Tongan community to attend church on Sunday followed by a family or community lunch – this meal almost always includes traditional ‘island foods’.

Taro remains the main ‘island staple’ purchased by Pacific Islanders in New Zealand as it is readily available at a much lower price than breadfruit (especially since Samoa has re-entered the market) (figure 41). However, because breadfruit is seasonal it provides a unique buying opportunity and Pacific Islanders will often ‘buy it while they can’ for a special occasion. Other root crops such as a cassava, yams and kumara are readily available and often provide cheaper alternatives to breadfruit.



Figure 41: Breadfruit available in a South Auckland store at a much higher price than taro

- **There is a small but growing market for breadfruit flour from ‘gluten free’ and ‘grain free’ buyers** – Discussions with one processor confirmed that there is a small but growing market for breadfruit flour from consumers that are ‘gluten free’ or ‘grain free’. This ‘gluten free’ or ‘grain free’ requirement from buyers is primarily due to the growing number of health conditions associated with gluten in grains.

Consultations with importers and retailers of breadfruit in New Zealand provided valuable information on sources, pricing and availability, this is summarized below:

- Fresh breadfruit in New Zealand is currently supplied exclusively from Fiji. Tonga had resumed fresh exports in 2015 and 2016 however this trade was suspended due to compliance issues and has not resumed. Fresh breadfruit exports from Samoa are currently constrained by the small scale of the HTFA quarantine treatment facility.
- Fiji breadfruit wholesales in Auckland at around NZD \$7/kg and is sold in 10 kg cartons. The average fruit size is 1.2 kgs. Fresh breadfruit retails in Auckland at around NZD \$8 – 10/kg. As a comparison, fresh taro retails at around NZD \$2- 6/kg.

- Fresh breadfruit is generally available in New Zealand between December – March and June-August.
- Frozen breadfruit in New Zealand is currently supplied from Fiji, Samoa and Tonga. Frozen breadfruit is generally sent as part of mixed frozen consignments that may including taro, cassava and a mix of ethnic vegetables.
- New Zealand used to allow cooked breadfruit to be imported into New Zealand however due to the discovery of several 'personal consignments' not being cooked properly, NZ MPI now requires that cooked breadfruit be done in commercial bakeries or frozen.
- Frozen breadfruit wholesales at around NZD \$4/kg and retails at around NZD \$5/kg. As a comparison, frozen taro wholesales at around NZD \$3.50/kg.
- Frozen breadfruit is generally available for around 6 months of the year coinciding with the main breadfruit seasons.
- Breadfruit is currently being supplied to Gluten Free Store from a source in Samoa. The product is packed in 20 kg 'flour bags' that are lined with plastic. The price paid NZD \$4.50 /kg plus freight (which is paid by the importer).



Figure 42: Frozen breadfruit available from Fiji, Samoa and Tonga, retailing for around NZD 5/kg

The breadfruit market visit to New Zealand revealed a number of issues and constraints which are summarized below:

- **Reliability of supply** – A common point of feedback from importers and retailers was the issue of reliability of supply. It is generally agreed that if breadfruit could be supplied on a more consistent basis there would an opportunity to really develop the market. As it is now, the importers and retailers are not sure from week to week if they will be receiving any supply and this complicates the planning and marketing.
- **Quality** – A number of quality issues were identified for fresh breadfruit in New Zealand including: immature fruit, short shelf life varieties and physical damage.

The issue of immature fruit was highlighted by several importers and retailers as a recent consignment from Fiji reportedly had a high amounts of immature fruit. Immature breadfruit will not cook properly and will be very watery. One retailer provided a sample of immature breadfruit that had been returned by a customer after they purchased it, cooked it and discovered it was not even edible. The retailer had to credit customer and also reduced his breadfruit order to the importer by 50% for the following week. It is reported that many Pacific Island customers are very knowledgeable about breadfruit maturity and when they see a very green fruit they will not buy it, they prefer to have fruit with a slight yellow colour on the skin.

- **Pest occurrence and biosecurity inspections/charges** – Feedback from importers in New Zealand highlighted pest occurrence and biosecurity inspections/charges as a major constraint/risk. The stem end of breadfruit provides a perfect hiding place for insects such as a mealy bug, scale and white fly. Upon arrival in NZ, MPI conducts inspection on a sample of fruit from the consignment and if any insects are found then a further inspection maybe required to

identify the insect and determine if they are alive or not. This pest ID will cost an additional NZD \$200 on top of the normal NZD \$500 inspection fee charged on all consignments. Other biosecurity related issues that were identified by importers included: the difficulty in securing an inspector to clear the consignment and a new requirement to use a biosecurity approved facility for inspections (additional costs on the importer).

- **High price** – The retail price of fresh breadfruit in New Zealand was generally regarded by importers as a major constraint to expanding sales. At a retail price of NZD \$8 – 10/kg, breadfruit is far more expensive than products such as fresh taro which retail at NZD \$2- 6/kg. The high retail price is a direct result of high costs across the value chain starting on the farm with BQA compliance requirements such as bait spraying and farm registration. High costs are also occurring around the labour required for harvesting, washing and grading to ensure that there are no pests present. Biosecurity, quarantine treatment and freight costs have also been increasing over the past decade which is impacting the landed cost of breadfruit. In New Zealand, importers face significant clearance, biosecurity, transport costs and run the risk of having to pay for a pest identification and worst case scenario for reshipment or destruction of a consignment. The retailers of breadfruit put a substantial mark up on fresh breadfruit due to its high perishability; they must make enough money on each fruit to cover the cost of losses.

Consultations with importers and retailers provided the following information regarding New Zealand market demand for breadfruit:

- **Fresh breadfruit** – Based on feedback from importers and retailers in the New Zealand market it is estimated at the current pricing the demand for fresh breadfruit will be around 8 tonnes per week from all sources and all markets. If six months of supply can be achieved this would be a total annual volume of around 190 tonnes. If a number of improvements in the value chain were made including bringing down the price of fresh breadfruit it is estimated that demand would increase to around 12 tonnes per week from all sources and all markets. If six months of supply can be achieved this would be a total annual volume of around 300 tonnes.
- **Frozen breadfruit** – Based on feedback from importers and retailers the overall estimated demand for frozen breadfruit at current pricing would be around 5 tonnes per week over a 12 month period which is 240 tonnes per annum. Frozen breadfruit market demand will always be linked to other root crops such as taro and cassava and if supply/prices fluctuate significantly this will affect the demand for breadfruit.
- **Breadfruit flour** – Only one buyer of breadfruit flour was identified in the New Zealand market with a requirement of 1 tonne of breadfruit flour every three months or a total of 4 tonnes of breadfruit flour per year. It can be assumed that there are at least 3 additional potential buyers of breadfruit flour from the gluten/grain free market in New Zealand which could result in a market demand of 12 tonnes per year.

The New Zealand market visit identified a number of improvements required to meet the identified market demand, including:

- **Improved quality (variety, maturity, handling)** – It was very clear from consultations with importers and retailers that if the quality of breadfruit is not improved in terms of the variety selection, stage of maturity and handling (reducing physical damage) that the market for fresh breadfruit will not be able to expand in New Zealand. Importers and retailers currently perceive breadfruit as a 'high risk' product due to the high costs and quality issues currently being faced.

Fortunately, many of these issues are relatively easy to overcome through improved harvest and post harvest handling. In the case of Fiji, where commercial orchards are now coming into production these quality issues become much more manageable. For the wild harvest production, these issues will continue to persist.

- **Improved consistency of supply and extended season** - A common point of feedback from importers and retailers was the issue of reliability of supply. It is generally agreed that breadfruit must be supplied on a more consistent basis in order to reach the identified market demand. Presently, the importers and retailers are not sure from week to week if they will be receiving any supply and this complicates the planning and marketing. Moving into commercial production of breadfruit and diversifying the 'market approved' varieties is seen as the primary way to address this issue of consistency of supply and extended season.

4 The demand for breadfruit and breadfruit products and the requirements to meet market opportunities

4.1 The drivers of demand

The demand for breadfruit, as for any product, is driven by a combination of the following variables:

- The price of the product and the price of competing substitutes
- Population growth
- Income growth and the income elasticity of demand for the product.
- Consumer tastes and preferences

These variables are considered below in terms of both domestic and export markets.

4.1.1 Domestic markets

The price of breadfruit and the price of close substitutes

Fresh breadfruit

For most PICs, fresh breadfruit is a minor product sold on domestic markets – with Samoa being an important exception. In Fiji, indications are that this is now starting to change with high quality *bale kana* fruit starting to become available in western Viti Levu markets source from the breadfruit orchards established by the PBP. As noted above, the two leading orchards in the Lautoka area were able to sell 3.5 tonnes of fruit in December 2017 at the Lautoka market valued at over FJD \$6,000 (\$1.70/kg or 1.75kg/fruit). More could have been sold if the fruit was available. As the orchards come into full production sales can be increased significantly – prices can be expected to fall, however the total revenue earned by the orchard farmers can be expected to increase.

In Samoa, in the 1990s, well over 100 tonnes of breadfruit was being sold annually on Apia's Fugalei market, which was around twice that of taro sales (MAFFM 2002). Depending on the time of year the price received for this breadfruit ranged from .4 to 1.5 tala/kg (figure 19). Since that time breadfruit prices have essentially doubled (Papalii Grant Percival presentation to the 2017 Breadfruit Summit). This price situation is unlikely to change for the foreseeable unless breadfruit starts to be grown as an orchard crop.

Close substitutes

For breadfruit sold on fresh product markets the main close fresh product substitutes are the other traditional staple crops and imported potatoes. To this has to be added the broader product substitution of traditional staples by imported grains (rice and wheat products).

For Fiji, the main traditional staples sold are dalo (*colocasia* taro), cassava, kumla and dalo ni tana (*xanathosoma* taro); for Samoa *colocasia* taro, Tonga *colocasia* taro, plantains and yams; and Vanuatu cassava, sweet potato and taro (*colocasia* and *xanathosoma*). These other traditional foods have a far greater share of the market and are generally sold at much lower prices than the small volume of fresh breadfruit that has entered the market – again the exception to some extent is Samoa.

In the case of Fiji, the main focus of this study, the breadfruit sales for fresh are insignificant compared with these products. According to the 2009 Agricultural Census some 40,000 farmers grew 40,500

tonnes (71% of production) is sold on domestic markets. The estimated market value of these sales was FJD 94.5 million (Fiji Min. Ag. 2017). This represents an average market value at the time of the 2009 Census of FJD 2.30/kg. For cassava the figures are somewhat less, but still substantial.

In December 2017 the average selling price for dalo in the Lautoka market was \$2.62/kg and for cassava \$0.81/kg (AgTrade Min. Ag Market Surveys). This compares with the \$1.70/kg received for *bale kana* breadfruit grown on PBP orchards. In February 2018, breadfruit was selling in Suva suburban road side markets for \$1/fruit (figure 43).

Thus, breadfruit was relatively price competitive with dalo and can be expected to become increasingly so as more breadfruit sourced from the orchards enters the market. Into the future, breadfruit can be expected to adapt better to climate change than dalo, which will impact on relative prices. If domestic fresh market sales from the breadfruit orchards reach 5% of the value of and cassava sales it would represent a market approaching FJD 10 m.

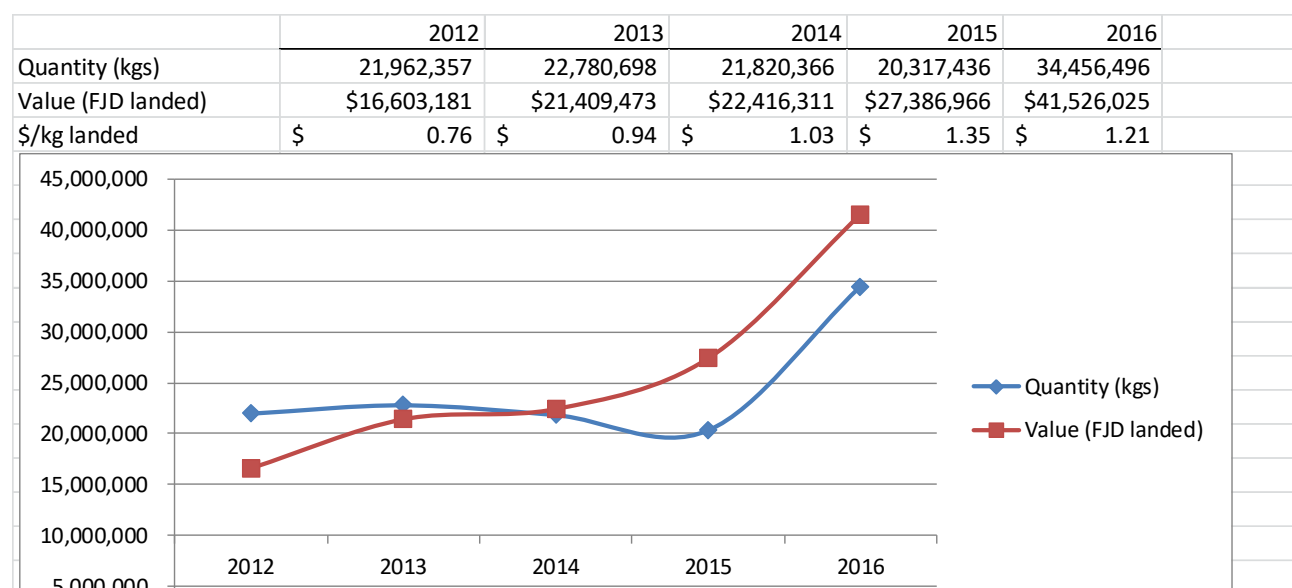


Figure 43: Breadfruit for sale at Narere roadside market Feb 2018

dalo

For the fresh breadfruit consumption, the major substituted fresh product is imported potatoes. Potatoes are also seen as the main imported product for frozen breadfruit. Fiji is a large importer of potatoes with nearly 35,000 tonnes, valued at over FJD 40 million, imported in 2016 (table 9). For many years the Fiji Ministry of Agriculture has been promoting local potato production as one of its major import substitution activities. Due to environmental and climatic considerations locally grown potatoes are seen to be increasingly unsustainable without substantial government subsidies. Orchard produced fresh breadfruit is seen to be already price competitive with imported potatoes, given the landed prices shown in table 9. However, the major disadvantage fresh breadfruit has relative to potatoes is its short shelf life. This disadvantage is largely overcome by frozen breadfruit pieces – however, such a product is yet to be available on the Fiji domestic market, and when it becomes available its price is likely to be significantly higher than that of imported potatoes.

It is projected that the price of imported potatoes, together with that of imported grain products, will increase relative to traditional staples including breadfruit due to the impact of climate change (see Section 1.6 above). Regardless of the impact of climate change, Table 8 shows a significant increase in the price of imported potatoes in recent years. If breadfruit (fresh and frozen) could capture only 5% of potato imports this would present a sizable market (around 1,700 valued at FJD 2 million at current import levels).

Table 9: Fiji's imports of fresh and frozen potatoes - 2012 – 2016*

* Source: Fiji Bureau of Statistics. (Excludes the import of seed potato for planting by farmers)

Processed breadfruit

Breadfruit flour

As yet, there is no commercial processing of breadfruit flour in the PICs thus is difficult to get data on actual prices for breadfruit flour. However, it can be expected that the price for breadfruit flour will be significantly higher than the price of its close substitute, imported wheat flour (or in the case of Fiji the wheat is imported and processed in Fiji).

Kuinimeri Asora- Finau in her 2017 Breadfruit Summit presentation on the breadfruit flour processing feasibility conducted by SROS said that the cost of producing breadfruit flour ranged from 3.60 tala to 18 tala/kg of finished product, depending on when in the season the breadfruit was purchased. The major costs identified were: the cost of raw material (the breadfruit); and, the cost of drying. The average weight of the fruit used in the SROS commercial processing trial was 2 kgs and on average six (6) fruit were required to produce one (1) kg of breadfruit flour. This translates to a particularly high conversion ratio of 12 kgs of raw material to produce 1 kg of final product.¹²

In Fiji, the TRTC has achieved somewhat better recovery with their small-scale breadfruit flour processing facility. Tutu has required 5 *bale kana* fruit (average weight per fruit 1.5 kgs) per kg of flour. The breadfruit has been sourced from the Centre's own orchard. Tutu generates its own electricity via its own long-established hydro-electricity facility – thus energy costs of drying are minimal. The breadfruit flour is being sold to a number of stores on Taveuni for FJD \$4/kg – which is seen to be the Centre's break-even price. The same stores retail wheat flour at less than half that price.

¹² In comparison the average extraction from wheat to flour is around 75% (<https://nebraskawheat.com/wp-content/uploads/2014/01/WheatFromFieldToFlour.pdf>.)

As shown in table 4 above, Fiji's average annual wheat product imports over the period 2012-16 was around 135,000 tonnes with an average landed value of FJD 106.6 million (FJD .82/kg). In Fiji, wheat flour is subject to price control under the Commerce Commission. In November 2017, the wholesale price for a bakery wishing to source wheat flour was FJD 28 per 25 kg bag (\$1.12/kg VIP)¹³. In major Viti Levu supermarkets white wheat flour retails for around FJD 5.20/for a 4kg bag (figure 44).



Figure 44: Flour retailing at New World Demodar City Suva January 2018.

Thus, breadfruit flour, from this limited initial experience in Samoa and Fiji, is currently a long way from being price competitive as a substitute for wheat flour in its general use. However, the more immediate direct market for breadfruit flour is in the niche gluten free bakery market. Here the competition is with rice, cassava, maize and millet flour. A bakery in Fiji wishing to source these gluten free products could source them for the following prices from Punjas (Fiji) Ltd¹⁴:

- Rice Flour 42.08/25 kg bag - \$1.69/kg VIP
- Cassava Flour \$56/25 kg bag - \$2.24/kg VIP

Small quantities of gluten-free flour are also retailing in major supermarkets such as New World. (Damodar City) Suva, which are not subject to price control. In January 2018, maize/cassava flour was FJD 8.75/750 gm (\$11.66/kg) and sorghum and millet flour imported from India FJD 8.95/kg (figure 45). Breadfruit flour could certainly compete with these products – particularly if they were well labelled and the consumers were made aware of the health and nutritional advantages offered by breadfruit flour.

¹³ Source Atela Yee Managing Director Raiwaqa Bakery.

¹⁴ Source Atela Yee Managing Director Raiwaqa Bakery



Figure 45: Gluten free flour products on sale at a major Suva supermarket

These imported gluten free flours are still significantly cheaper than the current price for breadfruit flour. It might be expected that this price difference could be bridged somewhat with the further development of breadfruit orchards and processing. However, if breadfruit flour is to compete it will need to differentiate itself from other gluten free ingredients. It has a strong basis for doing so, as discussed above, in terms of wider nutritional benefits and superior processing attributes. Breadfruit also offers considerable opportunities for image enhancing labelling. There is already a small niche retail gluten free market for which breadfruit flour would already be competitive with appropriate promotion. How big such a market would be currently is difficult to judge at this stage of industry development. Marketing emphasis should avoid direct substitute for wheat flour as a price competitive substitute commodity, but rather as product in its own right with unique processing characteristics.

Processed breadfruit – starch and starch derivatives

The initial work undertaken by Dr Richard Beyer with breadfruit processing at the Tutu Rural Training Centre suggested significant processing advantages for breadfruit starch and starch derivatives compared with mainstream cassava and corn starch, which are also duty free. However, in this preliminary stage, it is far beyond the scope of this study to explore the pricing requirements of this product on domestic markets or eventually on export markets. Such an investigation is now needed if advantage is to be taken of this particularly promising opportunity.

Processed breadfruit – chips

The domestic markets for chips and other such snack food is large – albeit much smaller than the flour market. The long experience of Samoa with breadfruit (and root crop) chips, and the more recent experience with the TRTC, indicate that these products have little difficulty in being price competitive with locally made potato and cassava chips (in Fiji retailing for around \$1.15 and \$1.30 per 50gm packet respectively). Tutu has had little difficulty in selling 50 gm packets of breadfruit chips at \$1 and making a worthwhile margin. For the foreseeable future these products should be the main focus of small and micro enterprises wishing to process breadfruit.

Population growth

Population growth is a major driver of demand for any product. For agricultural products, the rate of urbanization is also an important consideration. Increasing urbanization means a higher percentage of the population are not in a position to grow their own food and have to purchase it. For Fiji, the average annual rate of population growth over the decade up to September 2017 was only 0.6%. However, the proportion of Fiji's population living in urban areas has steadily increased over the last 4 decades¹⁵. Now around 56% of the population live in urban area. This means that significantly more people need to buy their food rather than grow it themselves. This increases the demand for all agricultural products – both domestically grown and imports. Even higher rates of urbanization are being experienced in the other Melanesian countries – but somewhat lower rates in Samoa and Tonga.

Income growth and the income elasticity for breadfruit and breadfruit products

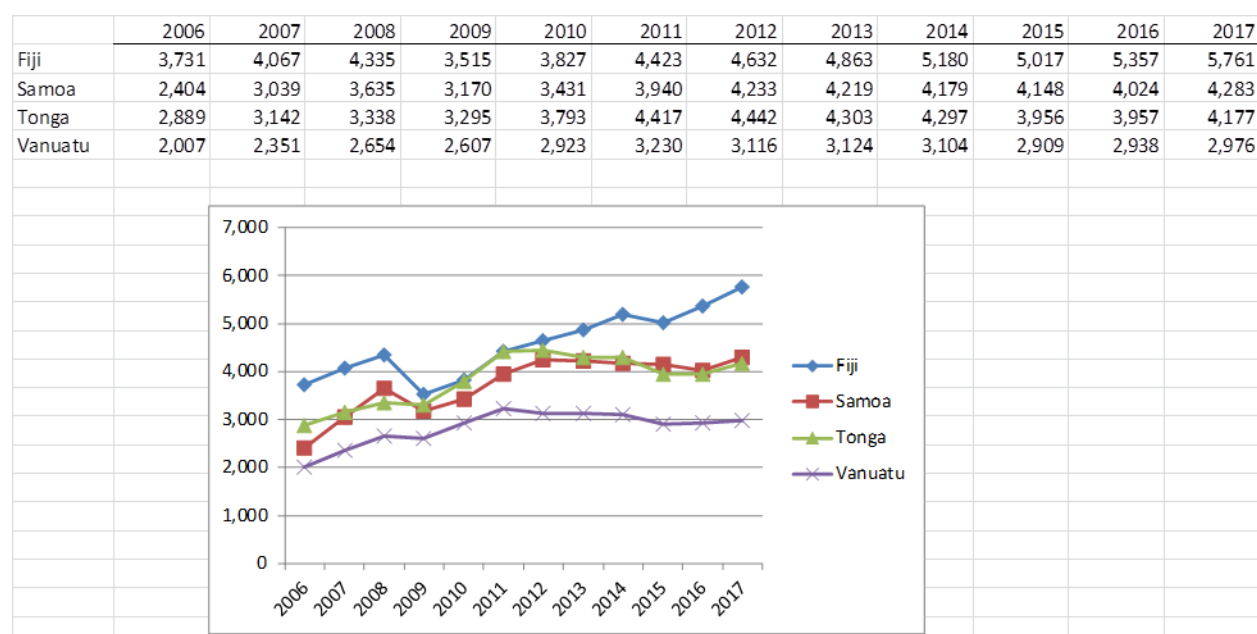
The following comparative World Bank income/capita statistics are provided for Fiji, Samoa, Tonga and Vanuatu (<https://knoema.com> › World Data Atlas)¹⁶

The per capita income and its growth for these four PICs is shown in table 10 below. Of the four countries, only Fiji has displayed a steady upward increase per capita income in recent years.

¹⁵ The last five Population and Housing Census report the following percentage of the population living in urban areas (Fiji Bureau of Statistics 2017 Population and Housing Census Release 1, January 2018):

- 1976 – 37.5%
- 1986 – 38.7%
- 1996 – 46.4%
- 2007 – 50.7%
- 2017 – 55.9%

- ¹⁶ **Fiji.** In **2017** per capita income (GDP/head) was **\$US 5,761** – increasing from \$US 2,105 in 1998 (an annual growth rate of **5.94 %**)
- **Samoa.** In **2017** per capita income (GDP/head) was **\$US 4283** - increasing from \$US 1,613 in 1998 (an annual growth rate of **5.67 %**)
- **Tonga.** In **2017** per capita income (GDP/head) was **\$US 4,177** - increasing from \$US 2,022 in 1998 (an annual growth rate of **4.20 %**)
- **Vanuatu.** In **2017** per capita income (GDP/head) was **\$US 2,976** - increasing from \$US 2,007 in 2006 (an annual growth rate of **4.30 %**)

Table 10: Per capita GDP for Fiji, Samoa, Tonga and Vanuatu (USD)*

*<https://knoema.com/atlas/GDP-per-capita>. Derived from IMF data

In comparison the GDP per capita for New Zealand and Australia was estimated at USD 41,629 and USD 56,135 respectively with an annual average growth rate over the period 1998-2017 of 6.23% and 6.11% respectively.

In Fiji, maintenance of annual per capita income growth rate levels of around 5% over the next decade should see a steady growth in demand for breadfruit products – particularly now that that an increasing majority of the population live in urban areas. In all four PICs shown above, breadfruit can be expected to have a reasonably high-income elasticity of demand¹⁷. This however has not been quantified and would not be feasible with currently available data. The processed breadfruit products, discussed above, might be expected to have higher income elasticity than fresh breadfruit given that these products are initially targeting niche markets. However, fresh breadfruit by no means could be considered an “inferior good”¹⁸ – given the reaction of consumers to the availability of fresh *bale kana* breadfruit on the Lautoka municipal market.

Consumer tastes and preferences

In the PICs breadfruit is a well-known traditional staple food. This is particularly true in Samoa where even most urban dwellers are familiar with the names and attributes of the various breadfruit varieties grown. It is notable that consumers in Lautoka soon became aware of superior *bale kana* breadfruit, grown on the nearby PBP breadfruit orchards, when it became available on the Lautoka Municipal Market. The *bale kana* planting material for these orchards was sourced from Natewa Bay on Vanua Levu. This augers well for the growth of fresh market demand for breadfruit – when more orchard grown fruit becomes available and the breadfruit seasonality is extended.

¹⁷ Income elasticity measure the % change in the demand for a product for a 1% increase in income after controlling for the other variables impacting on the demand for the product.

¹⁸ An “inferior good” is defined as one who’s consumption declines when income increases.

However, what consumers throughout the PICs are not generally aware of is the health and nutritional benefits breadfruit offers. This particularly applies to processed products such as breadfruit flour. Perhaps even more important than the final consumers of breadfruit products, at this stage of industry, is the awareness of processors and agribusinesses along the breadfruit value chain. It was clear from the interviews conducted during this study that these critical enterprises were generally unaware of the nutritional and processing advantages offered by breadfruit.

Conclusion: Major investment is now needed to create this enterprise and consumer awareness. A significant allocation of public sector funds (both donor and government) would be justified for this purpose given the huge cost that NCDs are increasingly incurring on PIC economies and communities

4.1.2 Exports Markets

In evaluating short and medium-term export markets for breadfruit and breadfruit products the focus is on the Australian and New Zealand markets. A sufficient supply base and the necessary large investment in processing capacity have yet to be established to warrant consideration of broader global markets. Some consideration is made, however, of the US fresh and frozen market given the sizable Samoan population resident there.

Fresh breadfruit

Some 15- years ago there was much optimism regarding exporting fresh breadfruit to New Zealand, Australia and the United States. However, to this day New Zealand remains the only country to which fresh breadfruit is permitted utilizing HTFA quarantine treatment facilities in Fiji, Tonga and Samoa. Despite long pending market access requests to the United States and more recently Australia, it is unlikely that this situation will change in the foreseeable future, unless this becomes a high priority of the Quarantine Authorities in both the importing and PIC exporting countries.

The main driver of demand for fresh breadfruit is the Pacific Islander population, particularly the Samoan population. The total New Zealand population as of the last Census in 2013 was 4,242,048 (an annual increase of 0.76% over the inter-censal period), the Pacific islander population was 295,941 of which the Samoan population made up nearly half. The Samoan population increased by 1.43% per annum over the Census period (table 11). Thus, it is estimated that the New Zealand Samoan population now stands at around 153,000. The Breadfruit Profile prepared by the Samoan Ministry Agriculture Forests and Meteorology in 2002 “conservatively” estimated the market for fresh breadfruit in New Zealand to be around 400 tonnes based on a Samoan population of 115,000. To this has to be added increasing numbers of Indians, Malaysians and Sri Lankan people who live in New Zealand who use breadfruit in curry dishes.

Table 11: New Zealand Population *

	2006	2013	Average annual % increase
Total New Zealand population	4,027,947	4,242,048	0.76%
Pacific islander population	265,974	295,941	1.61%
Samoan population	131,000	144,138	1.43%

Source: New Zealand Population Census 2006 and 2013

Australia has a smaller, but still significant, Samoan population. According to the 2011 ABS Census of Population and Housing there were 279,248 Pacific Islanders living in Australia of which 55,843 were Samoan. However, Australia has a much larger population of people from India, Malaysia and Sri Lanka. The Samoan population at the time of the 2010 Population Census was 184,440 up from 133,281 in the 2000 Census – an average annual increase of 1.4%.

In these high-income countries, it could be expected that a small but increasing percentage of the general population will have become interested in consuming fresh breadfruit given the increasing publicity and interest in gluten free products.

The Pacific island communities who constitute the main market for fresh breadfruit are generally found in the lower income segment. According to the 2013 Census the median income of Samoans over the age of 15 living in New Zealand is \$20,800. Breadfruit is a highly priced item, due largely to the high cost of airfreight and quarantine treatment¹⁹. Thus, it is considered as a luxury item largely consumed on Sundays and on special occasions. It generally cannot compete with wheat flour, rice and potatoes in every day consumption. However, the income elasticity of the demand for breadfruit amongst the Samoan and other Pacific islander communities could be expected to be high and demand increase significantly as incomes rise.

Frozen and cooked breadfruit

The demographic as described above will be the main market drivers for frozen and cooked breadfruit. However, the market could be expected to be somewhat larger offering the consumer convenience together with appeal to the broader Asian population as described above.

Processed breadfruit

The gluten free market

Much has been made of the huge gluten free market – with estimates of the current global annual market ranging from USD 3 billion to USD 15 billion and forecast to grow to USD 50 billion (Kirton 2016, Avegalio 2016). However, for the medium term at least, it is highly unlikely that breadfruit could obtain a share of this broad gluten free market. Not only is available breadfruit supply minuscule compared with demand – there are substantial bulk supplies available of much lower priced substitutes already available in the market in the form of rice, corn and cassava flour etc. Over the next decade or so the price relativities of breadfruit flour could well change as the impact of climate change is increasingly felt on grain crops.

High value niche product markets

For the foreseeable future export market prospects for processed breadfruit products, apart from frozen and cooked breadfruit, lies in high value niche markets, where breadfruit can differentiate in terms of non-price factors. This study identified two promising, but yet to be developed, niche market opportunities. These were:

- The superior processing characteristics
- Unique health and fitness characteristics

These are reiterated briefly below:

¹⁹ Fresh breadfruit was retailing between NZD \$7-9 during a February 2018 market visit.

Superior processing characteristics

Dr. Beyer in his brief work at TRTC found that a thickener from breadfruit flour can be derived, without the particles disaggregating, by simply adding a small quantity of cold water. It is not necessary to heat the liquid (as is the case with corn starch) or to add chemical derivatives (as required for cassava starch). Thus, breadfruit flour offers the prospect of producing a variety of gluten free mixes without heating or the addition of chemical additives. This opens up the prospects for a range of high value niche markets, where demand is highly price inelastic²⁰ and the income and the income elasticity of demand is high.

However, a lot more applied research and product development is required before specific markets can be identified let alone quantified. These markets are likely to develop initially domestically due to supply constraints.

Unique health and fitness characteristics:

There is a small but growing group of gluten and grain free buyers in Australia and New Zealand. Gluten free products are now widely perceived as health foods, even though being gluten free in itself is only of significant health benefit for a small percentage of the population. Gluten intolerance can bring with it serious health consequences through celiac disease that results in destruction of the bowel lining (Asiata Viali 2017). Celiac disease is a genetic disorder that affects about 1% of the population worldwide (Green, 2007). This disease is much more common amongst ethnic Caucasians and particularly people who originated from the Middle East and North Africa's Fertile Crescent. A low prevalence of celiac disease is found in the Pacific Islands, South-East Asia and eastern China, but higher rates are found countries west of India and China.

Celiac disease is not the only consequence of "gluten intolerance". Irritable Bowel Syndrome (IBS), is thought to be related to gluten intolerance. The incidence of IBS is far greater than celiac disease, impacting on up to 20% of the population in some Western countries such as Australia (<http://www.ibis-australia.org>).

4.2 Indicative estimates of the demand for Fiji's breadfruit and breadfruit products

Estimates, based on the information and analysis provided above, are made for the demand for Fiji's breadfruit and breadfruit products. Estimates are made for both current and medium term (5 to 10 years) demand. Ideally, such demand estimates should be based on statistical analysis, utilizing historical data. However, with breadfruit being a new commercial industry, the necessary data required for such statistical analysis is not available. Furthermore, recent technological and consumer preference changes have been such that these would not be captured by standard econometric analysis. Thus, the estimates made are more qualitative and indicative in nature based on the information that is available. As such, they should be seen as a guide to private investment in breadfruit production and processing and for public sector support in term of policy, investment in infrastructure and technical assistance. What is clear from the analysis above is that the identified markets for breadfruit and breadfruit products far exceeds the readily available supply and this is expected to be increasingly so in the medium term (next 5 to 10 years). The challenge now is to create the necessary linkages between breadfruit supply and identified markets. There are significant weaknesses in the breadfruit value chain that need to be addressed if the opportunities identified are to be anywhere near realised. These

²⁰ Consumer demand has a low response to changes in price

requirements are discussed in section 3.3. The focus of this report is on the domestic market – where the most immediate accessible opportunities lie.

4.2.1 Domestic market

The current and medium term indicative domestic demand estimates for breadfruit and breadfruit products are presented in table 12 and discussed below.

Table 12: Indicative estimates of Fiji's annual domestic demand for breadfruit and breadfruit products

	Current market estimate		Medium term demand projection (5 to 10-year)	
Domestic market				
Fresh market sales	quantity (tonnes)*	value (\$) **	quantity (tonnes)***	value **
Domestic staple market	405	\$ 945,000	1,200	\$ 2,800,000
Substitution for imported potatoes	243	\$ 259,000	486	\$ 518,000
Total	648	\$ 1,204,000	1,686	\$ 3,318,000
*(1% of the quantity of taro domestic market sales as per the 2009 Agricultural Census)+ (1% of the quantity of imported potatoes)				
** (Wholesale market value of taro as per the Taro Industry Plan)+(average landed value of imported potatoes 2012-2016)				
*** (2% of the projected 5 year demand for taro as per the Taro Industry Plan)+ (2% of the quantity of imported potatoes)				
Processed products				
Flour				
	quantity (tonnes)*	value (\$) **	quantity (tonnes)***	value (\$)****
Breadfruit flour	1,350	5,400,000	6,750	\$ 27,000,000
Raw material required (fresh breadfruit)	6,750	3,375,000	33,750	\$ 16,875,000
* 0.1% of average annual wheat imports (2012-16); 5:1 conversion of fresh breadfruit to flour				
** A purchase prices of \$4/kg of flour and \$0.50/kg fresh breadfruit assumed				
*** 0.5% of average wheat imports				
**** Current (2018 prices) - purchase prices of \$4/kg of flour and \$0.50/kg fresh breadfruit assumed				
Chips				
	quantity (tonnes)*	value (\$) **	quantity (tonnes)***	value (\$)****
Bread fruit chip sales	89	2,314,000	190	\$ 4,967,910
Raw material required (fresh breadfruit)	354	177,000	760	\$ 380,000
* Assumed 2 x 50gm pkts of breadfruit chips per capital/year: 4:1 conversion of fresh breadfruit to chips				
** purchase prices \$1.30/50 gm pack; \$0.50/kg fresh breadfruit				
*** Per capita demand doubles and population increases to 950,000				
**** Current (2018 prices) - purchase prices of 50gm pkts of chips \$1.30; fresh breadfruit purchased for \$0.50/kg				
Total indicative estimated domestic demand for breadfruit				
	Current estimated market demand		Medium term (5 to 10-year) demand projection	
	quantity (tonnes)	value (\$)	quantity (tonnes)	value (\$)
Fresh market	648	\$ 1,204,000	1,686	\$ 3,318,000
Supplying processors	7,104	\$ 3,552,000	34,510	\$ 17,255,000
Total	7,752	\$ 4,756,000	36,196	\$ 20,573,000

Current indicative demand

The indicative current demand for breadfruit is estimated to be in vicinity of 8,000 tonnes per annum valued at nearly \$5 million. The key considerations in deriving this seemingly high demand estimate are:

- The volume and value of root crops sold on domestic market (demand for breadfruit on the staple market put at 1% of taro sales)
- The volume and value of potatoes imported (demand for breadfruit as a substitute for imported potatoes put at 1% of potato imports)
- The volume and value of wheat imports (demand for breadfruit flour put at 0.1% of wheat imports.
- The high volume of potato chip consumption (demand for bread fruit chips is a minuscule fraction of this volume)
- The high cost to individuals and society of NCDs and the emerging awareness of the role that products such as breadfruit can play in addressing this health and economic sustainability issue.

Medium term (5 to 10 years) indicative demand for breadfruit and breadfruit products

The indicative medium-term demand for breadfruit is estimated to be some 35,000 tonnes per annum, valued at around FJD 20 million. To put these estimates in perspective: i) the fresh market demand estimate is equivalent to only 2% of current sales of taro and 2% of current potato imports; and, ii) breadfruit flour demand estimate is only 0.5% of current flour imports. The key variables driving this growth in estimated demand are:

- A continuing high rate of urbanization in Fiji, coupled with increasing per capita income
- Price relatives increasingly moving in favour of breadfruit compared with dalo, imported grains and potatoes. This is due to the impact of climate change and existing breadfruit orchards coming into full production and new breadfruit orchards being established.
- Price relativities in favour of breadfruit flour will be further enhanced by the expected investment in breadfruit processing and technological advances in processing
- Increasing public awareness of the costs and consequences of NCDs, together with the nutritional and health benefits of consuming breadfruit and breadfruit products.
- The increasing availability of breadfruit products. For new innovative products increasing availability and promotion can be expected to generate its own demand

4.2.2 Export markets

The current and medium term indicative export demand estimates for breadfruit and breadfruit products are presented in table 13.

The estimated indicative current export demand for Fiji's breadfruit and breadfruit products is estimated to be some 1,500 tonnes per annum, with a fob value of approximately FJD 6.5 million. This export market is shared with Samoa and Tonga. In the medium term this demand is projected to increase to some 2,500 tonnes, doubling in value to approximately \$12.5 million. These estimates are based on the following considerations:

Table 13: Indicative estimates of Fiji's annual export demand for breadfruit and breadfruit products

	Current market estimate		Medium term demand projection (5 to 10 years)			
	Quantity (tonnes)	Value (\$fob)	Quantity (tonnes)	Value (\$fob)		
New Zealand						
Fresh	500	\$ 1,500,000	600	\$ 1,800,000		
Frozen and cooked	600	\$ 3,000,000	700	\$ 3,500,000		
Breadfruit flour	-					
Sub-total	1100	\$ 4,500,000	1300	\$ 5,300,000		
Australia						
Fresh	250	\$ 750,000	300	\$ 900,000		
Frozen and cooked	350	\$ 1,750,000	450	\$ 2,250,000		
Breadfruit flour	50	\$ 400,000	200	\$ 1,600,000		
Sub-total	650	\$ 2,900,000	950	\$ 4,750,000		
Other						
Fresh			100	\$ 300,000		
Frozen and cooked	250	\$ 1,250,000	320	\$ 1,600,000		
Breadfruit flour			200	\$ 1,600,000		
Sub-total	250	\$ 1,250,000	620	\$ 3,500,000		
Total	2,000	\$ 8,650,000	2,870	\$ 13,550,000		

New Zealand

- The previous in-depth market studies of the New Zealand fresh breadfruit market were confirmed by this study still to be valid. These estimates have been adjusted to allow for growth in the New Zealand Pacific Islander population – particularly the Samoan community.
- Market interviews and discussions with exporters, particularly from Samoa, suggest that the frozen and cooked breadfruit market is somewhat more than half of the fresh breadfruit market.
- There is currently no realistic market for breadfruit flour in New Zealand – however, it can be expected to develop in the medium term as viable processing capability develops in Pacific islands and the market becomes aware of the health benefits accruing to the consumption of breadfruit flour. A notional medium-term market of 200 tonnes of breadfruit flour has been allowed for.

Australia

- Estimated size of the Australian fresh breadfruit market is based on the relative size of the Australian Samoan community relative to New Zealand. However, any realization of this market is not possible while Fiji's market access request for breadfruit to Australia remains pending.
- The demand estimates for frozen and cooked breadfruit in New Zealand based on discussion with Sai Yee Exports both in Fiji and Australia.
- A notional demand estimate for Fijian breadfruit flour has been allowed for Australia based on the discussions reported above.

Other markets

- Currently there are no realistic export markets for Fiji fresh breadfruit outside New Zealand. In the medium term a notional market of 100 tonnes is allowed for in the US market, given the size of the Samoan community. However, this assumes that Fiji will be able secure market access for fresh breadfruit in next few years.
- The frozen and cooked market estimates for the US are based on selling to the sizable Samoan community. These estimates are based on the previous experience of, the now closed, National Exports.
- Exceptionally large markets have been identified in the US, and elsewhere, for gluten free flour products. However, it could not be expected that Fiji breadfruit flour could be competitive on these markets for the foreseeable future – except for very narrow niche markets within this overall “gluten free” market. Thus, a notional medium-term demand projection for other markets of 200 tonnes has been allowed for.

4.3 Requirements to realise identified demand for breadfruit products

Sizable demand, for both domestic consumption and export, has been estimated for breadfruit and breadfruit products. These markets can be expected to increase significantly in the medium term (next 5 to 10 years). However, Fiji as well as Samoa and Tonga, currently fall far short of meeting this demand.

The absence of breadfruit orchards and thus the dependency on wild harvest had been identified as the major weakness in the breadfruit value chain. In Fiji, considerable progress has been addressing this constraint through PBP – although more work is still required in the area of orchard development. However, despite the importance of planting breadfruit orchards for commercial market development, this is not sufficient to allow underlying demand to be anywhere near satisfied. There are other weakness in the breadfruit value chain, both for domestic markets and export, which now need to be addressed. These include:

- The reform of the BQA for breadfruit exports to New Zealand and obtaining market access for fresh breadfruit to the Australian and United States markets.
- Inadequate local knowledge in the processing of domestically grown food, including breadfruit.
- The need for a substantial applied research effort directed at breadfruit processing.
- The linking of the local processors and exporting companies to the newly established breadfruit orchards
- Assistance in product development, labelling and consumer awareness

These weaknesses in the breadfruit value chain and the measures that need to be taken are discussed briefly below:

The reform of the BQA for breadfruit exports to New Zealand and obtaining market access for breadfruit to the Australian and United States markets.

The significant fresh export breadfruit market in New Zealand already exists and is being supplied by the recently established breadfruit orchards. Fiji has had market access for HTFA treated breadfruit since 1999 – while Tonga and Samoa obtained market access for fresh breadfruit to New Zealand somewhat later. However, as discussed in 2.1.3 above, the unnecessarily demanding bait spray requirements under the BQA for export undermine the commercial viability. An application will soon be made to reform the bait spray requirements utilizing data being collected by the NWC Research and Extension

Team. This work was undertaken with New Zealand aid funding. This BQA reform submission and follow-up of this application needs to be given the highest priority by the Bio Security Authority of Fiji (BAF) the designated responsible entity. Should Fiji's application prove successful similar reforms can be expected to be forthcoming for Tonga and Samoa.

There is as yet no access for fresh breadfruit exports to Australia and the United States, despite applications being pending for more than a decade (figure 46). **Follow up on these applications now needs to be given the highest priority by BAF.**

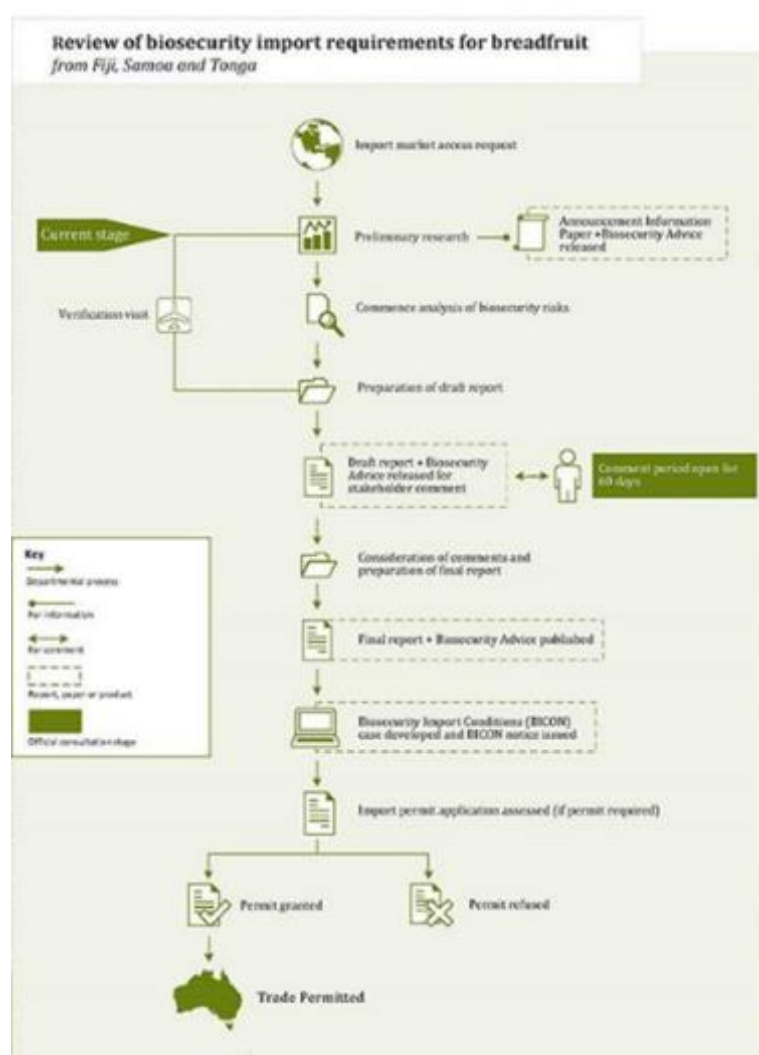


Figure 46: Breadfruit market access application to Australia from Fiji, Samoa and Tonga pending for over a decade

Inadequate local knowledge in the processing of domestically grown food, including breadfruit.

Recent industry studies for taro, pineapples and now this study in breadfruit, identified significant gaps in local know-how of how to process these products in appropriate ways to take full advantage of identified domestic market opportunities (Fiji Min. of Ag (2017); Koko Siga Pacific (2017)). This constraint applies to both larger agribusinesses and to small cottage industry scale enterprises. Recent FAO sponsored technical assistance with the Vanuatu pineapple industry ("Building local capacity to

produce and process pineapple products”) demonstrated how important appropriate targeted technical assistance and training in food processing can be in capturing the domestic market for locally grown fruit. Similar positive outcomes were achieved with the small-scale processing of breadfruit at the Tutu Rural Training Centre in Fiji as discussed above and outlined in detail in Chapter 6. The Tutu training utilized the services of the eminent food technologist Dr. Richard Beyer with funding provided by the Pacific Island Farmer Organization Network (PIFON). Follow-up breadfruit training and technical assistance is now required at Tutu with the program expanded to other locations, particularly on Viti Levu in closer proximity to major markets.

The need for a substantial applied research effort directed at breadfruit processing

The initial design of the ACIAR funded Pacific Breadfruit Project included a substantial applied processing research component. However, this was deleted on the understanding that the necessary processing research would be undertaken once the production base via orchard development had been established. The PBP has now made considerable progress in establishing the orchard production base. However, other than SROS in Samoa, this next crucial step of applied breadfruit processing research has not been forthcoming. In Fiji this is now required as a matter of urgency.

Dr Beyer’s initial breadfruit training effort at Tutu has identified a number of important applied research topics. These include:

- How to improve the flour and starch recover rates from breadfruit.
- Varietal evaluation in terms of their suitability for processing.
- A major investigative research effort directed at the initially identified unique positive characteristics of breadfruit starch and starch derivatives compared with other gluten free alternatives such as cassava and maize. With this information in hand, a substantial investigation of import substitution opportunities that arise would then be justified.
- Enhancing the energy efficiency of processing breadfruit – particularly with respect to drying.

Through the PBP, Fiji has been a regional and international leader in undertaking applied research developing horticultural practices for commercial breadfruit production. A similar research effort now needs to be devoted to breadfruit processing. As discussed above, SROS has led the way in this area. There are considerable opportunities for collaboration with SROS in this area. Pacific island countries should not see each other as competitors in developing breadfruit markets – but rather should work collaboratively. These are large undersupplied markets, for which consumer demand is expected to grow. Collaboration in appropriate applied research and the sharing of information can only expand the market to the benefit of breadfruit industries in all PICs involved.

The linking of the local processors companies to the newly established breadfruit orchards

The breadfruit orchards established under the PBP were almost entirely located in western Viti Levu, with the primary goal of supplying fresh breadfruit for export. The Tutu orchard on Taveuni was the exception. Linkages between the orchards and the fresh exporters have been created by the NWC’s Research and Extension Program. However, there has been no such mechanism to create linkages between the breadfruit orchards and the local food processing companies. As discussed above, some initial contact between the orchards and processing companies resulted from this market study. However, these initial contacts now need to be built on if market opportunities for processed breadfruit products are to be realised. This is seen to be a worthwhile area of involvement for the ACIAR Pacific Agribusiness Research for Development Initiative Phase II (PARDI II). Similarly, the small-scale

breadfruit flour processing initiative at Tutu needs assistance in establishing linkages to the various potential end uses that were identified in this study and other that can be expected to emerge.

Assistance in promoting consumer awareness

Section 1.3 discusses at length the nutrition and NCD crisis faced by Fiji and other PICs and the market opportunities this creates for breadfruit. However, major promotional campaigns are required if these opportunities are to be realized. Consumers need to be made aware of how breadfruit products can enhance their health, wellbeing, and that of their families. Processing and marketing enterprises need to appreciate the financial benefits that can be realised from the sale of products that address these issues.

Public sector (government and donor) assistance in promoting consumer awareness is more than justified, given the large economic and social benefits accruing from substantially increasing breadfruit consumption and the small size of the enterprises currently involved with the industry, assistance would include such things as:

- Funding technical assistance product development – for example the type of assistance that Dr. Richard Beyer has provided to Tutu and expanding this to larger enterprises on a cost share basis.
- Technical and funding assistance for product labelling development
- Incorporation of breadfruit information into the nutritional curriculum of schools and training institutions; and, including breadfruit products into school lunch programs.
- Support for television programs promoting breadfruit and breadfruit products and their benefits

Technical and funding assistance in product certification

Samples of breadfruit flour produced by Tutu were taken to meetings with Deeks Health Food in Australia. The company expressed keen interest in the product and would like to test it their product line. However, for this to happen a range of product certifications (gluten free, bacterial/microbial etc.) requirements would first have to be met. Small Pacific island companies interested in accessing this niche high value market will need start-up technical and financial assistance in navigating and meeting the range of product certification requirements.

5 The Australian and New Zealand market trip reports

5.1 The Australian market

5.1.1 Overview

The Australian component of the 'Breadfruit Market and Marketing Study' comprised visits to Melbourne, Canberra and Sydney. These visits were carried out by Kyle Stice and included meetings with importers, retailers and processors. In advance of the Australia field visit, meetings were also conducted with Fiji based exporters.

Support for the Australian field visit was provided by the Pacific Trade and Invest (PT&I) – Australia office. PT&I also provide some coordination support through Mr. Jeremy Grennel (Coordinator- Export and Enterprise Development, Sydney Office).

Over the course of the Australian Market visit, consultations were held with: 5 importers, 10 retailers and 1 processor.

Table 1: List of persons met during the Australia Breadfruit Market and Marketing Visit

Importers	Retailers	Processors
Darby Young. Owner. Container Forwarding Services International. Gte 3/ 20 Olympia Street, Tottenham VIC 3012. darby@cfsi.com.au +61412153742	Phil - Asian Grocery and mixed business 16 Railway Crescent Broad meadows. 0433012336	Deeks Health Foods Level 1, 52 Colbee Court, Phillip ACT 2606 (02) 6260 5797 info@deeks.com.au
John Truong, Owner. Aus Asia Produce, Melbourne Market, Store 94. 35 Produce Drive Epping 3076. john@ausasiaproduce.com.au 0406393399	Navdeep Nayyar, Shop Manager. Indian Grocery Store, 9/38 Reed Street North, Greenway, 2900, ACT. 0262933853, 0422177414 info@indiagrocerystore.com.au	
Jack Melbourne, Wholesale Fruit and Vegetable Merchants. Melbourne Market. jackmelb@hotmail.com 0411838555	Thanh, Thanh Phat Grocery. Shop 45, Homeworld Shopping Center, ACT 2904. 02 62931503	
Tom. Sai Yee Foods. 83 King Georges Road Wiley Park NSW 2195 Mob: 0401734536	Derrick Nguyen, Manager. Charmane Bakery and Groceries. 10 McRae St. Dandenong, VIC 3175. 0423969535	
Sini Frost (Distribution Manager, Brokers International - import/export of Pacific Island's Fine foods). 37 Kitchener Street	Deepak. Fiji Produce Indian Grocery Store. 3/10 Hammer Ct, Hoppers Crossing VIC 3029 fijiproduce.com.au (03) 8360 8698	

Broadmeadows 0401128831 sinifrost@gmail.com		
	Trang Ngo. Stall Number S01 (Fruit & Veg). Dandenong Market, 40 Cleeland Street, Dandenong VIC 3175 (p) 0400 847 277	
	Qiang Su & Yi Jun Hu. JJ's Fruit & Veg. Stall Number T04 (Fruit & Veg). Dandenong Market, 40 Cleeland Street, Dandenong VIC 3175 0421 679 203	
	Manaia Pacific Pty. Unit 30, 2 Railway Parade, Lidcombe NSW 2141. 0401734536 saiyeefoods@yahoo.com	
	Samoa Tradition Convenience Store Sydney Shop 6 /48-66 Horsley Drive Carramar Fairfield, New South Wales, Australia 0421 561 307	
	Duc Phat Asian Grocery.	

5.1.2 Buyers of breadfruit in Australia

The Australian market for horticultural products is by far the largest in the region, with more than 22 million relatively affluent consumers. Eastern Australia in particular, is a large market compared to New Zealand, with almost 11 million people (half the population) in the three eastern capitals (Brisbane, Sydney and Melbourne), a high degree of cultural and culinary diversity, a strong exchange rate relative to the Fiji dollar (and most other currencies), and high domestic food prices.

However, domestic horticulture production supplies almost all of that market year-round. This is unique among developed countries, most of which source fresh produce supplies from around the world, depending on prices and availability.

Discussions with importers, retailers and processors of breadfruit in Australia confirmed that the primary consumers of breadfruit in Australia are:

- Australians of Pacific Island Origin
- Australians of Asian Origin
- Gluten and grain free buyers

Breadfruit is also consumed by Australians of African and European origin but to a much lesser extent. The primary consumers groups of breadfruit are explored in more detail below.

Australians of Pacific Island origin

A recent report written by Jioji Ravulo²¹ on Pacific Communities in Australia explores the demographics of Australians of Pacific origin. This report explains that the majority of Pacific communities reside along the east coast of Australia (Figure 2), with the largest cohort living in Queensland, followed by New South Wales and Victoria.

When reviewing the data in terms of the current demographic and socio-economic context outlined in the above statistics, despite only constituting 1.3% of the Australian population, the Pacific community are set to rapidly grow 3% in the coming decades (College of Asia & Pacific 2014).

Based on the 5 largest Pacific cohorts in Australia, the largest Samoan, Tongan and Fijian communities reside in New South Wales; with the largest group of Maori and Cook Islanders residing in Queensland.

Based on the statistics of Pacific people living in capital cities along the east coast of Australia, 72,223 live in Sydney, 62,540 live in Greater Brisbane, and 34,568 live in Melbourne.

The Pacific population make up 1% of the total Australian population. The Pacific community in Australia is a rapidly growing and youthful population. The majority of the Pacific population range from 0 – 24 years, whereas the majority of the general Australian population range from 25 – 49 years of age.

Australians of Asian origin

For the purposes of aggregating data, the Australian Bureau of Statistics in its *Australian Standard Classification of Cultural and Ethnic Groups (ASCCEG)* has grouped certain ethnic groups into certain categories, including Northeast Asian (e.g. Chinese Australians), Southeast Asian (e.g. Vietnamese Australians) and South and Central Asian (e.g. Indian Australians).

Notably, Australia does not collect statistics on the racial origins of its residents, instead collecting data at each five-yearly census on ancestry (i.e. national ethnic rather than racial origin). At the 2016 census, there were 3,514,915 nominations of ancestries classified by the Australian Bureau of Statistics as falling within the geographical categories of Northeast Asia, Southeast Asia and Central and Southern Asia. This represents 11.82% of the total of 29,613,856 ancestry responses, or 16.15% of persons who nominated their ancestry. 2,665,814 persons claimed one of the six most commonly nominated Asian ancestries, namely Chinese, Indian, Filipino, Vietnamese, Korean and Sri Lankan, at the 2016 census. Persons claiming one of these six ancestries alone represented 12.25% of the total population who nominated their ancestry.

More than one million new migrants have come to Australia since 2011, with China (191,000) and India (163,000) the most common countries of birth for new arrivals.

This is followed by migrants from the UK (8.3 per cent growth), New Zealand (7.4 per cent growth) and the Philippines (4.9 per cent growth). Cities have absorbed the bulk of the migrants, with most settling in Sydney and Melbourne. (ABS Census 2016).

Figure 2: Pacific people across Australian states & territories

State/Territory	Pacific Population	% of State/Territory Population
New South Wales	92,028	1.3%
Victoria	43,066	0.8%
Queensland	102,320	2.4%
South Australia	5,246	0.3%
Western Australia	28,064	1.3%
Tasmania	1,821	0.4%
Northern Territory	2,827	1.3%
Australian Capital Territory	2,977	0.8%
TOTAL	270,228	1.3%*

* of Australia's total population of 21,507,719

²¹ Ravulo, Jioji. 2015. Pacific Communities in Australia. University of Western Sydney.

Gluten and grain free buyers

There is a small but growing group of gluten and grain free buyers in Australia. Gluten free products are now widely perceived as health foods, even though being gluten free in itself is only of significant health benefit for a small percentage of the population. Gluten intolerance can bring with it serious health consequences through coeliac disease that results in destruction of the bowel lining (Asiata, Viali 2017). Celiac disease is a genetic disorder, which affects about 1% of the population worldwide (Green, 2007). This disease is much more common amongst ethnic Caucasians and particularly people who originated from the Middle East and North Africa's Fertile Crescent. A low prevalence of celiac disease is found in the Pacific Islands, South-East Asia and eastern China, but higher rates are found countries west of India and China.

Coeliac disease is not the only consequence of "gluten intolerance". Irritable Bowel Syndrome (IBS), is thought to be related to gluten intolerance. The incidence of IBS is far greater than celiac disease, affecting up to 20% of the population in some Western countries such as Australia (<http://www.ibis-australia.org>).



Deeks Helath Foods based in Canberra, Australia is one of the pioneering companies supplying gluten and grain free breads and flour mixes to the small but growing group of gluten and grain free buyers.

Sources, pricing and availability

Discussions with importers, retailers and processors of breadfruit in Australia confirmed the following regarding sources, pricing and availability of breadfruit products in Australia:

1. All fresh breadfruit is currently supplied through domestic production
2. Domestic fresh breadfruit supply is very erratic and expensive due to the lack of commercial production
3. Frozen breadfruit supply is coming exclusively from the Pacific Islands

4. Fresh breadfruit imports are currently not permitted for any country however the Pacific is in the pipeline for market access

All fresh breadfruit is currently supplied through domestic production

Australia has not previously imported breadfruit and therefore all supply has been from domestic sources.

The Australian breadfruit industry is very small, with small-scale commercial production in the Northern Territory (around Darwin) and Queensland (north of Cairns). Breadfruit production in Australia is seasonal, with peak production occurring in February and March. The fruit is available at fresh produce markets in some of the major cities when in season.

Breadfruit is a minor industry, supplying the Australian fresh fruit market with an estimated annual production of 20 t, worth approximately AUD \$60,000 farm gate (Gobel 2004).

Domestic fresh breadfruit supply is very erratic and expensive due to the lack of commercial production

Most fresh produce wholesalers and retailers interviewed had never handled breadfruit due to the very erratic supply and high price.

In May 2017, Fresh Breadfruit was available at High Point Fruit and Vegetable Market for AUD \$19.99/kg, this fruit weighed in at over 3 kg which means the retail price for the one fruit was AUD \$60.

Fresh breadfruit is reportedly available in fresh produce markets around Cairns and Darwin (much closer to the domestic production areas at a retail price of around AUD \$8/kg



Frozen breadfruit supply is coming exclusively from the Pacific Islands and represents a good market opportunity

Frozen breadfruit is a relatively common product carried by major Pacific Island and Indian shops in Melbourne and Sydney. Currently, Tonga is the largest exporter of frozen breadfruit to Australia followed by Samoa and Fiji.

Frozen breadfruit retails at around AUD \$6-9 compared to frozen taro, which retails at around AUD \$4-6.

Despite the relatively high price (compared to other Pacific Island root crops), retailers reported that there is a very strong demand for frozen breadfruit and that they are currently undersupplied.



In the absence of fresh breadfruit, Pacific Islanders living in Australia have access to frozen breadfruit. According to importers and retailers surveyed, there is a strong demand for frozen breadfruit despite the fact that it is more expensive than other frozen root crops such as taro, cassava and yams.

Fresh breadfruit imports are currently not permitted for any country however the Pacific is in the pipeline for market access

Fresh breadfruit imports are not permitted into Australia based on quarantine risks, which state Condition C6066, 'this commodity is prohibited entry into Australia because insufficient information is available on its risk status'.

In recent years, industry has been pushing to obtain market access for fresh breadfruit into Australia. In Fiji, Nature's Way Cooperative (NWC) in collaboration with the Biosecurity Authority of Fiji (BAF), Ministry of Agriculture (MoA) and a market access specialist - Dr. Jack Armstrong - www.quarantinescientific.com worked to prepare a submission to get market access for breadfruit into Australia. Dr. Jack Armstrong worked with NWC and BAF back in 2009 to submit the US market access application for papaya and breadfruit. A series of stakeholder meetings took place in late 2016 that informed the preparation of this submission.

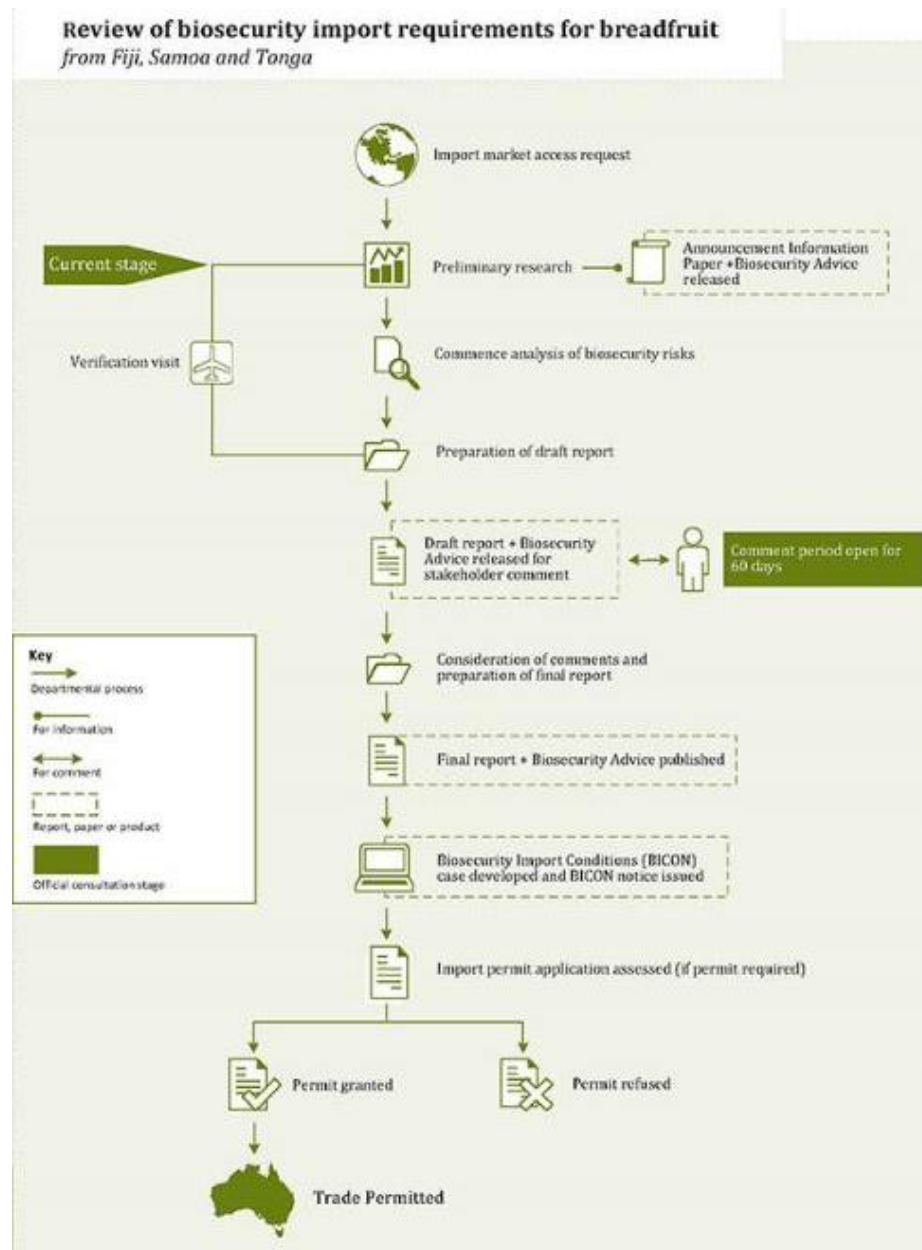
In February 2017, NWC submitted the completed application with all supporting documentation to BAF with a request and expectation that they would submit it to the Commonwealth of Australia and the Australian Department of Agriculture and Water Resources to initiate a risk analysis based on the BIRA provided for Fijian breadfruit. The information and the supporting documents were subsequently submitted by BAF in accordance with the Department of Agriculture and Water Resources BIRA guidelines.

In August 2017, AQIS released a 'Biosecurity Fact Sheet: Fresh breadfruit from Fiji, Samoa and Tonga' on its website. This fact sheet confirmed the following details:

- The Department of Agriculture and Water Resources is conducting a review of biosecurity import requirements for fresh breadfruit from Fiji, Samoa and Tonga.
- A draft report is scheduled to be published in late 2017. Stakeholders can lodge submissions on the draft report during a 60-calendar day formal consultation period.
- The final report is expected to be published in early 2018.
- Successive Australian governments have recognised that growing export industries in Pacific Island countries and increasing trade opportunities will boost regional economic activity. An important component of this is considering new market access to Australia. Through the [Pacific Horticultural and Agricultural Market Access](#) (PHAMA) program, the department implements biosecurity policies that ensure safe agricultural trade from Pacific Island countries to Australia. This involves considering access for new commodities as well as improving existing trade pathways.
- A review of biosecurity import requirements for fresh breadfruit has commenced in response to requests for market access for fresh breadfruit from Fiji and Samoa. The review has been expanded to cover Tonga.
- The pests associated with fresh breadfruit from Fiji, Samoa and Tonga that are identified as potentially being of quarantine concern are fruit flies and mealybugs. With Australia having already established phytosanitary measures for these pests for other horticultural commodities, this analysis will be conducted as a review of biosecurity import requirements (a [non-regulated risk analysis](#)).
- Australia's established phytosanitary measures include high temperature forced air (HTFA) treatment for fruit flies, and phytosanitary inspection and pre-export clearance for mealybugs.
- If new information about pests and diseases of fresh breadfruit in this region comes to light as the review progresses then this will be considered.

The fact sheet also released a diagram of the verification and approval process (see below). AQIS made a verification visit to Fiji including NWC on December 7th 2017. NWC made a number of presentations during this verification including an overview of NWC and rationale for breadfruit market access application, which stressed:

- Market access to NZ has been in place but commercial production has been the main constraint – this is now being addressed through orchards
- Australian market verification visit was recently conducted with strong demand identified in both Melbourne and Sydney



5.1.3 Estimates of Market Demand

Findings from 2012 PHAMA Market Study

At the request of the Fiji Market Access Working Group (MAWG), the PHAMA projected conducted preliminary export feasibility studies for six horticultural products to determine whether there was merit in pursuing formal market access arrangements for the Australian market. A study was undertaken by David Young who is an Economist and Market Analyst during January–February 2012 in Fiji and Australia to assess the commercial prospects for the six commodities identified by the Fiji MAWG including:

- Breadfruit
- Jackfruit
- Pineapple
- Chili
- Eggplant
- Bitter Gourd

The market study identified a number of supply and demand related issues for Pacific breadfruit exports to Australia including:

- Grown mainly as scattered trees and as a backyard crop. No formal plantation production.
- Highly seasonal production.
- Highly perishable – only suitable for airfreight.
- Local prices are low in season.
- Fruit fly host, but some fruit exported in frozen form.
- Only consumed by Pacific Island community in Australia.
- Some production in North Queensland supplying the Australian market.
- Market turnover is very low and not recorded by market reporting services.

The report went on to make the following conclusions regarding the market for breadfruit:

- Very limited prospects for profitable access to the Australian market.
- Analysis of marketing costs and margins not undertaken.
- Low priority.

Findings from 2018 Market Visit

Fresh breadfruit

With the current scenario of domestic supply, which is reportedly very sporadic and expensive, the market for fresh breadfruit is very limited – around 20 tonnes per year as is currently supplied.

With the prospect of market access for Pacific breadfruit a wholesale price of AUD \$7/kg for fresh breadfruit was calculated (using the NZ market as a comparison but factoring in real freight and

clearance costs for the Australian market). This wholesale price was used in discussions with importers and retailers in to Australia to determine the potential market. Based on feedback from importers and retailers, it is estimated that the immediate demand in Melbourne and Sydney alone would be around 9 tonnes per week. An additional 3 tonnes per week is estimated as the potential demand from Brisbane. If six months of supply can be achieved this would be a total annual volume of 288 tonnes from all suppliers and to all markets.

Frozen breadfruit

Based on feedback from importers and retailers the overall estimated demand for frozen breadfruit at current pricing would be around 4 tonnes per week over a 12-month period from all suppliers to all markets which is 240 tonnes per annum. Frozen breadfruit market demand will always be linked to other root crops such as taro and cassava and if supply/prices fluctuate significantly this will affect the demand for breadfruit.

Breadfruit flour

Only one potential buyer of breadfruit flour was identified in the market with a requirement of 400 kg of breadfruit flour every month or 4.8 tonnes of breadfruit flour per year. It can be assumed that there are potentially at least three additional potential buyers of breadfruit flour from the gluten/grain free market in Australia, which could result in a market demand of 14.4 tonnes per year.

Requirements to meet the identified market demand

Consultations with exporters, importers and retailers identified a number of key requirements for the Pacific Islands to meet the identified market demand for breadfruit in Australia including:

1. Market access achieved for fresh breadfruit
2. Consistency of supply and extended season
3. Careful attention to quality (variety, maturity, handling)
4. High volumes per consignment to spread out the high clearance costs in Australia

Market access achieved for fresh breadfruit

Achieving market access for fresh breadfruit into Australia for breadfruit from the Pacific is a critical requirement to meet the identified market demand. The Pacific has passed through the first hurdle, which is getting the application into the system however it is likely that the approval process will take several years and will require that the biosecurity regulatory authorities in the Pacific countries be proactive in supplying any additional required information and in asserting the importance of this market. The private sector will also have to play an active role in lobbying their governments, biosecurity and the Australian partners to give this market access application due importance.

Consistency of supply and extended season

Importers and retailers in the Australian market stressed the importance of a consistent supply throughout the season. There is a general concern that an erratic supply of breadfruit from Pacific suppliers will be difficult to market as importers and retailers are not sure from week to week, if they will be receiving any supply and this complicates the planning and marketing.

Moving into commercial production of breadfruit and diversifying the 'market approved' varieties is seen as the primary way to address this issue of consistency of supply and extended season.

Careful attention to quality (variety, maturity, handling)

Importers and retailers in Australia highlighted that because fresh breadfruit is an expensive and highly perishable product, there is no room for second grade quality.

Of particular importance to importers and retailers as it relates to quality is immature fruit, short shelf life varieties and physical damage.

Fortunately, many of these issues are relatively easy to overcome through improved harvest and post-harvest handling. In the case of Fiji, where commercial orchards are now coming into production, these quality issues become much more manageable. For the wild harvest production, these issues will be very difficult to manage.

High volumes per consignment to spread out the high clearance costs in Australia

Importers of fresh produce into Australia face significant clearance charges including airport fees, airport transport fees, customs broker fees, AQIS fees and quarantine approved pack house fees, transport etc. These fees can amount up to nearly AUD 1800 per consignment (regardless of the size of the consignment). If an importer is only bringing in 150 cartons then these charges can amount to around AUD 12 per carton, however if the importer is bringing in 600 cartons then the charges only amount to AUD 3 per carton. Importers into the Melbourne market have indicated that consignments of less than 400 cartons (2 tonnes) are not commercially viable.

5.2 The New Zealand Market trip report

5.2.1 Overview

A breadfruit market and marketing study visit was conducted in Auckland, NZ from February 14th – 18th, 2018. The market study covered fresh breadfruit, frozen breadfruit and breadfruit flour. The market visit coincided with the peak breadfruit season and was thus captured a number of valuable insights into the value chains for fresh and frozen breadfruit from Fiji to NZ. Funding for Kyle Stice's visit to the New Zealand market was provided by Natures Way Cooperative through NZ MFAT financed Research and Extension Program.

The market visit included discussions with four importers, six retailers and one processor (Table 1 below).

Table 1: List of persons met during New Zealand Breadfruit Market and Marketing Visit

Importers	Retailers	Processors
CIBUS NZ Ltd. 19B O'Shannessey Street, Papakura, Auckland 2110, New Zealand. 021308518 leslienmarshall@gmail.com	Stoddard Fruit Center 208 Stoddard Road, Auckland.	Gluten Free Store Ltd 6C Kellow Place Auckland 2104
Valley Fruit & Veges Ltd	Shiu Prasad and Sons NZ Ltd	

13 Culperry Road Auckland, New Zealand	4070 Great North Rd. Kelston, Auckland. New Zealand.	
Get Fresh	Get Fresh	
Farm Fresh Veggie Ltd Papatoetoe, Auckland, NZ	Food Village 9 Station Road. Otahuhu	
Tropical Fresh Limited 65 Tidal Road Mangere, Auckland, NZ	Otahuhu Fruit Mart 306 Main St. Otahuhu	
	Fruit Shed Supermarket Mangere Plaza	



A majority of importers and retailers of breadfruit are based in South Auckland in close proximity to the large Pacific Island communities.

5.2.2 Buyers of breadfruit in New Zealand

Discussions with importers, retailers and processors of breadfruit in New Zealand confirmed the following information about the buyers of breadfruit:

Primarily Pacific Islanders for fresh and frozen breadfruit

The main buyers of fresh and frozen breadfruit in New Zealand are Pacific Islanders who are either boiling, roasting or frying the fruit. New Zealanders of Samoan decent represent the largest segment of Pacific Islanders who buy breadfruit followed by Tongans and then Fijians.

According to the NZ Census 2013, the Pacific Peoples ethnic group was the fourth largest major ethnic group in 2013, behind European, Maori and Asian ethnic groups. Since 2006, this group has grown in both number and proportion of the population. In 2013, 7.4% of New Zealand's population (295,941) identified with one or more Pacific ethnic groups. Samoa remains the largest Pacific Peoples ethnic group in 2013 with 48.7% of the Pacific people's population (144,138). Cook Islands Maori 20.9% (61,839 people). Tongan 20.4% (60,333 people). Niuean 8.1% (23,883 people).

Almost two thirds of Pacific Peoples 62.3% (181,791 people) who identified with at least one Pacific ethnicity were born in New Zealand. The highest proportion of New Zealand born people included Niuean 78.9%. Cook Islands Maori 77.4%. Tokelauan 73.9%. Samoan 62.7%. Tongan 59.8%. Most Pacific Peoples (92.9% or 274,806 people) lived in the North Island in 2013. Almost two thirds (65.9% or 194,958 people) identified with at least one Pacific ethnicity lived in the Auckland region and 12.2% or 36,105 people, in the Wellington region. In contrast only 7.1% of Pacific Peoples (21,135 people) lived in the South Island in 2013. (Statistics NZ Census 2013). By 2026 it is projected that Pacific Peoples will be 10% of the population, compared to 7.4% in 2013.



The main buyers of fresh and frozen breadfruit in New Zealand are Pacific Islanders who are either boiling, roasting or frying the fruit. New Zealanders of Samoan decent represent the largest segment of Pacific Islanders who buy breadfruit followed by Tongans and then Fijians.

New Zealanders of Indian and Asian decent will buy breadfruit but in relatively small volumes

There exists a very large Indian and Asian community across New Zealand with a significant concentration in Auckland. Indians and Asians will purchase breadfruit when it is available however, the fruit is generally cooked as a curry and served as an accompaniment and not the main meal and thus the volume purchased per household is much lower compared to the Pacific Island consumer.

Price is an important factor and breadfruit will compete with other root crops

The Pacific Islanders living in Auckland are generally price conscious consumers however, the large number of family and community island functions results in high purchasing of Pacific foods including breadfruit. It is very common for the most members of the Samoan and Tongan community to attend church on Sunday followed by a family or community lunch – this meal usually includes traditional ‘island foods’.

Taro remains the main 'island staple' purchased by Pacific Islanders in New Zealand as it is readily available and reasonably priced (especially since Samoa has re-entered the market in a big way). However, because breadfruit is seasonal it provides a unique buying opportunity and Pacific Islanders will often 'buy it while they can'. Other root crops such as a cassava, yams and kumara are readily available and often provide cheaper alternatives to breadfruit.



The Pacific Islanders living in Auckland are generally price conscious consumers and have the option of buying much cheaper island staple foods such as taro and kumala. Breadfruit suppliers must work to be more price competitive in order to substantially increase sales

There is a small but growing market for breadfruit flour from 'gluten free' and 'grain free' buyers

Discussions with one processor confirmed that there is a small but growing market for breadfruit flour from consumers that are 'gluten free' or 'grain free'. This 'gluten free' or 'grain free' requirement from buyers is primarily due to the growing number of health conditions associated with gluten and grains.

Breadfruit flour sourced from Samoa is available in Auckland and online through <http://www.glutenfreestore.co.nz/>



5.2.3 Sources, pricing and availability

Fresh breadfruit

Fresh breadfruit in New Zealand is currently supplied exclusively from Fiji. Tonga had resumed fresh exports in 2015 and 2016 however, this trade was suspended due to compliance issues and has not resumed. Fresh breadfruit exports from Samoa are currently constrained by the small scale of the HTFA quarantine treatment facility.

Fiji breadfruit wholesales in Auckland at around NZD \$7/kg and is sold in 10 kg cartons. The average fruit size is 1.2 kg's. Fresh breadfruit retails in Auckland at around NZD \$7.99 – 9.99/kg. As a comparison, fresh taro retails at around NZD \$2- 6/kg.

Fresh breadfruit is generally available in New Zealand between December – March and June-August.

Frozen and cooked breadfruit

Frozen breadfruit in New Zealand is currently supplied from Fiji, Samoa and Tonga. Frozen breadfruit is generally sent as part of mixed frozen consignments that may including taro, cassava and a mix of ethnic vegetables.

New Zealand used to allow cooked breadfruit to be imported into New Zealand however due to the discovery of several 'personal consignments' not being cooked properly, NZ MPI now requires that cooked breadfruit be done in commercial bakeries or frozen.

Frozen breadfruit wholesales at around NZD \$4/kg and retails at around NZD \$5/kg. As a comparison, frozen taro wholesales at around NZD \$3.50/kg.



Frozen breadfruit in New Zealand is currently supplied from Fiji, Samoa and Tonga. Frozen breadfruit from Fiji wholesales at around NZD \$4/kg and retails at around NZD \$5/kg.

Frozen breadfruit is generally available for around 6 months of the year coinciding with the main breadfruit seasons.

Breadfruit flour – Breadfruit is currently being supplied to Gluten Free Store from a source in Samoa. The product is packed in 20 kg 'flour bags' that are lined with plastic. The price paid NZD \$4.50 /kg plus freight (which is paid by the importer).

5.2.4 Issues and constraints

Reliability of supply

A common point of feedback from importers and retailers was the issue of reliability of supply. It is generally agreed that if breadfruit could be supplied on a more consistent basis it would an opportunity

to really develop the market. As it is now, the importers and retailers are not sure from week to week, if they will be receiving any supply and this complicates the planning and marketing.

Quality

A number of quality issues were identified for fresh breadfruit in New Zealand including: immature fruit, short shelf life varieties and physical damage.

Several importers highlighted the issue of immature fruit and retailers as a recent consignment from Fiji reportedly had high amounts of immature fruit. Immature breadfruit will not cook properly and will be very watery. One retailers provided a sample of immature breadfruit that had been returned by a customer after they purchased it, cooked it and discovered it was not even edible. The retailer had to credit the customer and reduced his breadfruit order to the importer by 50% for the following week. It is reported that many Pacific Island customers are very knowledgeable about breadfruit maturity and when they see a very green fruit they will not buy it, they prefer to have fruit with a slight yellow colour on the skin.

Consignments observed during the market visit in February 2018 revealed a mix of breadfruit varieties including round, oval, large and small fruit. It was evident from these consignments that several of the larger and oval varieties had a very short shelf life (as little as 3-4 days) before they would start to go soft. This is compared to the smaller round 'Uto dina' varieties, which remain firm in the cooler up to 14 days.

Physical damage was observed on about 15% of the fruit assessed in the market place. The most common form of physical damage was bruising followed by puncture wounds. Much of this physical damage is considered 'hidden damage' in that it does not appear during harvest or packing, however several days later as the fruit ripens, the damage is apparent. Physical damage on breadfruit not only affects the appearance but also speeds up the ripening and softening of the fruit, physical damage also provides an entry point for post-harvest diseases such as phytophthora and anthracnose.

Pest occurrence and biosecurity inspections/charges

Feedback from importers in New Zealand highlighted pest occurrence and biosecurity inspections/charges as a major constraint/risk. The stem end of breadfruit provides a perfect hiding place for insects such as a mealy bug, scale and white fly. Upon arrival in NZ, MPI conducts inspection on a sample of fruit from the consignment and if any insects are found then a further inspection may be required to identify the insect and determine if they are alive or not. This pest ID will cost an additional NZD \$200 on top of the normal NZD \$500 inspection fee charged on all consignments. Other biosecurity related issues that were identified by importers included: the difficulty in securing an inspector to clear the consignment and a new requirement to use a biosecurity approved facility for inspections (additional costs on the importer).

High price

The retail price of fresh breadfruit in New Zealand was generally regarded by importers as a major constraint to expanding sales. At a retail price of NZD \$7.99 – 9.99/kg, breadfruit is far more expensive than products such as fresh taro, which retail at NZD \$2- 6/kg. The high retail price is a direct result of high costs across the value starting on the farm with BQA compliance requirements such as bait spraying and farm registration. High costs are also occurring around the labour required for harvesting, washing and grading to ensure that there are no pests present. Biosecurity, quarantine treatment and freight costs have also been increasing over the past decade, which is affecting the landed cost of breadfruit. In New Zealand, importers face significant clearance, biosecurity, transport costs and run the risk of having

to pay for a pest identification and worst-case scenario for reshipment or destruction of a consignment. The retailers of breadfruit put a substantial mark up on fresh breadfruit due to its high perishability; they must make enough money on each fruit to cover the cost of losses.

5.2.5 Estimation of market demand

Fresh breadfruit – Based on feedback from importers and retailers in the New Zealand market it is estimated at the current pricing the demand for fresh breadfruit will be around 8 tonnes per week from all sources and markets. If six months of supply can be achieved this would be a total annual volume of 192 tonnes.

If a number of improvements in the value chain were made, including bringing down the price of fresh breadfruit, it is estimated that demand would increase to around 12 tonnes per week from all sources and markets. If six months of supply can be achieved this would be a total annual volume of 288 tonnes.

Frozen breadfruit – Based on feedback from importers and retailers the overall estimated demand for frozen breadfruit at current pricing would be around 5 tonnes per week over a 12-month period which is 240 tonnes per annum. Frozen breadfruit market demand will always be linked to other root crops such as taro and cassava and if supply/prices fluctuate significantly this will affect the demand for breadfruit.

Breadfruit flour – Only one buyer of breadfruit flour was identified in the New Zealand market with a requirement of 1 tonne of breadfruit flour every three months or 4 tonnes of breadfruit flour per year. It can be assumed that there are at least three additional potential buyers of breadfruit flour from the gluten/grain free market in New Zealand, which could result in a market demand of 12 tonnes per year.

5.2.6 Improvements required to meet the identified market demand

Improved quality (variety, maturity, handling) – It was very clear from consultations with importers and retailers that if the quality of breadfruit is not improved in terms of the variety, selection, stage of maturity and handling (reducing physical damage), the market for fresh breadfruit will not be able to expand in New Zealand. Importers and retailers currently perceive breadfruit as a high-risk product due to the high costs and quality issues currently being faced.

Fortunately, many of these issues are relatively easy to overcome through improved harvest and post-harvest handling. In the case of Fiji, where commercial orchards are now coming into production these quality issues become much more manageable. For the wild harvest production, these issues will continue to persist.

Improved consistency of supply and extended season - A common point of feedback from importers and retailers was the issue of reliability of supply. It is generally agreed that breadfruit must be supplied on a more consistent basis in order to reach the identified market demand. Presently, the importers and retailers are not sure from week to week if they will be receiving any supply and this complicates the planning and marketing.

Moving into commercial production of breadfruit and diversifying the 'market approved' varieties is seen as the primary way to address this issue of consistency of supply and extended season.

6 Orchard and small-scale processing development: the case study of the Tutu Rural Training Centre

6.1 The Tutu Rural Training Centre

The Tutu Rural Training Centre (TRTC) was established by the Society of Mary (Marists) on the island of Taveuni in 1969. It is situated on some 1,200 acres of prime agricultural land. Since its inception, Tutu has provided quality non-formal livelihood education for local young men and women from Fiji's northern Provinces of Cakaudrove, Bua and Macuata. Some 2,000 people have completed the various training courses on offer at Tutu. Most graduates of TRTC return to productive lives, earning their livelihood from their own land. In addition, approximately 25,000 adults have attended shorter village-based training courses offered by TRTC.

TRTC have developed a successful model of non-formal education that trains young Fijian men and women to become self-employed farmers on their own land. Students are taught how to grow crops for food and income generation. They are taught budgeting and marketing skills and other valuable livelihood and life skills. A fundamental part of the 'Tutu Model' is the oscillation principle. This involves students spending half of their course time at the Training Centre on Taveuni, where they are allocated their own block of land. The other half of their course time is spent practicing the techniques they are learning on their own home village farm.

A FAO-funded review of the Centre's program in 2011, titled *Lessons in non-formal adult education for self-employment in agriculture*, confirmed the success of the TRTC in supporting rural youth to establish income generating livelihoods utilising their own land²². The review also made recommendations for improving the Centre's long-term sustainability and effectiveness of the courses offered. A Sustainability Programme was developed to respond to two key areas of need identified in the report. These were:

- Promoting sustainable agricultural practices and increasing diversification. The report recognised the benefits of integrating sustainable agricultural practices into the existing training courses offered at TRTC, to improve income generation potential for young farmers.
- Increasing TRTC's own income-generating capability in ways that also enhance the Centre's core training function, thus increasing TRTC's self-reliance.

Tutu's breadfruit development program was developed to contribute to both these areas.

6.2 The Tutu Breadfruit Development Program

A key objective of the Pacific Breadfruit Project (PBP) was to establish breadfruit as a smallholder-based orchard crop in Fiji. All of the PBP orchards, except one, were located in western Viti Levu, where they had ready access to the Natures Way Cooperative quarantine treatment for fresh exports. The exception was the orchard established at Tutu. Located on the island of Taveuni, growing for fresh exports was out of the question.

²² The FAO-funded report, *Lessons in non-formal adult education for self-employment in agriculture*, can be viewed at <http://www.spc.int/pafpnet/resources/publications/youth-development-documents/120-tutu-rural-training-center-lessons-in-non-formal-adult-education-for-self-employed-in-agriculture>

Breadfruit orchard development began at Tutu in 2013, with over 600 trees established over a 3-year period. Tutu, unlike the situation in western Viti Levu, already had access to considerable quantities of the superior *bale kana* breadfruit variety. The orchards established where in a linear in nature, established along Tutu's extensive internal roading system. Both root suckers and marcotted seedlings were planted (figure 2). Tutu also supplied *bale kana* planting material for the PBP's Viti Levu nurseries.

Tutu's first processing of breadfruit began in September 2017. This was 5-years after the initial planting of the orchards. There was some delay due to loss of fruit due to Cyclone Winston. However, the loss of trees was minimal – confirming the climate resilience of breadfruit. Processing at Tutu utilizes the power generated by the Centre's own hydroelectric infrastructure. The availability of hydroelectricity offers a substantial advantage in terms of free clean electricity.

The immediate objective of Tutu's breadfruit processing was to improve the nutrition of the Young Farmer trainees. Some 40 Young Farmers consume large numbers of buns, made from imported wheat flour, for breakfast each morning.

To facilitate Tutu's transition into breadfruit processing, technical assistance and training has been provided by the eminent food technologist Dr Richard Beyer. This has involved a partnership with the Pacific Islands Farmers Organization Network (PIFON), of which Tutu is a foundation member. PIFON also funded some of the equipment, including a peeler, slicer and grinder. This equipment was sourced Dr Beyer. Tutu was able to use its already in place driers which are used for kava powered by the Centres hydro-electricity system.

Dr Beyer delivered his first agro processing training at Tutu in September 2017. His report notes:

Following a week of intensive "hands on" training, 14 new "food scientists" emerged from amongst Tutu staff. Using the excellent facilities provided by the Training Centre, a whole spectrum of locally grown fruits and vegetable were transformed into food products some of which are of international standard. Excitement was generated when new equipment was commissioned to produce breadfruit flour in large quantities. This is used for partial replacement of flour in baking but will eventually find use as a thickener in a range of future products.

Simple demonstrations of jam, chutney and pickle making saw delegates sprint out of the starting blocks to mass produce preserves, chips, chutneys and sauces of all flavours. Not only do these items make good use of fruits and vegetables previously going to waste, they were transformed into products which will compete against imported 'junk,' drinks and snacks to those made out of local crops of much higher nutritional value. Exciting sauces and chutneys made from Tutu's tomatoes, papaya, chillies will add much variety to the usual dalo, cassava and vudi and will ensure that important nutrients such as vitamin C, vitamin A and fibre are added to diets. Cordials and juices have been made entirely from local crops. Such is the interest, that there is much anticipation that these wonderful products will eclipse such dietary demons as two-minute noodles and the cola range of drinks. As result twenty (28) new products were made in just four days.

The participants learned the importance of eliminating bacteria from food that will make them unsafe to eat or cause them to spoil. By workshops end this wonderful team were proficient in hygienic food processing techniques which became second nature to them.

This is the start of a continuum that will eventually become self-sustaining, reduce the reliance on imported food and reduce waste. Such will be the demand from the farms to support processing activity that the concept of farming as a profession will be embedded with dignity and pride.

With the completion of the training the Tutu processing unit has operated on a regular basis.



Bale kana root suckers in Tutu nursery in 2013



Marcotting bale kana breadfruit at Tutu



Loading breadfruit root suckers for transport to the PBP nurseries on Viti Levu



The first bearing of Tutu orchard breadfruit in 2016



Full bearing *Bale kana* breadfruit at Tutu in 2017



One of Tutu linear orchards, along “Breadfruit Boulevard” in 2017



State of the art peeler supplied by PIFON used for breadfruit



Tutu already established hydro power drying system



Grinder to manufacture flour manufactured four by PIFON used for breadfruit

Table 1 summarises the amount breadfruit processed and the products produced by the Tutu Food Processing Unit.

Table 3. Tutu Food Technology Units Processing, 2017

Month	No of breadfruit processed	Breadfruit weight (kgs)*	Quantity of breadfruit flour processed (kgs)	Flour to fruit extraction rate (%)	Quantity breadfruit chips manufactured (50 gm pkts)
October	150	180	30	17%	0
November	0	0	0	0	83
December	275	330	55	20%	49
* Based on an average bale kana weight of 1.2 kgs					

Tutu's breadfruit flour is being sold to a number of stores on Taveuni for \$5/kg – which is seen to be the Centre's break-even price. The same stores retail wheat flour at less than half that price.



The 28 processed fruit products produced at the Tutu agro processing



The breadfruit chips made at the training



The breadfruit flour made at the Tutu training



The bread and buns made with 30% breadfruit flour at the Tutu training



Mango pieces being packaged for freezing



Breadfruit chips being deep fried



"Babakau" made in Suva from Tutu breadfruit flour

The breadfruit flour is used in Tutu's own kitchens. Some has sold to local Taveuni shops at the estimated break-even price of \$5/kg. The same stores were selling wheat flour at less than half that price and it was thus not surprising that the product was a somewhat hard to move. A further 1kg was provided to Deakes Health in Australia as part of this study for their evaluation. Some sixty percent of the breadfruit flour, the balance of breadfruit flour stock from the 2017 processing, was sent to Suva. It was readily sold through Tutu's Viti Levu network. Tutu's current flour supply base is still not sufficient to create meaningful linkages with the private sector bakery product industry. Creating such linkages remains a challenge that will need to be overcome as supply increases.

There has been exceptional local demand on Taveuni for Tutu's breadfruit chips. The chips were packaged in 80gm bags and sold for \$1 at sporting events and at other gatherings. Breadfruit chips were found to be more than competitive with imported potato chips. As expected breadfruit chips, with markets already in place, were found to be much more amenable to cottage industry scale of business than breadfruit flour, where market linkages had to be established.

Dr Beyer, during his short visit to Tutu in September 2017, was able to initiate basic applied research into the properties of the starch derived from breadfruit flour. His work identified breadfruit starch as a particularly valuable natural thickener for food processing. A thickener from breadfruit flour was derived, without the partials disaggregating, by simply adding water. This contrasts to the requirements for deriving a thickener from corn flour or cassava flour. In the case of corn starch it is necessary to heat the liquid. While for cassava starch chemical additives are required. Thus breadfruit flour offers the prospect of simply producing a variety of gluten free mixes without heating or chemical additives. These mixes include high value products such as: custard and bistro sauce mixes, blancmange²³ and a variety of dips. Richard Beyer's preliminary work at Tutu demonstrated this on a cottage industry scale (figure 17). Various custard mixes are seen as products that fit well into Tutu's training program.

²³ Blancmange is a sweet dessert commonly made with milk or cream and sugar thickened with gelatin, corn starch or Irish moss, and often flavoured with almonds. It is usually set in a mould and served cold.



Tutu Rural Training Centre flour dissolved in cold water and used as a thickener for custard gel

Dr Beyer's September Mission, the Tutu Rural Training Centre undertook its own preliminary evaluation of the Food Technology Unit.

The positives identified were:

- A new consciousness of massive amount of fruit and root crops going to waste that can be preserved.
- Unending local market at the moment for all chips produced.
- Breadfruit flour market is moving along. Still too early to predict too much. Selling to local store for \$5 kg.
- Tutu has made 3 permanent staff available for this work and two others to work whilst young farmers are on home period. i.e. five out of ten weeks the unit has been in operation.
- The unit is directly in line with our overall mission of empowering people to become more autonomous, and take charge of their lives, through use of their own resources.
- Nutritional value of breadfruit in diet of local people.

On the negative side Tutu's evaluation concluded:

- The unit doesn't pay its own way particularly for staff wages and will require further financial assistance to become sustainable.
- Research is not Tutu's prime mission and can eat into our administrative time and energy.

Some previously unforeseen needs were identified as the result of Dr Beyer's visit.

- The need for a small commercial grade deep fry unit to enhance the quality of chips and the efficiency of processing.
- To remove a major processing bottleneck, a significantly larger grinding machine is required for flour.
- Half a container load of jars for the jams and chutneys etc. is required
- Appropriate labelling is required for the breadfruit flour and chips and the items produced by the processing unit. Assistance is being sought from a graphic artist who was brought up at Tutu. A water colour painting of Tutu breadfruit has been obtained with the expectation that this will be used in the labelling.



A Tutu breadfruit water colour painting expected to be utilised in product labelling

- A follow-up coaching mission will be required from Richard Beyer early in the New Year.

Dr Beyer made a return mission to Tutu in mid-February 2018. This was to provide follow up training for staff, to commission the deep fryer and the new larger grinder and to continue his applied research into processed breadfruit products.



Participants at the February food processing training at Tutu



Chips made at the Feb Processing Workshop selling in Suva

The essential findings of Richard Beyer's second mission can be listed as:

- The progress made by the food processing group has been remarkable and warrants further support.
- Sustainability is linked to return for effort and in turn requires that any activity is profitable without being exploitative.
- The initial priority for the work was processing breadfruit into flour but readily available demand may not necessarily meet production capacity.
- Breadfruit was not in evidence during the visit and no breadfruit was being processed.
- Breadfruit demand is not well defined.
- The participants are well versed in production of a variety of products from raw materials based at Tutu which are means of compensation for intermittent breadfruit supplies.
- During the time between the initial workshop and the present it appears that the three elements necessary for sustainable raw material supply, technology required to affect the changes and that command market demand are being met.
- The biggest selling item is fried vudi chips.
- There is significant evidence that current production levels fall well short of demand.
- The facilities for the production of processed foods do not inhibit activity but a program of continuing upgrade is required to cope with future demand.
- There is unilateral support to name the activity – the Food Development Unit which encompasses the spirit of continuous advancement and refinement.
- Throughput rate is often a determinant of profitability since economies can be realized by increasing scale (throughput rate).
- Constraints to breadfruit flour is the rate at which grinder can size-reduce the dried chips.
- The market demand for breadfruit flour must be determined.
- Constraints to chip making is the rate at which they can be fried.

Dr Beyer recommended

- Financial performance must be refined to ensure that the unit is self-supporting and does not drain precious resources from Tutu *in toto*.
- Payment is made to farmers for raw materials.
- Restraints to profitability must be rectified.

- Throughput rate is the likely determinant.
- Double basket deep fryer is recommended for chip manufacture.
- Cost benefit should be determined in detail to establish the need for greater grinding capacity.
- The current large scale dryers are unsuitable for the production of fruit and spice powders (and dried banana snacks) and a small scale bench top dryer is recommended for their production.
- Crinkle-cut chips adsorb too much fat and take too long to produce – they should not be offered as a product.
- Order the double fryer (RB)
- Source a suitable bench-top dehydrator (RB)
- Determine the profitability of the Food Development Unit (Tutu Staff)
- Determine a fair price for raw materials to the farmers. (Tutu Staff)

6.3 The way forward

It is expected that the Tutu's Food Processing Unit and the breadfruit orchard over the next few years will become a financially viable small enterprise that contributes to Tutu's sustainability and makes a significant contribution to the Centre's non-formal adult education training program for self-employment in agriculture.

Financially viability of the small enterprise is expected to result from:

- Throughput through the processing unit increases as the orchard's production increases and thereby spreading the unit's overhead costs.
- The efficiency and quality of production improves with the deep fryer and the new larger grinder becoming operational.
- Appropriate labelling enhances the marketability of the products, together with increasing consumer awareness of the value of breadfruit products.

Tutu's agro processing unit will remain a relatively small enterprise in line with the Centre's core training objectives. The processing of breadfruit is expected to earn revenue for the TRTC. However, more importantly, course participants are to be trained in the growing and processing of nutritious food that can be remuneratively sold in local markets.

The Tutu breadfruit orchard and processing unit has provided a demonstration of what can be achieved in terms of producing marketable breadfruit products. What has been achieved will need to be significantly scaled up if anywhere near full advantage is to be taken of the opportunities offered by breadfruit. However, this scaling up is not expected to occur at Tutu given that the Centre is primarily and rural training centre and not a commercial agro processing business. The challenge now is to encourage agro processing businesses to invest in breadfruit processing following the example provided by Tutu. Western Viti Levu would be the most appropriate location for such enterprises given the proximity to the breadfruit orchards established under the Pacific Breadfruit Project and to the major population centres that are the main market.

7 Main Findings and Recommendations

The main conclusions and recommendations of the breadfruit marketing and market study are listed as follows:

- There are substantial immediate market opportunities to expand fresh and frozen breadfruit export markets – however, significant marketing constraints remain that need to be addressed
- For the future, there are major opportunities in supplying processed breadfruit products to export markets. These markets are divided in two broad segments: gluten-free, grain-free product market; and, the market based on processing advantages potentially offered by breadfruit.
- For these markets to be realised, raw material supply constraints have to be overcome and there needs to be substantial capital investment and private sector involvement.
- It is unlikely, for the medium term at least, that breadfruit could obtain a significant share of the large gluten free export market.
- For the foreseeable future export market prospects for processed breadfruit products, apart from frozen and cooked breadfruit, lies in high value niche markets, where breadfruit can differentiate in terms of non-price factors. The study identified two promising, but yet to be developed, niche market opportunities:
 - The superior processing characteristics
 - Unique health and fitness characteristics
- More immediate market opportunities exist for processed breadfruit products on local markets. A particular opportunity is for breadfruit flour as a substitute for imported grains, particularly wheat flour. This domestic market is expected to be driven by NCD health concerns, together with the future impact of climate increasing the relative price of imported grains.
- A substantial increase in breadfruit consumption can make a significant contribution to the reduction of NCDs and this would yield large social and economic benefits. Thus substantial public sector (both government and donor) investment would be justified to encourage this consumption.
- The identified markets for breadfruit and breadfruit products far exceeds the readily available supply and this is expected to be increasingly so in the medium term. The challenge is to create the necessary linkages between breadfruit supply and identified markets.
- There are significant weaknesses in the breadfruit value chain that need to be addressed if the opportunities identified are to be anywhere near realised.
- The most immediate and accessible market opportunities lie on local markets.
- For Fiji, the indicative current annual demand for breadfruit is estimated to be around 8,000 tonnes (valued at nearly FJD5 million); with the indicative medium term (10 years) annual demand is estimated to increase to some 35,000 tonnes per annum (valued at around FJD20 million).
- The indicative current annual export demand for Fiji's breadfruit and breadfruit products estimated to be some 1,500 tonnes per annum, with a fob value of approximately FJD 6.5 million. In the medium term this demand is projected to increase to some 2,500 tonnes, doubling in value to approximately \$12.5 million.
- Despite the importance of planting breadfruit orchards for commercial market development, this alone is not sufficient to allow underlying demand to be anywhere near satisfied. There are

other weakness in the breadfruit value chain, both for domestic markets and export, which now need to be addressed. These include:

- The reform of the BQA for breadfruit exports to New Zealand and obtaining market access for fresh breadfruit to the Australian and United States markets.
- A substantial applied research effort directed at breadfruit processing.
- Linking local processors and exporting companies to the newly established breadfruit orchards.
- Assistance in product development, labelling and in developing consumer awareness.

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