

Pacific Quality Infrastructure (PQI)

FEASIBILITY STUDY ON THE BREADFRUIT VALUE CHAIN IN TUVALU

ITAIA LAUSAVEVE

2022



Acknowledgement

This study was carried out within the framework of the PQI Initiative funded by the Enhanced Integrated Framework, the European Union, the Department of Foreign Affairs and Trade, Australia, and the Federal Ministry for Economic Cooperation and Development, Germany. The PQI Initiative is being implemented by the Pacific Islands Forum Secretariat (PIFS).

PIFS gratefully acknowledges the following individuals and institutions that made this study possible: Health Department and the Biosecurity Division of the Department of Agriculture (DoA), all stakeholders of the breadfruit sector in Tuvalu, PTB, the German Metrology Institute for funding this work; and Mr Christian Schoen, Calidena facilitator, for providing technical guidance. Last but not least, we would like to express our sincere gratitude to the author Mr. Itaita Lausaveve for his commitment and hard work.

The PIFS PQI Team

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List of Acronyms and Abbreviations

Abbreviations	Description
CePaCT	Centre for Pacific Crops & Trees
COI	Certificate of Inspection
CPI	Consumer Price Index
DoA	Department of Agriculture
FNWC	Fiji Nature's Way Cooperative
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HTFA	High-Temperature Forced Air
IAE4LCR	Integrated Agro-ecosystem Approach for Enhancing Livelihoods and Climate Resilience in Tuvalu
ITPGR	International Treaty on Plant Genetic Resources
IPPC	International Plant Protection Convention
KOF	Kaupule of Funafuti
LRD	Land Resources Division
NBFSP	National Breadfruit Farming System Program
NCD	Non-Communicable Disease
NMI	National Metrology Institute
ODA	Overseas Development Assistance
OEC	Observatory of Economic Complexity
PACER	Pacific Agreement on Closer Economic Relations – Plus
PICTA	Pacific Island Countries Trade Agreement
PIFS	Pacific Islands Forum Secretariat
PQI	Pacific Quality Infrastructure Initiative
QI	Quality Infrastructure
SDE	Special Development Expenditure
SPC	Secretariat of the Pacific Community
SWOT	Strengths, Weaknesses, Opportunities & Threats - Analysis
TIN	Tax Identification Number
TNPSO	Tuvalu National Private Sector Organization
USP	University of the South Pacific
VC	Value Chain
WHO	World Health Organization

0 Executive Summary

This value chain (VC) and feasibility study provides Tuvalu's key stakeholders and decision-makers in the public and private sectors with important information on Tuvalu's potential to become an active exporter of essential local products such as breadfruit. Currently, Tuvalu's export sector is weak. The last time Tuvalu exported a valuable commodity was in 2002 when the final batch of a copra consignment was shipped to Fiji. After this shipment, the copra export industry ceased operation following a difficult government decision to end the unsustainable subsidy program for the copra industry.

More recently, the Pacific Island Forum (PIF) agreed to assist member countries in strengthening their trade capacity and expanding their economies to include exporting opportunities. This decision paved the way for developing and implementing the Pacific Quality Infrastructure (PQI) initiative. The PQI initiative has funded the preparation of this feasibility and value chain (VC) study to better understand the breadfruit VC and its export potential in Tuvalu and to investigate the country's quality infrastructure (QI) status. The PQI initiative and other projects will learn from the challenges facing the breadfruit VC and Tuvalu's QI status when considering what support is needed. Tuvalu stakeholders selected the breadfruit VC in 2021 through a participatory process due to its status as an essential food crop and potential export.

The PIF Secretariat (PIFS) has coordinated the preparation of this study from its headquarters in Suva, Fiji, with technical support provided by PTB, the national metrology institute of Germany, and a recruited local consultant. The local consultant facilitated the collection of information and the compilation of this study.

Based on PTB's Calidena¹ approach, the study's methodology involved collecting quantitative and qualitative information through literature review and online research, face-to-face interviews with selected persons of interest in the public and private sectors and an online survey with VC actors.

An initial study result is the breadfruit VC map. Presently, there is little commercial activity in the breadfruit VC in Tuvalu with regard to both fresh breadfruit and breadfruit chips. However, VC actors



1 <https://www.calidena.ptb.de>

and supporters in the breadfruit VC are active and can be identified. The breadfruit VC shows six distinct segments: inputs, production, processing, distribution, marketing and consumption. VC actors operate in each segment, adding value to the commodity along the VC. The VC supporters help or enable VC actors to produce high-quality products suitable for domestic and potential foreign markets and to manage their business.

Among these VC supporters are QI institutions and service providers. QI services involve metrology, standardization and conformity assessment (e.g., testing, certification). They are crucial in ensuring product quality and competitiveness in domestic and overseas markets. In Tuvalu, no comprehensive QI setup exists yet. Tuvalu does not have a national metrology institute, a national standards body or a formalized and internationally recognized accreditation body to prove the competence of conformity assessment bodies.

Only two supporting institutions provide quality infrastructure services to breadfruit VC actors – the Health Department and the Biosecurity Division of the Department of Agriculture (DoA). Based on the Food Safety Act, the Health and Environment Food Inspector inspects food processors in the breadfruit VC. The Biosecurity Inspector, under the Biosecurity Act, awards certificates of inspection (COIs) to breadfruit chip exporters if they are compliant with the respective standard, allowing breadfruit chips to be exported to Fiji, Australia or New Zealand. However, several other public and private institutions could potentially complement the QI if considerable investments are made in equipment and laboratories. Any QI, if fully established, would improve the quality of Tuvalu's breadfruit products and other products and services.

The current breadfruit VC has many quality gaps. Local farmers, processors and distributors lack knowledge and training to ensure breadfruit product quality in commercial or semi-commercial VC activities. Another challenge is that the few existing QI supporters have problems addressing the many quality gaps due to a lack of laboratories, equipment, standards and regulations. The Food Safety Act, at this point, still lacks the twenty regulations recommended for its implementation.

The study recommendations are:

- Conducting a full-fledged Calidena process with PQI support to identify and close quality gaps in the breadfruit VC
- Investing in Tuvalu's QI to support breadfruit and other export products. Existing facilities could potentially be expanded to support laboratory services
- Expanding the new DoA laboratory funded by the FAO under the Integrated Agro-Ecological Climate Resilient (IAE4LCR) project and ensuring its accreditation
- Strengthening the Farmers Association and upgrading it to the Tuvalu Farmers Organization
- Timely development of regulations under the Food Safety Act, e.g., on food safety and exports
- Further investigation of the temporary ban on breadfruit chip imports by the New Zealand Biosecurity Department
- Establishing a national food standards committee to provide guidelines on food standards
- Developing a national breadfruit farming system program (NBFSP) within the DoA that is orchard-oriented and could be incorporated into an agroforestry production approach
- The Food Inspector should define a standard practice for food processors when frying breadfruit chips or other processed food items, accompanied by compliance certifications.

In conclusion, there is still much for the breadfruit industry and its support structure, including QI institutions, to explore further and significant ways to enhance the potential of breadfruit to become an important export commodity for Tuvalu in the next few years.

1 Introduction

This report covers the feasibility and value chain study of breadfruit in Tuvalu that started in January 2022. The study is essential for informing key stakeholders and key decision makers in Tuvalu about the processes involved in the breadfruit value chain and its supporting quality infrastructure and about the economic potential of breadfruit as an agricultural export commodity for Tuvalu. Before this study was undertaken, the author of this report went through an intensive three-day training session (21–23 December 2021) on the Calidena² method. Calidena is a participatory methodology developed by PTB, the national metrology institute of Germany, to stimulate quality in value chains and support the development of the national quality infrastructure.

The study is structured in two parts that focus on different aspects of the value chain. The first part provides an overview of the elements that make up the value chain, how value is added to the product as it moves along the value chain and who the stakeholders are in the chain (referred to throughout this report as value chain actors). The second part examines quality infrastructure (QI), its important functions in ensuring the quality of breadfruit products and who QI stakeholders are (referred to in the report as supporting actors). These stakeholders have a unique, indirect intervention on the product as it moves along the different stages of the value chain. Standardization, metrology, conformity assessment (testing, certification, inspection) and accreditation are the services provided within the quality infrastructure. It is therefore important for specific and related institutions or department(s) in the public and private sectors to have the ability and capacity to deliver such QI services, as they directly determine the quality of a local product that must be internationally competitive. This study provides advanced knowledge and understanding of the breadfruit chip's potential, given its current parameters and its importance as an export commodity for Tuvalu in the future.

2 Objectives of the Breadfruit Feasibility Study

The objectives of this feasibility study are to enable Tuvalu stakeholders to achieve the following.

1. To investigate and develop the breadfruit value chain of Tuvalu in its current operational situation.
2. To assess which key figures in the quality infrastructure are relevant to the breadfruit value chain in terms of their presence in the public and private sectors and the extent to which their services and roles are designed to facilitate the export of breadfruit products in the foreseeable future.
3. To draw conclusions and recommendations that enable decisions to be made concerning how the Pacific Island Forum Secretariat (PIFS) is to provide support in Tuvalu to conduct a full-scale participatory Calidena exercise for the breadfruit value chain.

3 Methodology of the Feasibility Study

The methodology in this study involved a series of interviews³ with critical stakeholders to seek their views on the breadfruit value chain, the quality infrastructure in Tuvalu and the quality expectations of consumers regarding fresh breadfruit and breadfruit chips. The consultant conducted interviews

² <https://www.calidena.ptb.de>

³ Annex I - List of Interviewed individuals with occupation

with critical stakeholders by visiting their workplaces. In addition, the consultant carried out an online survey using Survey Monkey (a web application) with forty individuals in Tuvalu and in other countries. The results of the interviews and the online survey⁴ have been annexed to this report and are covered in more detail in a later chapter. Finally, the study conducted literature and internet research to complete the collection of relevant information and data.

4 General Economy of Tuvalu in Brief

Located in the South Pacific Ocean, Tuvalu⁵ is a small, developing island state comprising nine atolls totalling around 26 square kilometres in land area. Tuvalu is geographically between the island nation of the Republic of Fiji to the south and the Republic of Kiribati to the north. Tuvalu is isolated and highly vulnerable to climatic and economic shocks. It has a small private sector with limited resources to support socioeconomic development. The public sector is the primary driver of growth. Tuvalu's economy depends on fishing license fees that commercial fishing countries, especially South Korea, Japan, and the USA, pay annually. Tuvalu also has an investment fund called the Tuvalu Trust Fund which was established in 1986 to support the government's annual budget. Tuvalu continues to benefit from overseas development assistance (ODA) and overseas remittances from its diaspora in Fiji, New Zealand, and Australia.

Tuvalu's GDP in 2021 was around AuD \$74 million. Its GDP growth was at 3.6% in 2021, whilst its GDP per capita was estimated to be AuD \$4,154. Inflation via its consumer price index (CPI) was 2.15% in June 2020. By December 2021, the Tuvalu government statistics office recorded a high CPI of 9.8%.

Tuvalu has an unemployment challenge. In 2012, the Tuvalu Mini Census Report of 2016 indicated that unemployment was 39.6%, while in 2017, the unemployment rate dropped to 28.5 %. Within the last five years, unemployment has further decreased due to employment opportunities for its labour force of around 49% in building and construction in 2017 following increased infrastructure development projects beginning in 2018 and expanding to the remote outer islands in the construction of ports, housing schemes and new domestic airports. In 2020, Funafuti constructed an estimated three hectares of reclaimed land in the Funafuti Lagoon to provide space for Queen Elizabeth Park; this park is currently the location of the main government convention centre, which spans nearly one acre of floor space, and a temporary jetty for super barges and other vessels to discharge cargo.

According to the Observatory of Economic Complexity (OEC)⁶, Tuvalu's imports in 2020 were around USD \$60 million, \$13 million of which was spent on food and other goods. The country's exports were USD \$12 million. Fish was the main export product, and no figures were available for any agricultural commodities. This reflects the current situation of Tuvalu, which does not yet export agricultural commodities of significant importance. Records from the UN World Tourism Organization (UNWTO) indicated Tuvalu's tourism revenues in 2019 were USD \$2.4 million, corresponding to 4.9% of its GDP. In proportion to its population, Tuvalu's tourism per capita was around 0.31 tourists per resident, ranking 77th in the world and 3rd in Polynesia. Since the COVID-19 global outbreak in March 2020, Tuvalu experienced a total closure of its borders from April 2020 until September 2021. This closure is occasionally reinstated with few flights arriving; however, tourism has not fully returned to its pre-Covid-19 level. In the pre-COVID-19 era, there were around two flights a week. As of early 2022, there is only one flight nearly every two months, hugely affecting tourism travel by air.

4 Annex II -Online SurveyMonkey results

5 Asian Development Bank, fact sheet – updated March 2022.

6 <https://oec.world/en/profile/country/tuv>



Tuvalu's major traditional agricultural export was copra; such exports ceased in 2002 following the discontinuation of copra subsidies by the government. Since then, no other major agricultural commodity has been developed for export. Breadfruit, another traditional food crop, is not yet being exported for economic development. However, over the past ten years, considerable amounts of homemade breadfruit chips, which are popular locally, have been exported informally not as a source of income but as gifts to relatives and friends of the Tuvalu diaspora in Fiji, New Zealand, and Australia. The Department of Agriculture (DoA) confirmed in 2016 that breadfruit chips had been banned temporarily by biosecurity authorities in Auckland, New Zealand. The reason for the ban is not related to pest or disease problems and is still unclear but suspected by the DoA to be associated with the quality of the chips, perhaps during the cooking process at the time of confiscation by New Zealand biosecurity authorities. Ongoing dialogue between the DoA, the Secretariat of the Pacific Community (SPC) and NZ Biosecurity has attempted to articulate this issue. Until further notice, breadfruit chips from Tuvalu will continue to be banned from entering New Zealand.

5 Analysis of the Breadfruit Value Chain

Breadfruit in Tuvalu is an essential traditional starch and staple food and is second in importance to the Pulaka or giant swamp taro. The distribution of the breadfruit tree is wide, being found on all nine of the small atolls of Tuvalu. What is unique about the breadfruit in Tuvalu is that it is not a vital orchard tree crop as in Hawaii⁷ nor is it a wild⁸ species commonly harvested for commerce and exporting as in Fiji. However, in contrast, breadfruit in Tuvalu is widely found in all the village areas of Tuvalu's islands. Thus, many rural households have at least one or two breadfruit trees nearby for the sake of convenience. Breadfruit is therefore commonly found in Tuvalu villages and is one of

⁷ Breadfruit Production Guide, recommended growing, harvesting, and handling practices, 2nd edition.

⁸ Breadfruit Manual, A Manual for Growing and Marketing Breadfruit for Export, Dr Andrew MacGregor et al.

the primary tree species, covering an estimated 70 % of all trees in most villages. In this respect, the breadfruit tree is essential in providing shade and keeping villages cool. Besides providing food for households, dried breadfruit leaves are a popular and valuable compost ingredient for cultivating the traditional root crop Pulaka.

5.1 Map of the breadfruit value chain

Figure 1: Tuvalu breadfruit value chain map

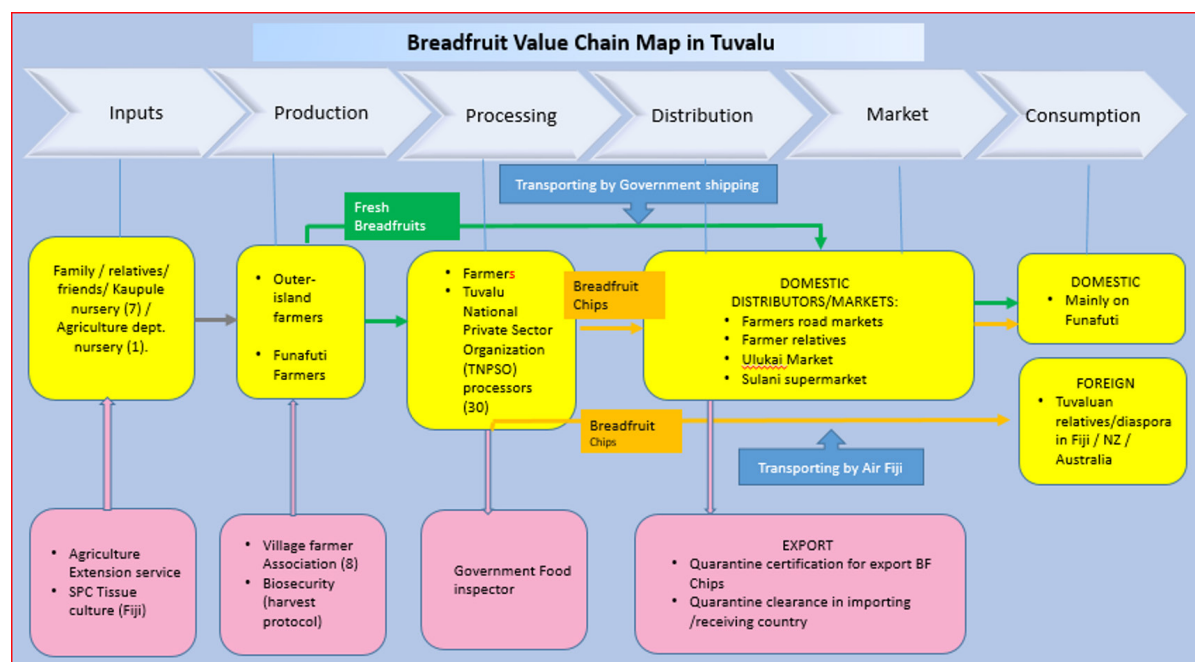


Figure 1 contains the current Tuvalu breadfruit value chain map. At the top of the map in the white arrowheads are the different elements of the value chain; the product or commodity (in this case, breadfruit) moves to the right along the value chain. The second map level (yellow boxes) contains the key actors who have a direct relationship or role in the corresponding elements of the value chain. The third level of the map (pink boxes) contains the known supporting actors. Their contributions are specific and indirect and include QI services such as testing and certification to ensure that a given breadfruit product complies with quality requirements while moving from one element to the next in the value chain.

The arrows and links on the map show the different relations and activities between actors and supporting actors and the corresponding elements of the value chain. The green arrows represent how the fresh breadfruit moves from one element to the next along the value chain. After production and harvesting, the outer island farmers ship the breadfruit directly to relatives or the Funafuti market, as indicated by the green arrow. The other link from the outer island and Funafuti farmers shows how value is added by transforming the product into breadfruit chips, indicated by the orange arrow linking the farmers and the food processors. In this study, although fresh breadfruit is important, discussions will focus more on breadfruit chips, given the objective and interest of this study on export potential.

The breadfruit chip is not currently a formally exported commodity in Tuvalu for income generation but is instead exported or sent as gifts to relatives and friends in the Tuvalu diaspora elsewhere. By contrast, fresh breadfruit is not shipped but sold in the domestic market. The primary domestic market is on the capital island of Funafuti, where nearly 60% of the population of Tuvalu lives. The population of Funafuti in 2017 was 6,716 people according to census⁹.

⁹ Tuvalu Population & Housing Mini-census 2017 Report.

5.1.1 Input Supply

Input supply is the first element of the breadfruit value chain in Tuvalu. The key actors providing vital inputs for cultivation of the breadfruit tree are the farmers themselves, who supply their seeds and planting materials, the Kaupule nurseries on the outer islands for supplying planting material for breadfruit and, finally, the DoA as another source of seedlings and cuttings from their nursery in Funafuti. The next level of important actors (pink boxes) are the supporting actors of the input supply, which are the DoA in providing extension training services to the farmers and the SPC Center for Pacific Crops and Trees (CePaCT) in Suva due to its important role in supplying virus-free planting materials in test tubes. CePaCT has been providing and distributing tissue-cultured planting materials, including breadfruit and other food crops, to all its Pacific island members including Tuvalu.

5.1.2 Production

Production is the second element in the breadfruit value chain and is carried out by farmers. Tuvalu has two central breadfruit production locations, as shown in the value chain map. The first production location is on the seven outer islands, and the second is on the capital island (Funafuti Atoll). The key actors in the production element of the breadfruit value chain are the farmers on the outer islands and the farmers on the capital island of Funafuti. The supporting actors in this element of the value chain include small village farmer associations that provide protective packaging materials to their members used during the transportation of breadfruit and other local food products to the market in Funafuti. However, not all outer islands have these informal farmer groups, even though their service is beneficial. The second crucial supporting actor is the extension division of the DoA. Their role is to ensure that any breadfruit product developed for exporting to relatives abroad must follow the harvesting and commodity pathway protocol that SPC helped develop for Tuvaluan breadfruit farmers. Breadfruit harvests that do not comply with this protocol will not receive certification for export by the DoA using its Quarantine Certificate of Inspection; this Col is necessary for biosecurity authorities in New Zealand, Fiji, and Australia to accept imports of breadfruit chips for friends and families.

Generally, breadfruit is grown only in the village areas of the Tuvalu islands. Farmers or households with breadfruit trees occasionally sell their breadfruit in the market. As a cultural practice, they also share their breadfruit with their neighbours and friends when there is a surplus.

5.1.3 Processing

The only processed breadfruit product of interest for this study is the breadfruit chip. In the processing stage of the value chain, one will note that fresh breadfruit is value added by transforming it into chips. According to the value chain map, the key actors in the processing element of the breadfruit value chain for both fresh breadfruit and chips include farmers themselves and members of the Tuvalu National Private Sector Organization who are registered as food caterers. Both groups are currently making or processing chips marketed domestically and exported to relatives. The movement of the chips from one element of the value chain to another is shown by the orange arrows. There are two outflows: one shows the chip's movement in the value chain from the processing element to distribution and then to the domestic market. The second orange arrow shows the chips in the processing element moving directly to be exported to reach consumers overseas.

There are three key supporting actors in the processing of breadfruit chips: the public health department's food inspector, the government's business registration authority, and the Funafuti Kaupule (council), which administers business operating licenses. The roles of these supporting actors are as follows:

1. Any person that wants to establish a business must first register with the business registration authority of the government to be issued a registration certificate and a tax identification number (TIN). Without a registration and a TIN, no one can operate a local business compliant with the Business Registration Act.



2. The following step is to obtain an operating license from the Funafuti Kaupule (council) that is collected annually and protected under the by-laws of the Funafuti Kaupule from the Falakaupule Act, which all local businesses must comply with. Therefore, most TNPSO registered members (actor group) can commercially market breadfruit chips in Funafuti.
3. The other significant authority is the Public Health Department, which inspects any processed food sold to the public and must comply with the Tuvalu Food Safety Act food standards. Although the Act contains recommendations for several regulations to assist with local food standards, these regulations have not been drafted to date. The Public Health Department has confirmed that the WHO and FAO would provide the support necessary to draft these regulations in the near future.

While quality assurance services have not been fully developed or formalized in Tuvalu, they will become necessary, particularly in the processing stage of the value chain.

5.1.4 Distribution and Markets

Given the small market for breadfruit on Funafuti (the capital island of Tuvalu), the key actors in the distribution and marketing elements of the value chain are nearly the same. Farmers play an important role in distributing and marketing the fresh breadfruit for fresh breadfruit. Most breadfruit farmers in Funafuti sell fresh breadfruit on the roadside next to their homes. However, a few farmers send some of their harvested fresh breadfruit to the Ulukai open market in Funafuti. Sulani supermarket has sold locally processed breadfruit chips in the past and is the only supermarket that has allowed local food processors to sell their local processed food products, provided they fulfil the supermarket's quality standards. Sulani was previously supplied with chips from both the outer islands and Funafuti processors. This marketing cooperation has been put on hiatus as the supermarket undergoes restructuring and renovation. Nevertheless, according to its financial manager, locally processed food will continue to be sold via its two other branches in Funafuti.

A crucial supporting actor of the value chain in the distribution/marketing element is Tuvalu's biosecurity/quarantine authority, which plays an important role in providing clearance of breadfruit chips for exporting to New Zealand, Fiji, Australia and other places worldwide. All clients must send their chips for inspection by the quarantine authority of the DoA. All agricultural materials, including food, must be compliant with the provisions of the Biosecurity Act of Tuvalu during exporting or importing, as such products have the potential to carry harmful pests and diseases. If found clean, the breadfruit chips will be issued with a certificate of inspection (Col) that will accompany the consignment of the chips to the destination country. The Col is therefore a compliance tool that the biosecurity authority uses to enable the breadfruit chip to move to export and thus consumption abroad.

5.1.5 Consumption

Consumption is the sixth and final element of the breadfruit value chain. In the value chain map above, there are two groups of consumers: local consumers on Funafuti Atoll and overseas consumers: Tuvaluans in the diaspora of Fiji, New Zealand and Australia.

Breadfruit chip exports from Tuvalu are only sent as gifts to family members, relatives and friends in the diaspora of Tuvaluans in these countries, of which New Zealand has the largest Tuvaluan population. With its informal export background, breadfruit chips may serve as a source of lessons to local processors on improving packaging in order to prevent the chips from being confiscated by New Zealand biosecurity.

5.2 Breadfruit Quality Perspectives

Fresh breadfruit and breadfruit chips share some standard requirements on how different actors along the value chain perceive them. These requirements will be discussed separately for fresh breadfruit and breadfruit chips in more detail, relating feedback obtained within the scope of the study from the different actors in the six stages of the breadfruit value chain.

5.2.1 Breadfruit Chip Quality from Distributors' Perspective.

Sulani supermarket is used for breadfruit chip orders from outer island farmers and food processors. When these orders arrive in Funafuti, farmers and processors take samples to evaluate the crunchiness and aroma of the chips and to ensure that the chips are not saturated with cooking oil. If the chips are deemed to be satisfactory, the supplier is paid and the breadfruit chips are repackaged under the supermarket's label and sold from a local market outlet for domestic consumers. Inspectors often encounter sub-standard, low-quality chips even without any laboratory support.

Table 1: Comparison of requirements to determine the quality of local-standard breadfruit chips with an International Certification Board body – the IFT

Parameter	Local general standard	International Food Technologists (IFT) ¹⁰ , USA registered
Breadfruit chip size	Potato peeler size	1.25 mm
Oil	Any imported oil	Soya
Salt	To individual taste	1.5% of chip weight
Cooking temperature	Self-determined	165 degrees Celsius

Table 1 shows that breadfruit chip manufacturing in Tuvalu does not follow any recognized formal standard to certify its quality.

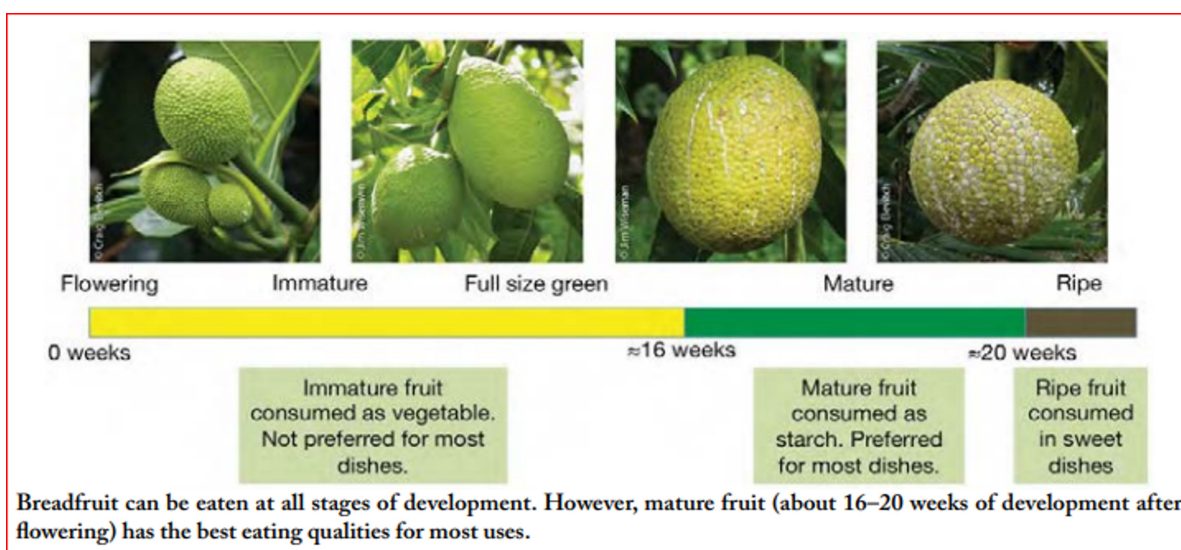
5.2.2 Qualities of Fresh Edible Breadfruit

Tuvalans consume both mature and over-ripe breadfruit. The Mafala, Mei-Niutao and the Vaelua varieties are the most popular for cooking breadfruit chips. When boiled, the Vaelua variety is the most popular because of its compact texture, which resembles that of a sweet potato. The pokeke and the vaelua are seedless varieties. The Tuvaluan Common Variety (mei fakatatou) is the sweetest of all types and is often eaten raw when it is over-ripe. No standard is currently in place at the open Ulukai market or on roadside markets; however, informally, breadfruit can be considered fit for sale provided that it is clean, has no bruises or cracks and is laid out neatly to attract the consumer's attention.

The US state of Hawaii has documented maturity as a quality-related feature of breadfruit, as illustrated in the graphic below.

10 Institute of Food Technologists. The Institute of Food Technologists is a registered 501(c) 3 organization EIN 36-2136957

Figure 2: Quality-related features of breadfruit



Source: *Breadfruit Production Guide, 2nd Edition. Craig Elevitch & et al.*

Hawaii has also further experimented with young, under-mature, mature and ripe fruit in cooking and has documented taste and other important quality features. The above data from Hawaii on the consumption of immature breadfruit as “vegetables” could be further investigated by local food processors to add flavour to Tuvalu’s own breadfruit dishes.

5.2.3 Other Breadfruit Quality Processes

As discussed above, an existing commodity pathway protocol developed by the DoA with support from SPC is used to standardize the way breadfruit is harvested and prepared for the breadfruit chip market in New Zealand. This protocol was adopted in Tuvalu as a guideline for local exporters of breadfruit chips and other products. Locals are familiar with the quality they want for their chips: crunchy, fresh smell, not saturated with cooking oil, thinly sliced and packed in airtight plastic. However, locally packaged breadfruit chips do not follow any standard weight per package. These quality requirements are generally followed by processors of breadfruit chips that are informally exported to relatives and families in New Zealand.

The only enforced compliance procedure required for exporting breadfruit chips is the quarantine inspection of the DoA. If cleared, packaged breadfruit chips will be issued a certificate of inspection (Col) to confirm that the products have passed Tuvalu quarantine and have been visually inspected and found to be clean and safe for consumers in New Zealand. The biosecurity or quarantine role in any country is to prevent unwanted harmful pests and plant and animal diseases from entering the recipient country to avoid pest or disease outbreaks in the country’s agriculture, livestock and food industry. In future, as breadfruit chips “graduate” to become a formalized commodity for export from Tuvalu to New Zealand, it is anticipated that new compliance regulations may be imposed because the increased export volume will entail a greater biosecurity risk.

5.2.4 Nutrition composition

The nutrition content of fresh breadfruit and processed products is relevant to this study. Due to consumers’ awareness of health-related issues, labels showing which nutrients are contained in the product are essential and important information must be attached by the breadfruit industry and other agricultural industries. A publication¹¹ from Hawaii on the nutritional contents of breadfruit – shown in Figure 3 - compares breadfruit with rice and white potatoes, showing that breadfruit is superior in terms of both macro- and micronutrients including vitamins A and C and a few minerals.

¹¹ Breadfruit nutritional value and versatility (growables.org)

Figure 3: Comparison in nutrition between breadfruit, white potatoes and white rice.

	Breadfruit*	White potato	White rice
Protein (g)	4.0	1.7	2.4
Carbohydrate (g)	31.9	15.7	28.6
Fiber (g)	5.4	2.4	0.3
Phosphorus (mg)	43.1	62.0	37.0
Potassium (mg)	376.7	407.0	29.0
Calcium (mg)	16.8	9.0	3.0
Magnesium (mg)	34.3	21.0	13.0
Sodium (mg)	19.4	16.0	0.0
Iron (mg)	0.5	0.5	0.20
Zinc (mg)	0.1	0.29	0.42
Vitamin C (mg)	2.4	9.1	0.0
Thiamin (mg)	0.1	0.07	0.02
Riboflavin (mg)	0.0	0.03	0.016
Niacin (mg)	0.9	1.06	0.40
Vitamin A (ug)	1.4	0.0	0.0
Lutein (ug)	96.3	0	0
B-Carotene (ug)	15.1	0	0

Source: www.ars.usda.gov/ba/bhnrc/ndl

5.2.5 Breadfruit Production Experience from Other Pacific Islands

Production figures for fresh locally marketed breadfruit and exported breadfruit chips are unavailable. The biosecurity division of the DoA normally only records the number of packages of breadfruit chips but not their weight. The reason for the poor data collection on breadfruit is its insignificance as an export food product. Data related to breadfruit in Tuvalu are available only in a very limited form.

Nevertheless, it is interesting to look at the neighbouring island countries of Fiji and Samoa and even the US state of Hawaii with respect to the production levels of their breadfruit industry since commercialization began around thirty years ago. Of special interest are the breadfruit production systems and support services provided to farmers in these regions to increase productivity. Quality infrastructure and services from both the public and private sectors are designed to enhance the quality of these regions' exports. For example, Nature's Way Cooperative (NWC) in Fiji is a privately registered farming organization that is one of the key supporting actors facilitating the collection and classification of breadfruit from registered farmers that is then subjected to high temperature forced air (HTFA) by Fiji biosecurity to rid the fresh breadfruit of any unwanted pests.

In Hawaii and Fiji, breadfruit is planted either in a block orchard or a linear orchard design. In some cases, both orchard types are integrated into an agroforestry farming system that could be suitable for Tuvalu as well. Hawaii, on the other hand, has pioneered techniques for maintaining breadfruit trees at a height of 4 to 5 meters by constant pruning to increase their productivity and, more importantly, to make their fruits easy to reach during harvesting. In Tuvalu, such management and farming systems are not part of traditional breadfruit farming, resulting in low productivity. To increase the production of breadfruit, Tuvalu will have to develop a new farming system along the lines of the production systems introduced in Hawaii and Fiji, as they have demonstrated their viability to sustain supplies of breadfruit for the breadfruit export industries.

6 Analysis of Quality Infrastructure

6.1 Introduction

Quality infrastructure (QI) refers to all aspects of metrology, standardization, testing and quality management including certification and accreditation. This includes public and private institutions and the regulatory framework within which they operate (Sanetra & Marban, 2007)¹². To put this into a meaningful context, in a society where the aspects of QI are well established, consumers are generally willing to pay any value on the goods, services and products they receive because of the quality assurance included. Linking this to a bigger picture, QI is an important instrument for any country's economic development, as it is the main driver for enhancing both domestic and international trade.

Figure 4 shows how complex a QI may be structured in a developed country such as Australia or New Zealand. To ensure export competitiveness, the actors in a commodity value the use metrology services such as calibration of measurement instruments. Recognized standards relevant for the commodity are followed; the commodity is tested for quality requirements in export markets and certified if accepted by customers or the authorities and all conformity assessment services (testing, certification, inspection) are provided by competent conformity assessment bodies that have been accredited by an internationally recognized accreditation body.

Figure 4: Quality Infrastructure



Source: *Calidena Handbook 2.0*, Dr. Ulrich Harmes-Liedtke, Reinhard Schiel, Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin, National Metrology Institute, German Cooperation.

In Tuvalu's context and comparison, the quality infrastructure set up according to Figure 4 above does not fully exist. However, a few institutions (primarily government-operated institutions as well as some private sector-operated institutions) have responsibilities and roles in quality management in a few development sectors.

First, Tuvalu does not have a national metrology institute (NMI) nor a major need in the foreseeable future for comprehensive metrology services. Tuvalu would have to receive its metrology services from another country where an NMI exists, for example, the National Measurement Institute of

¹² The Answer to Global Quality Challenge, A NATIONAL QUALITY INFRASTRUCTURE, Dr Clemens Sanetra & Rocio M. Marban, 2006.

Australia¹³. Tuvalu does not have a formalized or recognized accreditation body that the government has established to prove the competence of conformity assessment bodies.

When needed, the assurance of correct measurements is followed and complied with by service providers and local manufacturers. There are numerous institutions in both the public and the private sectors that do not conduct formal metrology operations although they have the potential to do so. For example, domestic commercial fishing is quite a large sector active on both the capital island of Funafuti and on the outer islands. The Department of Fisheries (DOF) is a key player that provides effective technical and extension services to both subsistence and commercial fishermen. The DOF also has great potential to undertake metrology services to improve quality in the fishing sector. An issue of importance to consumers is the accuracy of weights commercial fishermen use. Currently, there is no legal metrology mechanism that allows weighing equipment to be inspected regularly or verified as being within the tolerance measures allowed by law or an agreed standard, meaning consumers always pay for the exact weight of their fish products. At the same time, there is no monitoring in place by the DOF to maintain this quality measure or other quality issues, as its current lab infrastructure is not fully equipped for measurement compliance. Interest in this matter would have to be referred overseas, for example, to the Australian National Measurement Institute, where such quality parameters can be verified for fair commerce.

The Public Works Department, on the other hand, is involved in large building and other civil infrastructure activities but has no established metrology unit to ensure that quality measures of both public and private sectors are adhered to in civil engineering, building, water, energy and manufacturing products and services.

However, some government authorities in Tuvalu provide certification services for specialized needs. For example, the government operates a biosecurity authority as part of the DoA to perform phytosanitary inspection and certification services to export any plant item or product that requires an import permit in the importing country. This is a requirement of the International Plant Protection Convention (IPPC) that Tuvalu has signed. Tuvalu has conformed to this international biosecurity commerce standard for inspection and certification since joining the IPPC in 2005.

For other quality services, Tuvalu lacks a laboratory to test the quality parameters of food items such as breadfruit chips or other potential export products. Instead, Tuvalu needs to send test samples for quality assurance to a regional laboratory such as the University of the South Pacific (USP) in Fiji, which provides such services for food and non-food products. Whilst Tuvalu has a food safety act in place, supporting regulations to this act still need to be developed. The FAO and the WHO, of which Tuvalu is a full member, set voluntary food standards. The FAO mainly assists member countries in developing their food standards by adapting internationally recognized food standards.

The lack of QI services is due to (i) a lack of products with an export orientation that requires the establishment of QI service providers, (ii) a small number of QI bodies in the government and the private sector without any recent or foreseeable staff upgrading.

The handful of QI institutions in Tuvalu have the following issues:

1. The Agriculture Department lacks trained food scientists for food laboratories.
2. The Public Health Department also lacks trained specialists to handle specialized equipment to assist their food inspectors in determining the quality of imported fresh food and stored food.
3. The Fisheries Department has no dedicated specialist to test according to standards on fish products for local producers and (in particular) for targeted export markets.
4. The Customs Department has no trained specialist or system to track suspected imports to their places of origin.
5. The Public Works Department has no trained inspector to set local standards in measurements or devices for the manufacturing of goods in building and construction.

13 <https://www.industry.gov.au/policies-and-initiatives/national-measurement-institute>

6. The Tuvalu National Private Sector Organization lacks facilities and specialists to assist local food processors in upgrading their food products to recognized voluntary standards for local consumers and exporting.
7. The Department of Trade has no quality infrastructure specialist to assist local institutions in the public and private sectors in providing quality assurance services for locally manufactured goods destined for domestic and export markets.
8. Existing laboratory facilities at the Princess Margaret Hospital and the current DOF laboratory are the only laboratories in the country, but are reserved for other purposes and not equipped to conduct quality assurance services for export commodities.

Any QI, if fully set up, would have great potential to improve the quality of domestic goods and services in Tuvalu.

6.2 Inventory of Standards and Technical Regulations

Biosecurity authorities currently handle the physical certification process by issuing phytosanitary certificates and certificates of inspection (Cols), both of which are regulated under biosecurity legislation to enable food of plant origin to be exported. They are also responsible for coordinating pathway commodity processes for exporting agricultural produce. The commodity pathway is an agreed standard for exporting breadfruit chips to the New Zealand market. The standard includes all steps from when a mature breadfruit is identified and how it is harvested, cleaned and cut into thin strips to when it is fried and packaged. This is the only standardized commodity formally developed for Tuvalu breadfruit chips for export. This pathway, however, has certain limitations for not having any standardized laboratory inspection process and clearance thus far but rather only visual inspection. It therefore needs to be further enhanced for quality by introducing standards for and for testing the product in terms of its crunchiness, salt content and packaging. The certification must be in the form of a standard logo that SPC and the government may use. This process will yield a breadfruit chip product that consumers will be assured has the quality they anticipate.

The Codex Alimentarius, an internationally recognized body that sets out voluntary standards, is an option for Tuvalu to use for its national food standards before developing its own food standard. Tuvalu's current Food Safety Act identifies which regulations still need to be drafted.

Table 2: Inventory of some standards and regulations

Standards	Regulation
- Protocol on breadfruit harvesting for export - Certificates of inspection (Cols) - Plant, animal & soil import permits - Plant phytosanitary certificates following International Standards for Phytosanitary Measures (ISPMs) of the International Treaty of Plant Genetic Resources for Food and Agriculture (ITPGRFA)	- Biosecurity Act (2017) - ITPGRFA
Currently visual inspection basis only	Tuvalu Food Safety Act (2008 revised edition)
Certificates of inspection (Cols)	Biosecurity Act 2017 (Tuvalu)
Trade portal for Tuvalu local products	- National Trade Policy, focal points for the PICTA - Fiji Bilateral Trade Agreement - PACER Plus - PICTA (Pacific Islands Countries Trade Agreement)
Government business registration certification	Foreign Investment Act
Annual business operation licensing	Tuvalu Kaupule Act

Table 2 does not include standards or regulations related to the following institutions: Marine & Shipping Authorities, Aviation Authority, the Public Works Department, the Ulukai market, the University of the South Pacific – Tuvalu Campus.

6.2.1 Tuvalu Food Safety Standards

Tuvalu has yet to establish any formal food safety standards that local food processors can follow. Households and a few commercial food processors have been using their own quality requirements from their experience in food processing, which local consumers have accepted for many years. However, this ongoing practice does not conform to any formalized standards in line with the Tuvalu Food Safety Act (2008). This act has identified over twenty potential regulations¹⁴ for determining food import and export standards, but none has been drafted to date. According to a source from the Public Health Division, the regulations have not been of high priority. There is also a lack of capacity to draft these regulations.

6.2.2 Pacific Islands Food Standards

Several Pacific Islands, notably Fiji and Samoa, have well-developed breadfruit industries that have experience in exporting fresh breadfruit and several other processed breadfruit products. Both countries' export markets are New Zealand and Australia, and most of their export products are shipped via air freight. They have over twenty years of combined experience in breadfruit exports.

Both countries also have a well-established quality infrastructure including laboratories and equipment to experiment with preserving breadfruit and other local fresh foods such as mangoes. Hence, their food standards¹⁵ have helped their local food processors maintain very high levels of hygiene in their processing units, follow recommended cooking and storage temperatures and create packaging that can preserve the product quality until it reaches its export destination.

6.3 Quality Infrastructure Gaps (Breadfruit Value Chain)

A SWOT analysis has been undertaken to facilitate the structural assets and gaps in the current quality infrastructure in Tuvalu, the results of which are displayed below.



¹⁴ Annex 4

¹⁵

Table 2: SWOT Analysis of QI Gaps

STRENGTH		WEAKNESS	
INTERNAL	- Biosecurity has a commodity pathway/protocol for breadfruit farmers/processors to follow - Quarantine Col is issued when chips are clean of bugs - Government key institutions and supporting actors, including the tissue culture center of SPC - CePaCT (Centre for Pacific Crops & Trees) in Suva - Biosecurity regulation exists to control and protect local food crops from harmful pests and diseases from incoming international flights and sea-going vessels - Strategic policies of the DoA and the Trade and Health Departments link up to a national strategic 10-year plan: "Te Kete" - 2020 -2030 - Tuvalu Food Safety Act (2008) - Party to the Pacific Island Countries Trade Agreement (PICTA) - Party to PACER Plus Trade Agreement - Tuvalu is a member of FAO and can access/buy Codex Alimentarius - DoA will be building its first laboratory to analyze nutrients in the soil and compost mixes from leaf samples		- Biosecurity does not know if breadfruit farmers follow commodity pathway protocol when harvesting - Lack of information on temporary breadfruit chip ban in New Zealand - No national food standard for commercially preserved products - Food Safety Act lacks appropriate regulations - No food laboratories to test for moisture content, colour, taste, crunchiness, smell, oiliness or packaging airtightness - Health food inspectors do not have formal certification - Lack of certification bodies to test and certify products according to agreed standards - Stakeholders do not take advantage of PICTA & PACER Plus trade agreements to improve QI - Lack of awareness in Tuvalu on QI benefits for Tuvalu's social and economic development
OPPORTUNITIES		THREATS	
EXTERNAL	- Tuvalu government to continue consultations with NZ biosecurity authorities via SPC in Suva to clear the ban on Tuvalu breadfruit chips - Departments of Agriculture and Trade to increase public awareness of QI and its impact on Tuvalu's social and economic development - Public and private sectors to invest in QI to offer services to add value via quality assurance of products/goods - The DoA plans to establish a laboratory under FAO/GEF project funding support within two years to enhance the quality of the breadfruit chip and other food products with export potential - The Departments of Agriculture and the Public Health give priority to the Food Safety Act of 2008 to develop appropriate regulations to improve Tuvalu's export opportunities including Tuvalu's breadfruit industry		- Other important priorities from key stakeholders may delay QI interests for breadfruit chips - Strengthening QI for interested public/private stakeholders faced with high investment costs - The creation of an enabling environment may be impeded by key players, as formulating recommended regulations is time-consuming (no new regulations since 2008) - Rough seas, poor storage capacities and working conditions during shipment of commodities from outer islands are a threat to product losses and quality - Temporary breadfruit chip ban by New Zealand authorities

To summarize the above SWOT analysis, the breadfruit industry in Tuvalu has ongoing support from current development projects from the FAO and IFAD that are willing to help the DoA establish its laboratory. In addition, Tuvalu's Food Safety Act is the main driver to ensure that quality processes are developed, especially in developing food standards and key regulations that have already been identified in the Act regarding imports and exports but are yet to be developed.

Key stakeholders in Tuvalu such as the Departments of Trade, Health, Fisheries, Customs, and Marine and Port Services are supporters of the breadfruit industry. Regional bodies such as the LRD of the SPC are also strong regional partners of Tuvalu for technical assistance around QI development. QI improvement will lead to better quality assurance for products and services that local customers require to improve their well-being.

Achieving significant investments in establishing a quality infrastructure will undoubtedly be a great challenge that may impede and discourage interested stakeholders from exploring the full potential of advanced QI.

7 Interaction Matrix and Impact Analysis

7.1 Interaction Matrix

The purpose of the interaction matrix below is to discuss the costs/risks and benefits/opportunities of more interaction between breadfruit value chain actors and quality infrastructure stakeholders. The matrix indicates what benefits/opportunities and costs/risks value chain actors and quality infrastructure stakeholders might consider when intensifying interaction and cooperation, for example, by offering and using QI services. Actors are assessed first from their own business viewpoint, then by considering what the considerations are when they perceive themselves as the other party.

Table 3: Interaction matrix

	Benefits / Opportunities	Costs / Risks
Business/VC actors	- VC actors have a dialogue with QI stakeholders to improve product quality - VC actors can articulate quality training needs - VC actors in breadfruit can enter service relations with QI institutions to address quality issues - VC actors get to know other VC actors and supporters in the value chain to cooperate and maintain a high-quality status - VC actors learn about the scope of quality requirements upstream and downstream on the value chain - VC actors learn better about the market potential of their products	- QI services for breadfruit VC actors are not equally accessible, esp. on the outer islands - QI services are more affordable for VC actors located closer to the QI service providers - Preferential QI service offers to some VC actors by QI stakeholders - Risk of exposing business secrets to business competitors - Products with short shelf life will affect the quality and cost of products

	Benefits / Opportunities	Costs / Risks
QI stakeholders	• Meet and get to know VC operators (future clients) • Learn more about supporting roles in the VC • Learn about VC actors and their respective roles • Meet with VC players to discuss important matters and identify gaps in their quality services in the breadfruit value chain • Draft regulations for food exports and other related issues provided in the Food Safety Act • Follow up/contribute to setting up local food standards for food processors to comply with • Develop a strategy to collect data on product exports • Meet other QI providers to identify gaps and improve their QI services for breadfruit VC • Lobby for policy and legislation adjustments to facilitate VC operators/businesses • Collect insight on investment needs to persuade the government to invest in QI to improve quality of products and services	• Financial and time constraints to participate in physical workshops and meetings, esp. from outer islands and Suva, the location of SPC • Non-government QI stakeholders may not participate • No decision-making during dialogues and workshops; public officers may be mandated not to make any firm decisions but give suggestions only • Kaupule of Funafuti (KOF) and other QI entities may have conflicting interests: for example, the government and KOF have separate housing schemes that do not follow a commonly recognized standard such as room size per occupancy and other housing quality issues for consumer satisfaction • Sharing information that may be confidential or sensitive to the government; this issue applies to all other public and private entities participating • Establishing and maintaining a QI in Tuvalu may be costly for one commodity or one product for exporting (e.g., lab for moisture content testing in breadfruit chips) • Drafting regulations to the Food Safety Act is a precondition for QI to further develop, but time-consuming • The temporary ban in New Zealand on Tuvalu's breadfruit chip is a challenge to formalizing the breadfruit export

The results in the above interaction matrix have been collected from personal interviews conducted with key stakeholders and from feedback collected from the online survey of individuals of interest in Tuvalu and in overseas. Information obtained from literature was also considered.

7.2 Impact Analysis

The results of the interaction matrix from the perspectives of the VC stakeholders and potential QI stakeholders suggest that the breadfruit chip export industry is important. Developing quality assurance for this industry's commercial development may be worth pursuing further despite the key challenges noted in the "costs and risks" columns for both types of stakeholders.

Several significant gaps must be closed before the quality infrastructure can function effectively. These QI gaps include creation of a testing laboratory appropriate to the breadfruit industry with all equipment required for quality assurance of breadfruit chips. Furthermore, safety regulations based on quality standards for food in Tuvalu have not yet been drafted. A cost-benefit analysis to assess the scope of the QI setup in Tuvalu also needs to be conducted. These aspects need attention and effort by the government with potential regional support.

The column of benefits and opportunities in the matrix for both QI and VC stakeholders strongly suggests that there is a great interest in pursuing quality assurance of breadfruit as a tree crop that has great export potential. Tuvalu has not exported any agricultural commodity since the decline of its Coconut Copra industry in 2002, which had been the mainstay of livelihoods for an estimated 90% of the population since the 1960s. A competitive, quality-assured breadfruit industry has the

potential to become the next sustainable income-generating opportunity for most of the people in Tuvalu and should be investigated further.

In conclusion, the impact analysis shows that both VC and QI stakeholders are willing to work in close collaboration with each other to establish a booming breadfruit chip export sector in the future.

7.3 Calidena Process in Tuvalu

First, the study has revealed that the selected commodity, breadfruit, is yet to be fully developed as a significant and formal agricultural export commodity. Second, the overwhelming feedback from the interview session with key stakeholders and the survey indicates support for further investigating the potential of breadfruit as an export commodity. Third, some stakeholders revealed that breadfruit is more critical for food security reasons than commercialization because of the lack of investment in the current breadfruit industry. However, the most crucial issue that has surfaced in the study is the lack of QI development and services supporting the breadfruit industry at the domestic and export level. It is therefore vital to continue to fully explore the potential of QI services relevant to the breadfruit industry. This investigation could take the form of a Calidena diagnosis workshop and its follow-up process in the near future. The potential host for the Calidena exercise is the Department of Trade to facilitate the logistics of the Calidena workshop and monitor the implementation of the action plan.

8 Conclusions

The breadfruit feasibility study covers a wide range of important issues based on information collected from local and external sources and experiences from various stakeholders. The study provides a reasonable understanding of the breadfruit value chain and the current QI of Tuvalu. More than 80% of those who participated in the online survey or the face-to-face interviews considered it worthwhile to explore the export potential of the breadfruit chip industry.

Tuvalu's QI should support breadfruit chip quality improvement to reach export standards and achieve the same for other products with export potential. The study addresses the lack of appropriate government and private sector QI to provide adequate metrology, standardization, testing, certification, and accreditation services. This includes the lack of accredited laboratories to conduct quality tests and certification according to international standards, a lack of trained and specialized staff to provide such quality services and a lack of supporting regulations and policies by the government to support, monitor and regulate the quality of food and other local products and services.

The study also revealed how the breadfruit industry could potentially contribute significant social and economic benefits to improving the living standards of Tuvalu's people, especially its rural population living on the outer islands; neighbouring countries such as Samoa and Fiji could contribute their experience in export-oriented breadfruit production systems. These examples have served this study to describe opportunities to consider for Tuvalu such as the linear orchard breadfruit production system and the management of tree height to increase production.

A market study on breadfruit in the Pacific by McGregor & Stice (2018)¹⁶ indicates that adequate consumption of breadfruit can reduce non-communicable diseases (NCDs) significantly, which is a significant health problem in the Pacific Islands including Tuvalu. Breadfruit would generate social and economic benefits, especially to rural communities, by saving costs when homegrown breadfruit is consumed compared to buying imported flour and rice. Improved health will reduce

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spending government public funds on referral to medical treatment overseas, which is contributing to increased budget expenditures every year.

The study has helped to distinguish between value chain processes and quality assurance services for the breadfruit industry. Here, it is important to fulfil and implement human resource development needs and appropriate planning for QI investments, policy and regulation development to provide an enabling environment for the breadfruit export industry in Tuvalu.

Another important development, the current ban on breadfruit chips in New Zealand, has been identified as another pressing issue. This issue needs to be addressed appropriately with all key partners: NZ Biosecurity, the SPC-LRD advisory team and the DoA of the government of Tuvalu and its biosecurity services .

9 Recommendations

- The study has shown that breadfruit could become a priority food product for export development of Tuvalu within one to two years. An important strategy to address this is to investigate how the existing production and management system for breadfruit can be improved. As a precondition, the potential of breadfruit to become an export opportunity for farmers in Tuvalu must be fully understood and its associated QI identified by key stakeholders in the public and private sectors in Tuvalu. Therefore, undertaking a complete Calidena process in the near future with PIFS support is strongly recommended.
- Investing in QI to support breadfruit and other export products should be considered. Existing facilities could be expanded to support laboratory services. For example, the DoA has confirmed a testing laboratory will be established as one of the outputs of the GEF/FAO-funded climate resilience and food security project¹⁷, which will be implemented during the next three years. Additional investment by the Tuvalu government to improve this laboratory can also be sought by the DoA through government grants for Special Development Expenditure (SDE)¹⁸ if feasible and realistic under their annual budget submissions.
- The DoA should consider expanding its new lab funded by the FAO under the Integrated Agro-ecosystem Approach for Enhancing Livelihoods and Climate Resilience (IAE4LCR) project with new, additional investments to accommodate laboratory needs in terms of equipment and manpower training to conduct safety tests and diagnoses on locally processed food products. In the medium term, the laboratory should be accredited to perform quality certification for domestic and international export food supplies.
- As a lesson from the value chain map discussion, the Farmers Association needs to be strengthened, upgraded and renamed the Tuvalu Farmers Organization. While already managed from Funafuti, it should also be established on the outer islands to involve critical actors in the breadfruit value chain's production, processing, and distribution stages to facilitate breadfruit export.
- The Food Safety Act has numerous regulations concerning food safety standards for imported goods and exports that must be developed in a timely fashion for the formal exportation of breadfruit.
- The temporary ban on breadfruit chips by New Zealand Biosecurity needs to be further investigated to attain clearance with the assistance of the Secretariat of the Pacific Community (SPC). It is important to note that the issue is not related to biosecurity but is presumably a food safety issue regarding the cooking oil involved in the cooking process. The government of Tuvalu, through the DoA, should continue an effective formal dialogue with the biosecurity

¹⁷ Integrated Agro-ecosystem Approach for enhancing Livelihoods and Climate Resilience in Tuvalu (IAE4LCR) Project 2022-2025 funded by GEF and coordinated by FAO for the government and people of Tuvalu.

¹⁸ Special Development Expenditure (SDE), Government of Tuvalu

authority of New Zealand and with the assistance of the SPC's Land Resource Division (LRD) in Suva, Fiji, to resolve the temporary ban on Tuvalu's breadfruit chip exports to New Zealand.

- The Director of the DoA and the Director of the Department of Health should begin consultations on collaborating with local stakeholders to work with the Attorney General's Office to develop the outstanding regulations of the Tuvalu Food Safety Act of 2008 that are essential and relevant for domestic food safety protection and exports.
- A National Food Standards Committee is to be established to provide guidelines on food standards, spearheaded by the Departments of Health and Agriculture with the technical assistance of the FAO or the WHO.
- The DoA should develop a national breadfruit farming system program (NBFSP) that is orchard-oriented and could be integrated with an agroforestry production approach within the next two years. After three or four years, the NBFSP will begin to become productive, depending on the variety planted. This initiative, if implemented, will support production necessary for breadfruit chips and other breadfruit products such as flour and frozen breadfruit for exporting within five to six years as an appropriate assumption from a technical agronomy viewpoint.
- As other actors supporting the processing stage in the value chain, the Food Inspector should define a standard practice that food processors can comply with when frying breadfruit chips or other processed food. This will clear the way for issuing compliance certification.

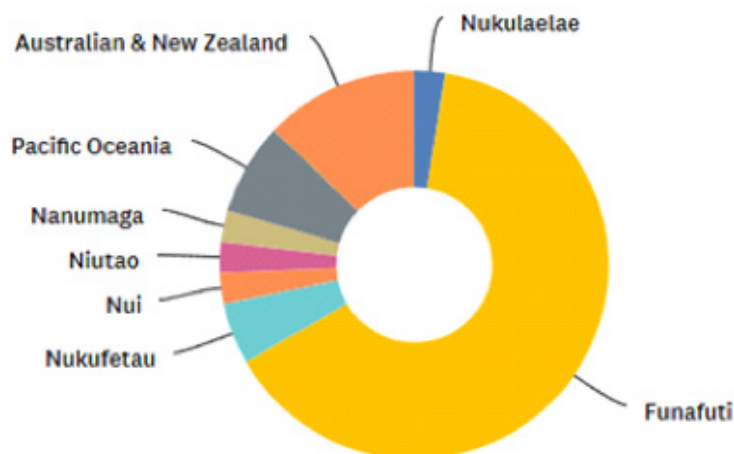


10 Annex 1: List of Individuals Interviewed

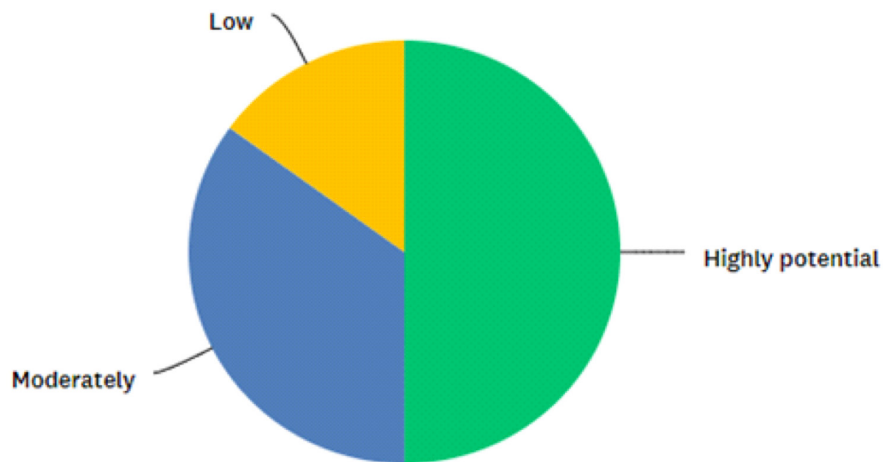
Name	Title	Institution
Mr Uatea vave	Director of Agriculture	Department of Agriculture
Ms Mati Afelee	Project Coordinator Tuvalu Sustainable Healthy Food Security Strategy (TSHFSS)	Ministry of Local Government & Agriculture
Ms Galivaka Piliota	Local Government Officer (Acting)	Ministry of Local Government & Agriculture
Mr Taasi Pitoi	Director of Marine and Port Services	Marine & Ports Authority
Mr Temumuni Talitiga	Director of Customs	Ministry of Finance
Ms Sania Amasone	Director of Tax	Ministry of Finance
Mr Falaoa Sione	Director of Trade	Ministry of Trade
Ms Petesa Finikaso	Director of Business	Ministry of Finance
Mr Laisini Papamau	Board of Directors	Tuvalu National Private Sector Organization
Ms Tilou Talia	Chief Executive Officer	Tuvalu National Private Sector
Mr Raymond	Finance Manager	Sulani Supermarket
Mr Tavita Falefaea	Supervisor	Mackenzie Trading Limited
Mr Tala Simeti	Economist	Fisheries Department
Mr Vine Sosene	Public Health Officer	Ministry of Health

11 Annex 2: Online Survey Results (April 2020)

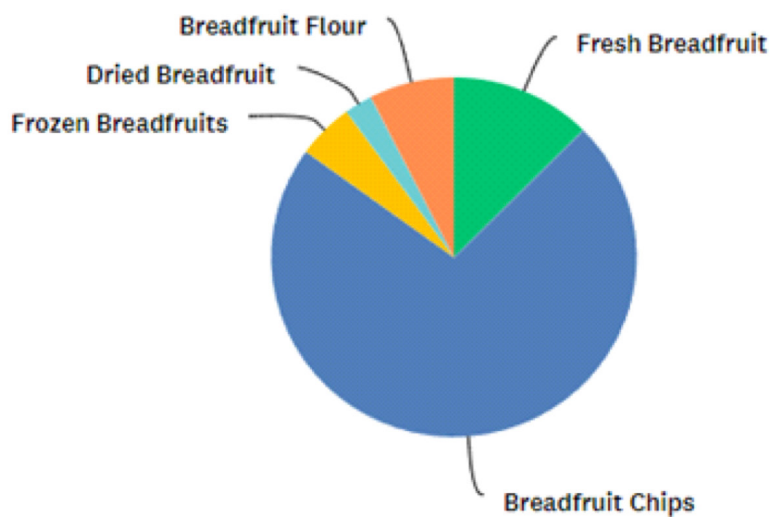
Please what island in Tuvalu are you responding from or what region in overseas?



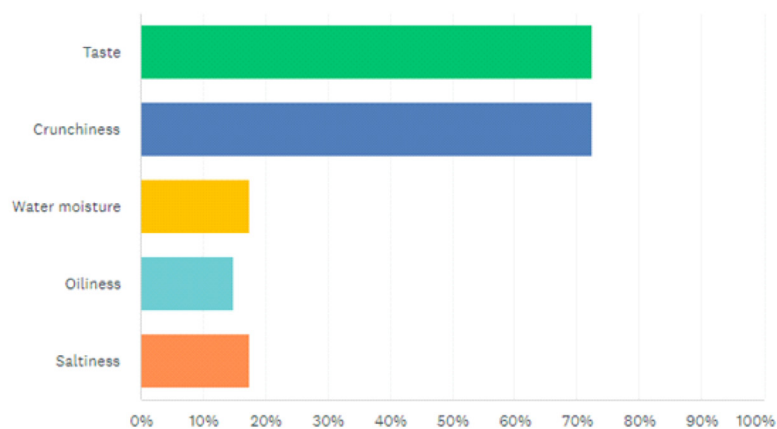
Were do you rank breadfruit to be a great potential commodity to export?



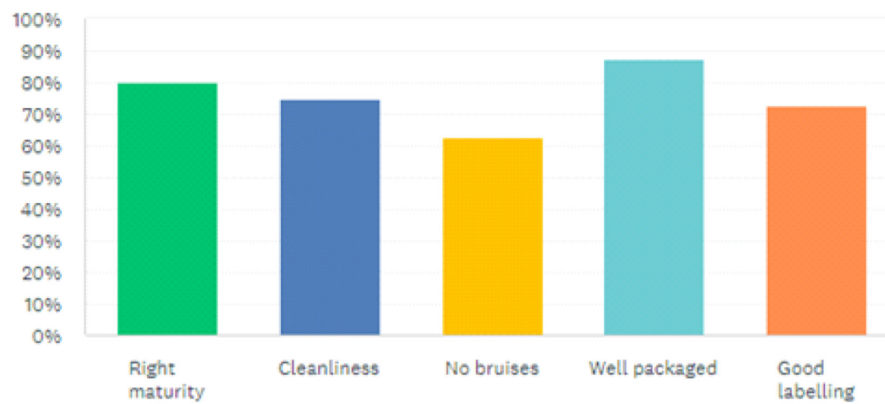
What is the most easy and popular product of breadfruit that you think will bring much revenue to Tuvalu from its export?



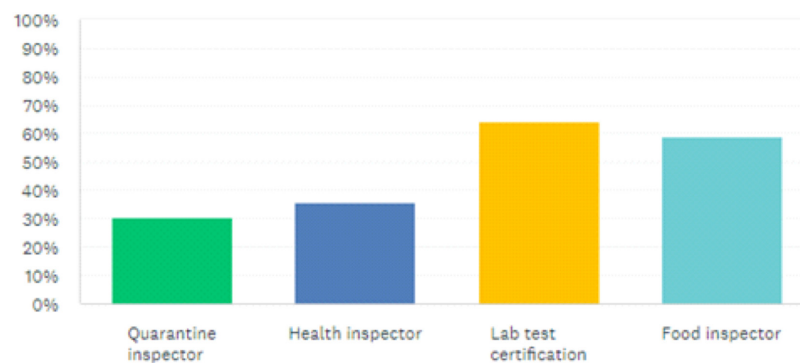
What quality do you want to be promoted if we are to export breadfruit chips?



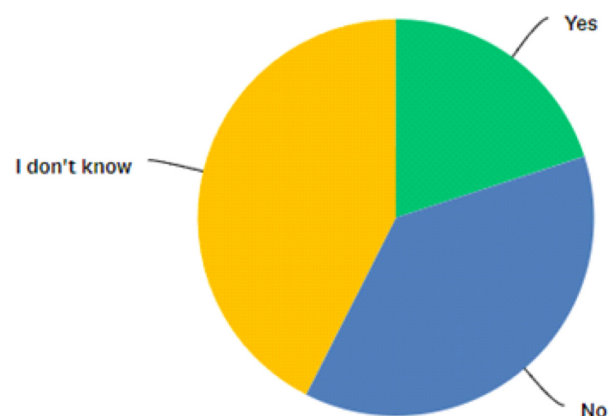
What qualities are you looking for in fresh breadfruit if to be exported? (Tick as many boxes)



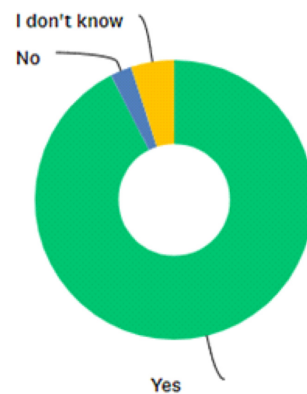
Regardless of the breadfruit product whether fresh/chips/flour and others, how do you know the qualities you are looking for are in the product? (Tick any two)



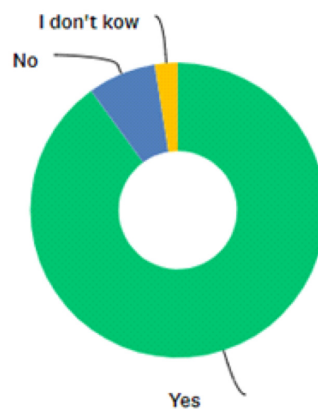
Is there any local standard to set the quality of Tuvalu chips or fresh or some other form of for export?



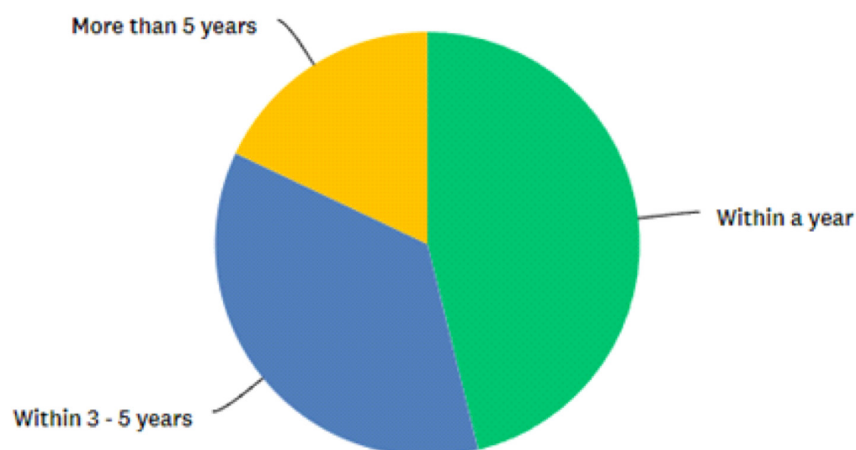
Do you think having a national standard set for quality breadfruit for export is important to have?



Having laboratories and equipment including the training of staff to handle some of the quality issues discussed. Is it worth for Tuvalu government or private sector to invest in these infrastructure to improve our breadfruit export?



For those of you who said yes, when do you think Tuvalu is ready to have such quality infrastructure like a good lab established to help export our breadfruit with quality? From today:



12 Annex 3: Pacific Islands Food Standards

Samoa, one of the leading countries in the Pacific food technology research, improves the quality of its food products for both domestic and export markets. In this regard, Samoa has set the following special standards for most of its local preserved food and breadfruit.

12.1 Chilling

Breadfruit extends its shelf life when refrigerated at 12 to 23 degrees Celsius. However, below 8 degrees Celsius, the breadfruit will suffer from chill damage and deteriorate quickly. To further extend the shelf life, the breadfruit could also be wrapped with plastic which could cause condensation and accelerate the rotting of the breadfruit. Chilling can therefore maintain fruit quality when there is a delay in delivering freshly harvested fruit to the customer. Post-harvest experiments in Samoa recently proved the effectiveness of storing the puou variety for a maximum of ten days and the ma'afala variety for 16 days at 17 degrees Celsius. A large refrigerator is adequate for chilling breadfruit.

12.2 Freezing

Freezing is another method of preserving breadfruit to stay fresh, even though it is expensive. Mature breadfruit should be first washed, peeled, cut into recommended sizes and packed according to the market specifications. When delivered to the processors, it must be in the best condition possible because delays affect its texture. Before freezing, it should be packed in size 50-micron polypropylene plastics and then frozen, where it can be preserved for 6 to 8 weeks. Frozen foods can dry out, lose some flavour, and become tainted. Domestic home freezers are suitable for small-scale production, but chest freezers are preferred because less warm air can enter them.

Freezing for formal markets and export should be below minus 18 degrees Celsius, which is a standard Samoa follows based on the Codex Alimentarius and the national food standards of Australia and New Zealand. The quality of frozen foods once thawed depends on the rate at which they are frozen. Cooling in the range of minus 0.5°C to minus 5.5°C as quickly as possible is essential since this causes minor damage to the food structure. Blast freezers are best for carrying out this process since they blow frigid air across the food at a very high speed. Based on experience collected in Samoa, current breadfruit supplies cannot meet this requirement. Therefore, processors use large-scale blast freezers for freezing all starchy staples and for breadfruit when collections are available. For successful marketing, the freezing or cold chain must be in place from the point of manufacture to the end of the sale. This means there must be refrigeration at minus 18°C at the processing point, during distribution (refrigerated trucks) and at the retail outlet. Instructions on labels must include 'Store at minus 18°C' and 'Do not refreeze after thawing.'

12.3 Drying

Drying breadfruit is best done when sliced into pieces and laid in homemade dryers or a low-temperature oven at 50°C or in a dehydrator. Several types of solar dryers exist, including active and passive dryers, tent, box or cabinet designs, and backup heating designs. The moisture content of fresh breadfruit must be around 20% (+/-2%) – the moisture content must be below 4% for stability. According to the Trees that Feed Foundation, using their hybrid solar dryer, 50 kg of fresh fruit will produce approximately 15 kilograms of dried fruit daily. Drying efficiency depends on the relative humidity of the air around the slices. The most suitable time for drying is when the air has a humidity of less than 40%; without fans, it is rarely possible to control air circulation around the breadfruit. If the humidity rises, the breadfruit will not dry sufficiently, and mould will become a problem. Breadfruit can be dried in any climate, but the cost is always higher in high-humidity environments. Low rainfalls in the northern group of islands of Tuvalu will undoubtedly support efficient drying.

The moisture (water) content of drying chips should be monitored and below 7-8% after the drying process. Without moisture meters, one should aim for brittle and crisp slices. For packaging, polypropylene 50 microns thick would be sufficient to prevent softening of the dried breadfruit product, provided the product is stored in a cool, dry place. Dried breadfruit slices have several uses such as in soups, casseroles and puddings. The final pulverizing stage is simple, and for breadfruit 'flour,' the dried slices are ground up either by hand or using a mill ranging in size from a domestic coffee grinder to a large flour mill. The significant advantage that breadfruit flour has over other starch-based commodities is its gelling properties. It disperses almost instantly in cold water and does not clump. It is a perfect gluten-free base for instant soups and sauces and a direct gluten-free corn flour replacer. Breadfruit flour, therefore, has enormous potential as a gluten-free thickener in products such as blancmange, gravy thickener and instant pudding. However, this level of value adding is still in the research stage.

12.4 Packaging and Branding Requirements

Good packaging would help a brand catch the attention of consumers. Intact packaging materials are also barriers to micro-organisms, but poor seals on the packaging are a potential source of contamination. Packaging that is folded, stapled or twist-wrapped is not truly sealed, and constant abrasion on plastic films can cause packaging to wear and become permeable to gases, bacteria and moisture. The choice of the packaging material (whether plastic or in a can) will depend on these factors while adding value and costs to the breadfruit chips. The packaging materials also rely on the breadfruit product (i.e., chips or semi-processed fresh breadfruit that needs vacuum packaging). Packaging must be presentable, informative, and attractive. The Codex Alimentarius of the FAO mandates the requirements of the label, but the label must also attract the consumer and be instantly recognizable to help develop 'brand loyalty'.

12.5 Aflatoxins

Aflatoxins are common in most Pacific Island root crops, although in a local context, little is known or documented about aflatoxins in breadfruit. However, a breadfruit study conducted in Nigeria in 2017 concluded that aflatoxins and microbial loads in breadfruit chips are minimal. Thus, some processing techniques can be used to reduce human exposure to aflatoxins such as cleaning to remove poor-quality breadfruit samples and thorough washing before processing; drying breadfruit chips to a safe moisture level and storing in an air-tight container are also valuable processes that can be adopted to prevent post-harvest losses.

According to Wikipedia, aflatoxins are various poisonous carcinogens and mutagens produced by certain moulds, particularly *Aspergillus*. The fungi grow in soil, decaying vegetation and various staple foodstuffs and commodities such as hay, sweetcorn, wheat, millet, sorghum, cassava, rice, chilli peppers, cottonseed, peanuts, tree nuts, sesame seeds, sunflower seeds, and various spices. In short, the relevant fungi grow on almost any crop or food. When such contaminated food is processed or consumed, aflatoxins enter the general food supply.

13 Annex 4: Abstract from the Tuvalu Food Safety Act 2006¹⁹

PART VI – MISCELLANEOUS

4.1 Regulations

(1) The Minister, acting by the advice of the Cabinet, may make any regulations necessary to give effect to this Act, including, but not limited to, —

- a. prescribing standards;
- b. regulating specified modes of preparation of food or specified classes of food such as organic food;
- c. prescribing labelling requirements;
- d. regulating the importation and exportation of food;
- e. regulating fish and fisheries products;
- f. regulations that give effect to obligations resulting from Tuvalu being a signatory to an international agreement; (g) regulating genetically modified food;
- g. exempting any article from any provision of the Act;
- h. regulating production, processing, preparation, packaging, storage, transportation, display and selling practices;
- i. providing for fees for inspection and analysis;
- j. regulations on licensing and conditions for licences to be awarded;
- k. providing for the tracing and recall of food where necessary; Section 42 Food Safety Act 2006 Page 20 Act ?? of 2006
- l. regulating breast milk substitutes;
- m. regulating advertising about food;
- n. regulating the inspection, sampling and analysis of food;
- o. regulating the sale of food after its “best before” date;
- p. providing for the establishment of a food safety committee to address food from production to consumption;
- q. regulating plant and animal feed and chemicals as they relate to food safety; and
- r. any other matter necessary or convenient for carrying out or giving effect to this Act

¹⁹ Note: regulations not developed yet