PACIFIC ISLAND **TARO MARKET** ACCESS SCOPING STUDY

The EU-Funded Facilitating
Agricultural Commodity Trade Project

SPC Land Resources Division

ACKNOWLEDGEMENTS

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The data presented, conclusions drawn and the recommendations made are the sole responsibility of the authors.

CONTENTS

ACRONYMS

ACIAR	Australian Center for International Agricultural Research
AQIS	Australian Quarantine and Inspection Service, DAFF
BA	Biosecurity Australia
BCR	Border Cargo Release (USDA -APHIS)
BSA	New Zealand Biosecurity Act (1993)
CARDI	Caribbean Agricultural Research and Development Institute
CEvA	*Colocasia esculenta* var. *antiquorum* (Sato-imo, Japanese taro)
DAFF	Department of Agriculture, Fisheries and Forestry, Australia
EU	European Union
FACT	Facilitating Agricultural Commodity Trade Project – Implemented by SPC funded by the EU
FAO	Food and Agriculture Organisation of the United Nations
FEA	Fiji Electricity Authority
FQIS	Fiji Quarantine Inspection Service
OECS	Organization of Eastern Caribbean States
MAF	Ministry Agriculture and Forestry (New Zealand)
NARD	National Agriculture Release Program (USDA -APHIS)
PHAMA	Pacific Horticultural and Agricultural Market Access Program - AusAID
HSNO	Hazardous Substances New Organisms Act (New Zealand)
PICs	Pacific Island Countries
PRA	Pest Risk Analysis
PPQ	Plant Protection and Quarantine
RIRDC	Rural Industries Research and Development Corporation, Australia
SPC	Secretariat of the Pacific Community
SPS	Sanitary and Phytosanitary Measures Agreement, WTO
TGA	Taro Growers Australia
TLB	Taro leaf blight (*Phytophthora colocasia*e)
USDA-APHIS	United States Department of Agriculture – Animal and Plant Health Inspection Service
USP	University of the South Pacific
WTO	World Trade Organization

Exchange rates per unit of foreign currency (mid-market rate Oct 25th 2010)

	USD	**AUD**	**NZD**	**JPY**
FJD	0.537	0.550	0.717	43.8
WST	0.427	0.437	0.570	34.8
TOP	0.519	0.532	0.694	42.4

Source: Universal Currency Convertor

01 INTRODUCTION

1.1 BACKGROUND AND METHODOLOGY

This scoping study hereafter referred to as the "the study" was initiated by the SPC/EU Facilitating Agricultural Commodity Trade (FACT) Project in response to the high rejection rate of taro exported to Australia during the first half of 2010. The study reviews the taro import protocols for the four major markets for Pacific taro (United States, Japan, Australia and New Zealand), together with their justifications, applications and impacts on taro imports.

The aim of the study is to understand the constraints and opportunities related to fresh taro exports from PICs. The study undertakes a comparative analysis of quarantine requirements of the major markets for fresh taro and includes an evaluation of the domestic taro industries of Australia, USA (including Hawaii) and Japan. The study also reviews the Caribbean taro export industry because the region is a major supplier of taro to the United States. Ultimately, the study provides a basis for facilitating regulatory reforms that result in uniform import requirements based on scientific merit.

A detailed analysis is undertaken of the present and potential export markets for Pacific island taro. Although New Zealand is the primary market, Australia and the United States are also important markets and Japan offers significant potential for sato-imo taro.

A review of the disease status for taro exporting and importing countries has been undertaken based on available literature. The emphasis is on diseases of quarantine concern and possible quarantine concern, in particular viruses and taro leaf blight. While considerable literature was found to be available on pest and disease status of taro in PICs and Hawaii, similar literature for Australia and the United States mainland was less comprehensive. This marked difference is likely a reflection of the importance of taro to the Pacific Islands and Hawaii and its minor importance in Australia and the USA mainland. Fiji, Tonga and Vanuatu were found to have a relatively favourable pest and disease status, with no records of taro leaf blight and the major viruses of concern. Taro leaf blight is a major disease in Samoa. Papua New Guinea and the Solomon Islands have the least favourable pest and disease status.

The study was coordinated by Andrew McGregor, Managing Director Koko Siga (Fiji) Ltd. The team comprised Pousima Afeaki (taro exporter, Tinopai Farm Tonga), Dr John (Jack) Armstrong (Hawaii and New Zealand based quarantine treatment and market access consultant), Amanda Hamilton (Trinidad and Tobago based agricultural economist, Dr Jim Hollyer (University of Hawaii taro expert), Roy Masamdu (Biosecurity & Trade Facilitation Officer, SPC), and Kevin Nalder (New Zealand based, market access consultant). The inputs of Rajneel Deo, Rob Duthie, Calvin Qiu, Rohit Lal, Dr Vincent Lebot, Arthur Mar, Dr Richard Markham, Kalara McGregor, Dr Lex Thomson, Tuifa'asisina Steve Rogers and Sanfred Smith are gratefully acknowledged. The data presented, conclusions drawn and the recommendations made are the sole responsibility of the authors.

1.2 WHAT IS TARO?

Edible aroids or 'taros' are members of the family Araceae, the most common being species of *Colocasia*, *Alocasia*, Amorphophallus, Cyrtosperma and *Xanthosoma*. In the
Pacific Islands the most important taro species are:

- Taro *(Colocasia esculentum)* – taro, talo or dalo in Fiji
- Cocoyam (*Xanthosoma sagittifolium*)- dalo ni tana in Fiji, talo futuna in Tonga, talo palangi in Samoa
- Giant swamp taro (*Cyrtosperma merkusii*)– via or viakana in Fiji, pula'a in Tonga, babai in Kiribati
- Giant taro (*Alocasia macrorrhizos*) – kape in Tonga and ta'amu in Samoa

Two botanical varieties of *Colocasia* taro have been recognized: *C. esculenta* var. *esculenta*, commonly known as dasheen, and *C. esculenta* var. *antiquorum* (CEvA), commonly known as eddoe. Dasheen varieties have large central corms, with suckers and/or stolons, whereas eddoes have a relatively small central corm and a large number of smaller cormels (Purseglove 1972). Pursglove (1968) suggested that the English names taro, dasheen, and cocoyam be used for *Colocasia esculenta* var. *esculenta* while eddoe be used for *Colocasia esculenta* var. *antiquorum*. However, many references tend to use cocoyam mainly for *Xanthosoma sagittifolium* (Manner and Taylor 2010, Lebot 2009).

Whatever the edible aroid tuber is called (taro, dasheen, cocoyam, eddoe), the various genera of taro provide a high carbohydrate vegetable to millions of consumers worldwide. The market demand is such that taro may be produced, consumed, and exported by the same country that also imports taro. An example of this phenomenon is Hawaii, where locally grown taro does not satisfy all the different types of consumers so an import market exists along with taro production.

The United Nation's Food and Agriculture Organization (FAO) databases are the primary sources of taro production, export and import data. According to the FAO, West Africa (Nigeria, Cameroon, Ghana and Ivory Coast) is by far the largest taro producing region. In the Pacific Island Countries (PICs), *Colocasia* taro is an important crop but relatively small compared with global production. The FAO data combines all genera of taro into one category called taro (cocoyam), which requires in-country knowledge to untangle the local names and identify exactly how taro is moving and used by a range of consumers in an economy.

1.3 A SUMMARY OF MAJOR FINDINGS

Taro is one of the few fresh commodities for which PICs have been able to achieve significant levels of exports, with 10,000-12,000 tonnes exported annually (fob value approximately USD 6 million). Fiji currently accounts for 95% of these exports with little or no growth in export volume in recent years.

There is potential for considerable export expansion if quarantine protocol regimes were reformed and there were parallel and substantial improvements in the taro production, export certification and marketing pathways.

Quarantine import protocols and their application are a major factor determining the ability of PICs to maintain and expand taro exports. However, considerable export expansion would occur if: (1) quarantine protocols were reviewed to eliminate regulations that were not science-based and (2) taro production and marketing pathway were substantially improved.

Pacific Island taro exports have the potential to more than double if the product can be made more competitive in terms of price and quality. However, the Australian market for fresh taro may no longer be economically viable for Pacific Island exporters if the current quarantine requirement for devitalisation (to prevent propagation) remains in place.

Increased taro exports would result in significant benefits for large numbers of low-income rural people. The Fijian, Samoan, Tongan and Vanuatu taro industries offer the greatest potential, in terms of exports.
The major findings of the study are with respect to the Australian taro market access are:

- The current import protocol requiring devitalisation made the export of fresh taro to Australia a high risk business and caused Fiji taro to become non-competitive on the Australian market and greatly limited market expansion.
- No scientific basis was found to justify the current taro devitalisation regulation.
- The United States (including Hawaii) and Japan have significantly larger domestic taro industries than Australia and do not require devitalisation for taro imports. The WTO/International Sanitary and Phytosanitary (SPS) Agreement principles of consistency and equivalence in phytosanitary measures and their application are seen as relevant in this respect.
- Fiji, Tonga and Vanuatu have a well-documented favourable taro disease status based on the absence of virus and fungal diseases of quarantine concern. Australia, compared with the PICs, has a significantly less well documented disease status for taro.
- There is a case for these three countries to be considered a pest free/low prevalence area under International SPS standards.
- There is evidence that devitalisation is a major underlying factor in the high incidence of corm rot recently experienced with Fiji taro exported to Australia.
- The questionable efficacy of the current devitalisation procedures in terms of preventing propagation and the spread of disease.

The major findings of the study with respect to the New Zealand taro market access are:

- The high rate of fumigation required for imported taro due to the interception of nematodes is not justified because the majority of nematodes found on Pacific island taro pose no threat to New Zealand agriculture.
- Consequently, these commonly-intercepted nematodes associated with Fiji taro need to be identified and, if found to be of low or no risk, then reclassified as non-regulated pests, thereby eliminating the need for a quarantine fumigation.
- In essence, the quarantine status of PIC nematodes would return to their original pre-2005 status whereby they were accepted as non-pathogenic/saprophytic species of no quarantine concern and thus requiring no action.

Quarantine import protocol reform is a necessary requirement for expanding Pacific Island taro exports. However, major expansion in exports also requires substantial improvement in production, post harvest handling practices and export certification systems. This not only applies to the exported product but also to the containers in which they are shipped (i.e. to manage "hitch-hiker" pests of concern using best practice container hygiene measures).

The taro quarantine import protocol reforms recommended by this study are:

- Repeal of the devitalisation protocol requirements for Pacific Island taro exports to Australia (with the exception of those countries in which taro viruses of quarantine concern have been recorded).
- Repeal of the ban on the importation of small corm taro from the Pacific Islands.
- Reclassify commonly intercepted nematodes associated with Pacific Island taro as non-regulated pests that do not require quarantine fumigation.

Taro research priorities to improve market access are divided into two broad categories: Those relating to:

- Reforming taro quarantine import protocols; and,
- Improving taro production and marketing pathways.

AusAID's Pacific Horticultural and Agricultural Market Access Program (PHAMA), scheduled to commence implementation in January 2011, is expected to provide a substantial pool of resources to fund applied research activities that facilitate market access for priority commodities. Taro should be one such priority commodity.

Applied research directed at the reform of Australia's taro import protocol could include:

- The extent to which fungi and viruses are transmitted via corms.
- The effect of viruses on taro yields.
- The efficacy of the current devitalisation procedures.
- A comprehensive taro pest and disease survey in Australia.
- Quantification of the relationship between devitalization and taro rots.

A series of inter-related applied research activities specific to New Zealand are required to provide a scientific basis for changing import protocols, including:

- Undertake a risk assessment on each species to determine the regulatory status of nematodes associated with Fiji taro.
- A review of the current practices for managing "hitchhiker" pests routinely intercepted.

Research priorities identified for improving the taro marketing pathways include:

- Alternative packaging and transportation from the field to the pack houses.
- Identifying suitable disinfectants to reduce corm rots in storage and during transportation.
- Alternative packaging materials for export consignments.

A project funded by the Australian Centre for International Agricultural Research (ACIAR) (currently in the final design stages and tentatively scheduled to start at the beginning of 2011) is expected to undertake some of these research activities, especially those relating to taro quality improvement.

02 TARO AS AN INTERNATIONALLY TRADED COMMODITY

The EU-Funded Facilitating
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2.1 GLOBAL PRODUCTION

2008 is the latest year that FAO has published global data on the production. Table 1 lists the top 20 producers globally, in terms of volume. These data also show that Papua New Guinea, Fiji and Solomon Islands have the highest production in the Pacific Islands.

TABLE 1 TOP 20 PRODUCERS OF TARO, RANKED BY PRODUCTION

Rank	Country	Production value (USD 1,000)	Production (tonnes)
1	Nigeria	554,968	5,387,000
2	Ghana	173,931	1,688,330
3	China	160,558	1,638,592
4	Cameroon	98,899	1,200,000
5	Papua New Guinea	29,360	285,000
6	Madagascar	17,307	240,000
7	Japan	15,513	179,700
8	Egypt	13,698	151,971
9	Rwanda	11,394	110,607
10	Philippines	10,400	115,956
11	Central African Republic	10,302	100,000
12	Thailand	8,087	78,500
13	Côte d'Ivoire	7,717	93,639
14	Fiji	7,624	74,009
15	Democratic Republic of the Congo	6,825	66,250
16	Burundi	5,988	58,125
17	Gabon	5,279	56,000
18	Solomon Islands	4,532	44,000
19	Liberia	3,090	30,000
20	Guinea	2,892	31,200

Source: http://faostat.fao.org/

2.2 GLOBAL TRADE IN FRESH TARO

Only 100,000 tonnes (or < 1%) of the 11 million tonnes of taro grown and consumed worldwide globally enters international trade (FAO 2008a, b) of which Japan and the United States are by far the largest importers. However, Manner and Taylor (2010) noted that caution should be exercised when interpreting these data because they are incomplete and may include other aroids in addition to *Colocasia* taro.

It is difficult to find information on the taro imports and exports for PICs that is both current and complete. Although Fiji, Tonga, Solomon Islands, Kiribati and Samoa together produced 125,000 tonnes of taro in 2007 (FAOSTAT, 2009), Fiji is the only significant exporter of taro. Australia and New Zealand are the two major destinations for Pacific Island taro exports. The USA and Japan also import Pacific Island taro.

China is the number one exporter of taro (Table 2). It is not surprising to see Fiji, Tonga and Samoa on the top of the list as they export to Pacific Islanders around the globe. However, it is interesting that the United States is ranked third. It is possible that this data might contain transshipments because Hawaii does not export taro and Florida, the other large producer of taro in the U.S., ships most of their taro to Latino consumers in the northern states. This number might contain some data from the USA-affiliated Pacific and Caribbean Islands.

TABLE 2: THE TOP TARO EXPORTERS (2007)

Rank	Area	Quantity (tonnes)	Value (USD 1,000)	Unit value (USD/tonne)
1	China	70,235	39,937	569
2	Fiji	12,661	15,885	1,255
3	United States of America	6,307	6,850	1,086
4	Dominica	500	694	1,388
5	Tonga	852	405	$475
6	Samoa	199	224	1,126

TABLE 3: GLOBAL TARO IMPORTS

Country	Volume (tonnes)	Value (USD,000)
American Samoa	253	447
Australia	3,000	7,000
China	921	574
Japan	46,276	43,370
New Zealand	6,500	11,000
United States	39,215	36,295
Total	**96,165**	**98,686**

Derived from Manner and Taylor (2010), FAO 2008, Daniels 2005, PITIC 2008

2.2.1 TARO IMPORTERS

FAO 2007 data for imports is the most recent data available. Japan tops the list of countries importing taro followed by the United States. New Zealand and Australia, the main markets for Pacific Island taro, do not feature in the FAO taro trade data. FAO data in Table 4 is supplemented with New Zealand and Australian trade data.

TABLE 4 TOP IMPORTERS OF TARO

Rank	Country	Quantity (tonnes)	Value (USD/000)	Unit value (USD/tonne)
1	Japan	44,222	45,771	1,035
2	United States	48,907	38,216	781
3	New Zealand	6,500	11,000	1,700
4	Australia	3,000	7,000	2,300
5	Trinidad and Tobago	1,505	964	641
6	China	1,408	962	683
7	American Samoa	236R	270 R	1,144
8	China, Macao SAR	225 R	155 R	689
9	Antigua and Barbuda	65 R	102 R	1,569

Source: http://faostat.fao.org/; New Zealand - PITIC 2008; Australia – RIDC 2009. R = Estimated data using trading partners database

The FAO data shows that the USA is the largest importer. Imports to the U.S. would contain taro from places such as Fiji and Tonga in the Pacific and from the Caribbean (Dominica, Dominican Republic and Saint Vincent) and Latin American nations (for example, Costa Rica, Nicaragua and Ecuador). They would be both *Xanthosoma* and *Colocasia* types as U.S. consumers would typically be from Africa, Asia, South America, the Caribbean, and the Pacific – a large and varied set of consumers.

Imports to the U.S. includes taro from Fiji and Tonga in the Pacific, from the Caribbean (Dominica, Dominican Republic and Saint Vincent) and Latin American (e.g., Costa Rica, Nicaragua and Ecuador). USA taro imports include both *Xanthosoma* and *Colocasia* types because the large and culturally diverse consumer groups represent immigrants from Africa, Asia, South America, the Caribbean, and the Pacific. Noteworthy in the USA is a unique cultural crossover started by the Los Angeles company, Montalvan's Sales, that was established in the early 1990's. Montalvan's Sales found that Pacific Islanders in the Los Angeles area would eat taro that is imported from South America (where it is cheaper and more abundant).

Japan, the other large-volume taro importer, typically consists of consumers who predominately eat the small corm *Colocasia* taro (Sato-imo, Ishikawa Wase) and *Xanthosoma* taro to a much lesser extent. *Colocasia* taro imports from the Pacific Islands account for most of the taro imports into New Zealand and Australia.

03 THE CONTRIBUTION OF TARO EXPORTS TO PACIFIC ISLAND ECONOMIES AND LIVELIHOODS

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3.1 AN OVERVIEW

Taro is ranked in the top five food crops for most PICs, and with many consumers it is the first or second most important staple on a daily basis. The following two tables using FAO data illustrate area, yield and production in the Oceania region.

TABLE 5: TARO AREA HARVESTED FOR OCEANIA (HA)

Country	2005	2006	2007	2008	2009
Australia*				200 to 300*	
Fiji	3,200 F	3,200 F	6,385	10,236	6,957
Kiribati	430 F	440 F	450 F	450 F	M
New Caledonia	130 F	105 F	110 F	110 F	M
Niue	430 F	430 F	440 F	440 F	M
Papua New Guinea	40,000 F	40,000 F	44,000 F	44,000 F	M
Samoa	3,500 F	3,550 F	4,000 F	3,700 F	4,000 F
Solomon Islands	2,200 F	2,000 F	2,200 F	2,200 F	M
Tonga	400 F	420 F	450 F	450 F	M
Wallis and Futuna Islands	120 F	120 F	130 F	130 F	M

Source: http://faostat.fao.org/
F = FAO estimate, M = Data not available * Author estimate

TABLE 6: TARO PRODUCTION FOR OCEANIA (TONNES)

Country	2005	2006	2007	2008	2009
American Samoa	9,000 F	9,000 F	9,000 F	9,000 F	M
Australia*				1000 - 1,500*	
Fiji	83,751	76,156	61,662	74,009	69,863
Kiribati	2,000 F	2,150 F	2,200 F	2,200 F	M
New Caledonia	443	366	388	388 F	M
Niue	3,200 F	3,200 F	3,300 F	3,300 F	M
Papua New Guinea	260,000 F	260,000 F	285,000 F	285,000 F	M
Samoa	17,000 F	17,500 F	20,175	18,634	20,248
Solomon Islands	44,000 F	40,000 F	44,000 F	44,000 F	M
Tonga	3,700 F	3,750 F	3,800 F	3,800 F	M
Wallis and Futuna Islands	1,600 F	1,600 F	1,700 F	1,700 F	M

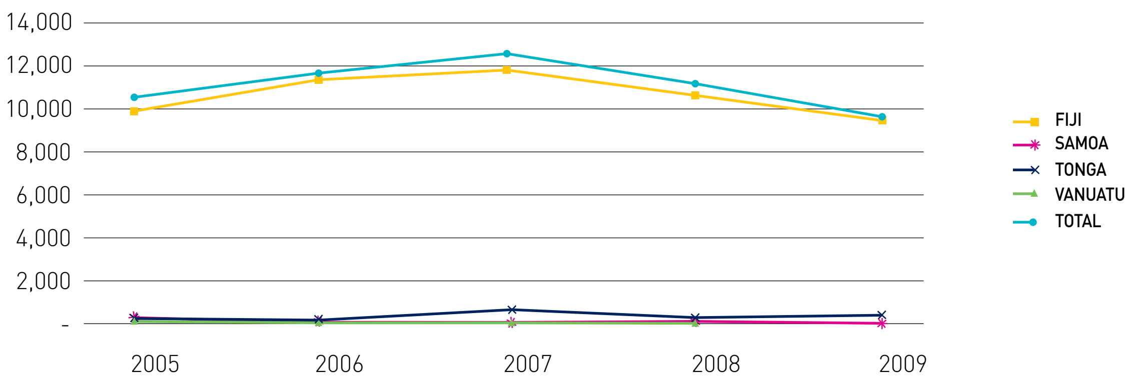
Source: http://faostat.fao.org/
Notes: F = FAO estimate, M = Data not available; * authors estimate

3.2 PACIFIC ISLAND TARO EXPORT INDUSTRIES

Between 2005 and 2009, Pacific Island countries exported between 10,000-12,000 tonnes of taro annually with little or no export market growth (Table 7). The fact that Fiji was responsible for over 95% of all taro exports during this period (Table 8) demonstrates that other PICs are greatly underrepresented in taro export markets. Moreover, the lack of growth in taro exports is economically problematic and underscores the importance of this study. If root crops are by far the most important fresh produce export for Pacific Island countries (Table 9) with a value of USD 11 million (Table 2), what is impeding export growth? This section reviews taro exports for each PIC to better understand the delimiting factors and provide a basis for identifying potential improvements that will increase exports.

TABLE 7 PACIFIC ISLAND TARO EXPORTS 2005 – 2009 (TONNES)*

	2005	2006	2007	2008	2009
Fiji	9,959	11,434	11,894	10,794	9,482
Samoa	253	86	75	97	85
Tonga	220	208	626	249	323
Vanuatu	101	69	69	65	
Total	**10,533**	**11,797**	**12,664**	**11,205**	**9,890**



* SPC Pacific Island Trade database

TABLE 8: A SUMMARY OF NON-COMMODITY AGRICULTURAL EXPORTS FROM THE PICS (2005)*

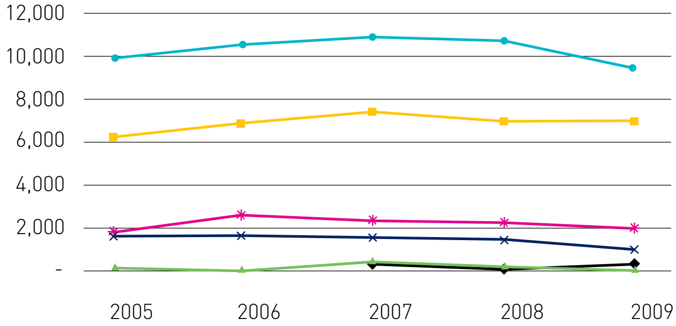
Country	Product	Market	Approx value
Fiji	Root crops	Aus/NZ/USA	12,500
	Root ginger	NZ/USA/Euro	845
	Papaya	Aus/NZ/Jap.	1,230
	Mangoes	NZ	50
	Eggplant	NZ	1,525
	Breadfruit	NZ	55
	Chillies	NZ	75
	Okra	Aus/NZ	33
	Spices	Aus/NZ/USA	530
	Noni Juice	Aus/USA/Euro	213
	Cut flower bulbs	NZ	3
Sub-total			**17,059**
Tonga	Squash	Japan	9,000
	Vanilla	USA/Aus/Jap/NZ/Euro	3,500
	Coconuts	Aus/NZ	310
	Root crops	Aus/NZ	280
Sub-total			**13,090**
PNG	Copra meal	Aus/NZ	3,500
	Spices (vanilla)	Aus/NZ/USA/Jap/Euro	10,000
Sub-total			**13,500**
French Polynesia	Noni Juice	USA/Aus/Jap/NZ/Euro	12,500
Samoa	Bananas	NZ	2
	Breadfruit	NZ	20
	Coconuts	NZ/Aus	290
	Coconut cream	NZ	910
	Papaya	NZ	5
	Noni Juice	NZ/Aus/USA	3,230
	Taro	NZ	10
Sub-total			**4,467**
Vanuatu	Beef	Japan/Aus	1,300
	Root crops	Aus	310
	Coconut meal	Aus/NZ	1,100
	Citrus	NZ	33
	Vanilla	USA/Aus/Japan	130
	Essential oils	Aus	450
Sub-total			**3,323**
New Caledonia	Citrus	NZ	70
	Squash	Japan	1,500
	Preserved meat product	Aus	180
Sub-total			**1,750**
Cook Islands	Taro	NZ	10
	papaya	NZ	35
	Cut flower & bulbs	NZ	5
	Noni juice	NZ/Aus/USA	420
Sub-total			**470**
Solomon Islands	Cold press coconut oil	USA/Aus	93
	Copra meal	Aus	28
	Noni juice	Aus/Korea	35
Sub-total			**156**
Niue	Honey		4
	Taro		32
Sub-total			**36**
Kiribati	Copra meal		65
Grand Total			**66,416**

* Source: McGregor (2007)

3.2.1 FIJI

Taro is Fiji's largest agricultural export after sugar (Table 8). Fiji's annual taro export volume over the last few years has hovered around 10,000 tonnes, with about 65% going to New Zealand and the balance to Australia and the USA (Table 10). The annual value of Fiji's taro exports during the same period was FJD 19 – 20 million, with the New Zealand market making up 55% of the total annual value (Table 11).

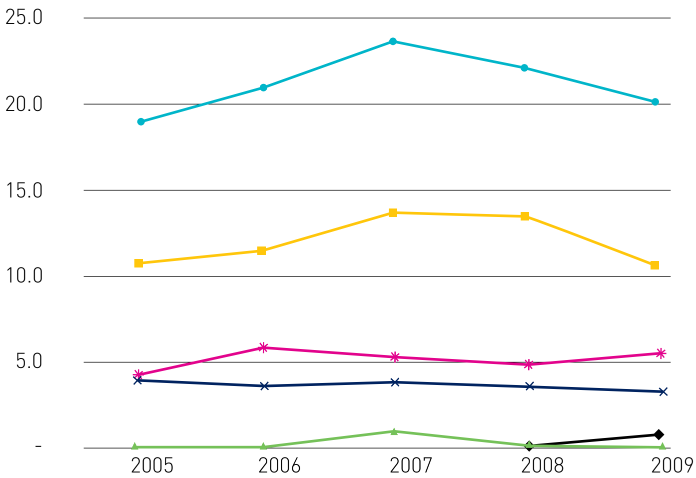
TABLE 9: FIJI TARO EXPORTS 2005-2009 (TONNES)*



* SPC Pacific Island Trade database

	2005	2006	2007	2008	2009
NZ	6,302	6,974	7,469	6,842	6,169
Aus	1,878	2,703	2,390	2,264	1,969
USA	1,720	1,722	1,677	1,531	1,080
USA (Hawaii)			162	51	210
Other	59	35	196	106	54
Total	**9,959**	**11,434**	**11,894**	**10,794**	**9,482**

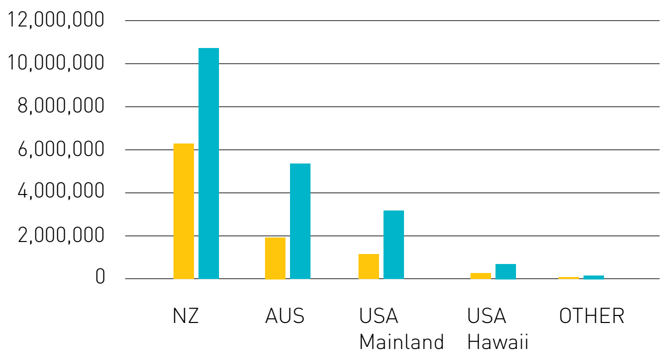
TABLE 10: FIJI TARO EXPORTS 2005-2009 (VALUE FJD MILLION FOB)*



*Source: SPC Pacific Islands Trade Database

	2005	2006	2007	2008	2009
NZ	10.8	11.5	13.7	13.4	10.7
Aus	4.2	5.8	5.3	4.9	5.5
USA	3.9	3.5	3.8	3.5	3.1
USA (Hawaii)				0.1	0.7
Other	0.1	0.1	0.8	0.2	0.1
Total	**19.0**	**20.9**	**23.6**	**22.1**	**20.1**

TABLE 11: DISTRIBUTION OF FIJI TARO EXPORT TRADE, 2009*



* SPC Trade Data Base

	Kgs	FJD / fob	FJD/fob
NZ	6,168,740	10,706,219	1.74
Aus	1,969,194	5,468,703	2.78
USA	1,080,199	3,147,560	2.91
USA (Hawaii)	210,000	655,365	3.12
Other	54,151	110,822	2.05

Nearly 70% of Fiji taro exports originate from the island of Taveuni (table 12). The taro from Taveuni is pink taro of the Tausala ni Samoa variety. Tausala ni Samoa (synonomous with Taro Niue) is the same favoured traditional Samoa cultivar that was decimated by taro leaf blight in 1993.[1] Although Taveuni grew rapidly as a centre for commercial taro production after the demise of Samoa's taro export industry, Taveuni's taro exports stagnated during recent years because of declining productivity, increasing production costs and market access problems with exports to Australia and New Zealand. The balance of Fiji's taro exports (including both pink and white taro varieties) comes from high rainfall areas on Viti Levu that are located within close proximity to the port at Suva, which helps maintain quality. Tausala taro for export is also grown around Savusavu on the main island of Vanua Levu and on the island of Koro.

Table 12: Monthly taro exports from Taveuni 2003-2009 (tonnes)*

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dev	Total
2003	318	395	275	204	234	225	325	465	500	253	244	197	3,635
2004	209	314	385	390	393	450	530	534	520	478	498	480	5,181
2005	389	410	405	469	479	410	403	398	380	380	480	490	5,093
2006	285	479	596	787	765	625	615	681	708	743	904	920	8,108
2007	497	509	560	602	789	654	637	790	770	550	870	940	8,168
2008	650	580	575	550	550	560	640	750	786	769	789	790	7,989
2009	567	599	570	556	537	550	579	755	760	780	785	790	7,828

*Data supplied by the Agricultural Officer Taveuni Rohit Lal.

On Taveuni, there are an estimated 3,700 farmers, including farmers on the island of Qamea. The majority of these farmers (some 2,000) fall into the semi-subsistence category (5,000-15,000 plants). There are about 750 taro farmers that would be classified as fully commercial (→15,000 plants) (pers. comm., Taveuni agricultural officer). It is estimated that around 17,000 people on Taveuni depend directly or indirectly on taro for income (Taveuni Agriculture Department Statistics).

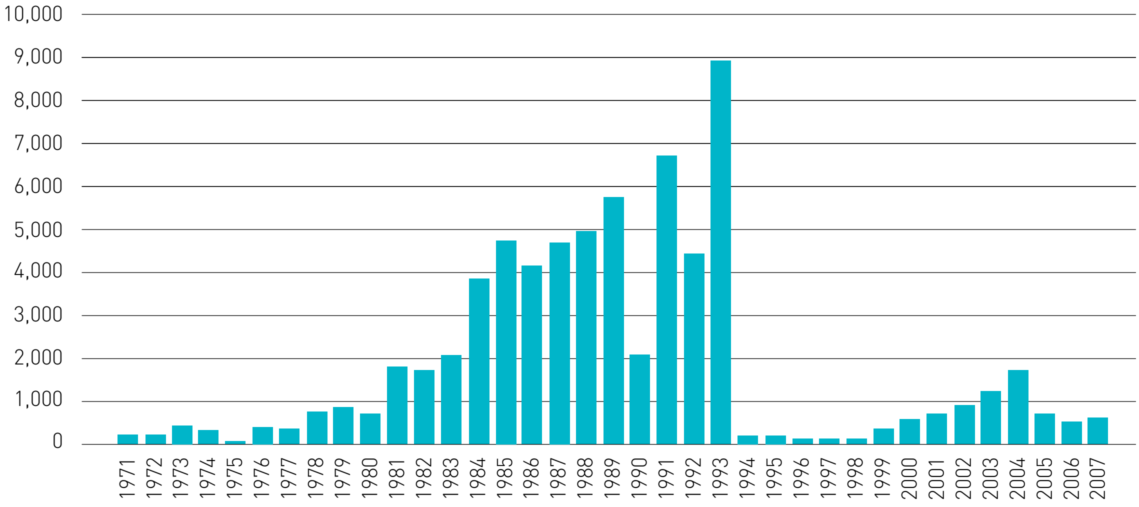
3.2.2 SAMOA

Although Fiji initiated taro shipments to New Zealand in the early 1950s, it was Samoa that fully developed this market. Severe flooding in Fiji in 1963 provided the impetus for Samoa to start exporting taro to New Zealand (Vinning and Young 2003). Ironically, yet another disaster, in this case the biological disaster of the taro leaf blight (TLB), resulted in Fiji again replacing Samoa as the dominant supplier of taro to New Zealand. Taro was Samoa's largest export commodity and primary source of farm income until TLB devastated the Samoan taro industry in late 1993. Pouono et al. (1994) estimated that 95% of Samoa's taro plantations were severely affected. Paulson and Rogers (1997) report that supplies of taro on the local market in June 1994 were only 1% of the supplies that were available in June the previous year. Since 2003, Samoa's taro exports have remained at a low level (Table 13). From 2002-09, annual exports averaged 153 tonnes, of which 82% has been exported to American Samoa. This level of exports is a far cry from the 7,800 tonnes shipped in 1989.

[1] The 'Talo Niue' collected from Samoa and 'Tausala ni Samoa" from Fiji were DNA fingerprinted by University of Queensland under then TaroGEN project and found out to be different by only one band of DNA (pers, comm. , Valerie S. Tuia).

Figure 1 shows the value of Samoa's taro exports to New Zealand reached WST 9.5 million in 1993 (approximately 6,300 tonnes or 60% of Samoa's total exports for that year). The largest volume of taro exports (about 7,800 tonnes) occurred in 1989 (Central Bank of Samoa 1999). It is notable that this volume significantly exceeds Fiji's current taro exports, which underscores the potential for expanding Pacific Island taro exports to New Zealand.

FIGURE 1. VALUE OF SAMOAN TARO EXPORTS – 1971 TO 2007 (1,000 TALA)*



* Central Bank of Samoa. Samoa's National Export Strategy 200, p, 9

The overwhelmingly dominant taro variety grown in 1993 was Taro Niue, a variety highly susceptible to TLB. As a result, Samoa's taro production was decimated. Pouono et.al. (1994) estimated that 95% of Samoa's taro plantations were severely affected. Paulson and Rogers (1997) report that supplies of taro in the local market in June 1994 were only 1% of the supplies that were available in June the previous year. Since 1993, Samoa's taro exports have remained at a low level (Table 13). From 2002-09, annual exports averaged 153 tonnes, of which 82% has been to American Samoa. This level of exports is a far cry from the 7,800 tonnes that were exported in 1989.

TABLE 13: SAMOA'S TARO EXPORTS 2002-2009 (TONNES)*

Country	2002	2003	2004	2005	2006	2007	2008	2009
American Samoa	133	140	152	253	72	75	95	78
New Zealand	87	63	6	0	5	0	1	0
Tokelau	11	14	0	0	10	0	0	5
Australia	4	0	0	0	0	0	0	0
Total	**235**	**217**	**158**	**253**	**87**	**75**	**96**	**83**

* SPC Trade Database

Early efforts to contain TLB with fungicides proved ineffective and, despite heavy subsidisation of the cost of fungicides, [2] most farmers who grew taro traditionally could afford neither the extra costs of fungicides nor the labour involved in leaf removal and spraying. Programs to improve cultural practices fared little better. When it became clear that the favoured traditional taro Niue could no longer be economically grown in the presence of TLB, attention turned to selecting and breeding blight resistant, or at least tolerant, varieties.[3] The challenge was not only to develop resistant varieties but also to

[2] WST$600,000 was allocated for this purpose (Chan, 1994).

[3] A blight resistant variety from Palau, Ngeruuch, featured prominently in the USP's taro breeding program. It was highly recommended as a potential parent for the Samoan taro breeding programs for its higher level of resistance against taro leaf blight with good yield and eating quality (Losefa 2010). Breeding for resistance to leaf blight has taken place in the Solomon Islands and Papua New Guinea for a number of years. However, considerable care had to be taken in sourcing genetic material from these sources.

meet the demanding taste requirements of Samoan communities at home and abroad, and to provide for a shelf life that would allow export by sea. The Taro Improvement Programme located at the University of the South Pacific, Alafua Campus, played a leading role in this long process based on a conventional plant breeding approach.

New varieties, such as Talo Voli and Talo Meamata, were released. Although the new varieties were accepted locally, they could not compete with the Fijian Tausala ni Samoa taro that was preferred by Samoans living abroad until blight-resistant taro varieties that met the taste requirements of New Zealand's Samoan communities were released in 2010 (17 years after the arrival of TLB). According to an article in the Samoan Observer dated 28 June 2010:

> ‘ A shipment of taro has left Samoa to test the New Zealand market. It contains five different varieties of taro, products of new research, said Asuao Kirifi Pouono, Chief Executive Officer of Ministry of Agriculture and Fisheries. The initiative is driven by the private sector with the ministry contributing its usual technical support, Mr Asuao said. The varieties on route to New Zealand are known only by the technical names, he said. Like Samoa I, Samoa II and so on. Continual research into new varieties started after taro leaf blight destroyed exports in 1993. Old favourites like Taro Niue vanished from the country. However their genes and those of imported varieties were used to produce taro resistant to the blight. Many different varieties have resulted. Farmers who cultivated them gave feedback as to taste and other properties. Talo Voli was a favourite for several years. After that Talo Meamata emerged as a favourite. Even that seems to have been overtaken by other varieties. ’

Samoa is now on the verge of reestablishing itself as a major taro exporter with 15 recommended TLB-resistant varieties, of which 5 are for the export market. The favoured varieties for export are Talo Mumu and Polovoli Samasama (pers. comm. Tuifa'asisina Steve Rogers).[4] A recent trial shipment to New Zealand was reported to have been well received in the market. For Samoa, the major constraint to expanding taro exports to New Zealand is the shortage of planting material for desired varieties (pers. comm, Tolo Iosefa).

Both Solomon Islands and Papua New Guinea are home to taro viruses that are of major quarantine concern in the region. Alomae, a lethal disease of taro, is present in both countries and is believed to arise from a mixed infection with taro large bacilliform virus (TLBV) and taro small bacilliform virus (TSBV). Both viruses can be transmitted by planting material and there is uncertainty about the seed transmission of both viruses.

[4] Tuifa'asisina Steve Rogers described recommended export varieties on display as "All corms on display looked excellent and would probably weigh in excess of 1.5kg each making a 1x1m planting yield around 15 tonnes/ha".

TABLE 14: NUMBER OF HOLDINGS GROWING CROPS BY TYPE OF CROP* (2005 AGRICULTURE SURVEY)

Crops	Region				
	Total	Apia Urban Area	North West Upolu	Rest of Upolu	Savaii
Coconut	15,581	1,338	4,556	4,721	4,965
Cocoa SAmoa	10,419	821	3,306	2,450	3,841
Cocoa Solomon	909	9	256	277	366
Taro	15,574	1,407	4,399	4,784	4,985
Taro Palagi	3,351	303	1,288	899	861
Taamu	13,738	1,041	4,248	3,646	4,803
Yam	10,935	813	3,222	3,182	3,718
Cassava	1,446	159	400	209	678
Kava	885	39	121	225	500
Banana	17,209	2,074	5,428	4,708	4,999
Nonu	650	38	190	301	120
Peanut	134	9	92	22	10
Pawpaw	8,224	767	2,644	2,223	2,591
Tomatoe	3,066	295	1,139	544	1,088
Head Cabbage	166	57	51	32	26
Chinese Cabbage	920	89	340	299	191
Egg Plant	3,271	344	1,082	945	900
Long Beans	2,238	172	844	448	774
Short Beans	909	54	358	204	293
Cucumber	3,290	143	1,145	906	1,096
Breadfruit	15,184	1,867	4,686	4,047	4,584

* Source 2005 Agricultural Survey

Taro is now well and truly reestablished as a major food security and domestic market crop in Samoa. Table 14 shows that 15, 574 holdings grew taro, second only to bananas (17,209 holdings) and coconuts (15,581 holdings). Of these holdings, 5,140 grew taro for at least some sale. This far exceeds any other crop – banana ranked second with 2,993 holders growing for sale and partly for home consumption. Moreover, the re-establishment of significant export sales for taro will have a major impact on the Samoan economy.

3.2.3 TONGA

Tonga is able to grow a wide range of root crops because of its fertile soil and favourable climate. The Agricultural Census 2001 reported 4,300 ha of root crops were harvested in the country during the year. Based on this data, a conservative estimate of the total production of root crops is > 40,000 tons per annum (Ha'unga and Taufatofua, 2010). The total annual export of root crops is about 2,800 tonnes (or 7.5% of the total production), which is dominated primarily by cassava (fresh and frozen) and followed by yams (Ha'unga and Taufatofua, 2010). Tonga exported an average of 2,729 tonnes of root crops each year over the period 2004-08 (table 15), and root crop exports have overtaken squash exports to become Tonga's largest-volume export commodity.

TABLE 15: EXPORTS OF ROOT CROPS FROM TONGA, 2001-2008*

Country	2001	2004	2005	2006	2007	2008
Talotonga (Swamp taro-*colocasia esculenta*)	1,159	284	112	182	73	572
Tarua Taro-Talofutuna (*xanthosoma*)	851	288	244	208	626	725
Kape (giant taro-*Alocasia*)	577	139	89	127	150	532
Cassava (*Manihot esculenta*)	423	1,568	672	346	680	959
Ufi (yam-*Dioscorea*)	993	1,467	1,011	573	1,272	754
Total	**4,003**	**3,746**	**2,128**	**1,436**	**2,801**	**3,542**

Source: Ha'unga and Taufatofua, 2010

Tonga exports three distinct varieities of taro: Talotonga/swamp taro (*Colocasia*); Tarua taro/tarofutuna (*Xanthosoma*); and Kapa/giant taro(*Alocasia*). Tonga's drier conditions favour *Xanthosoma* compared with *colocasia* taro. In 2008, there were 725 tonnes of Tarua taro exported compared with 572 tonnes of Talotonga (table 14). New Zealand and the United States are the main markets for Tongan taro exports. However, a significant development since 2004 has been the export of Japanese taro or sato-imo taro (eddoe) (CEvA) to Japan.[5] In 2006, a sample of CEvA shipped to Sydney was well received and resulted in a subsequent order for an additional two tonnes. However, the importation of CEvA to Australia was prohibited in December 2006 by Biosecurity Australia on the grounds that CEvA had a higher capacity to propagate (Annex 1 of the Scoping Study, WTO Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures).

3.2.4 VANUATU

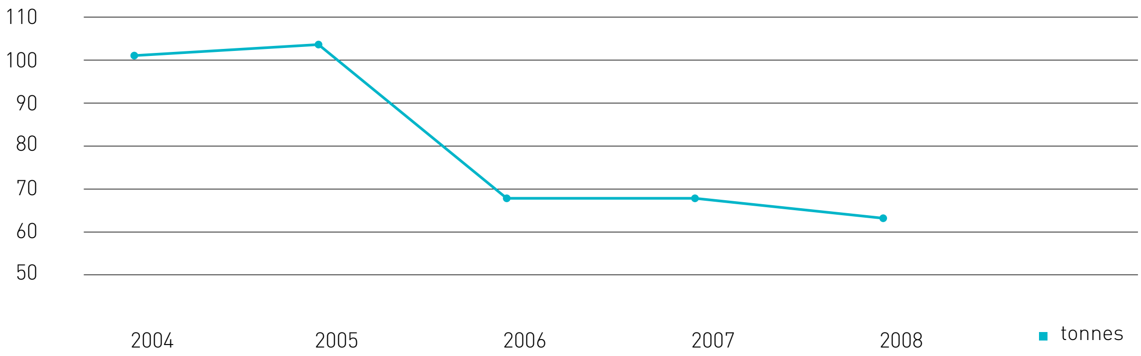
The food cropping systems of Vanuatu are traditionally based on either predominately yam (genus *Dioscorea*) or Island (aeland) taro (*Colocasia*) (Vanuatu Land Use Planning Project 1999). Taro dominates the gardens of the wet northern and eastern islands, particularly in upland areas. There is far less of a yam/taro dichotomy today because the important food crops have shifted to banana (probably the most important food staple), Fiji taro (*xanthosoma*) and cassava. There are no estimates of total taro production for Vanuatu, unlike those available for the other Melanesian countries. However, based on the FAO estimates for PNG and the Solomon Islands and an understanding of Vanuatu farming systems, annual taro production is likely to be of the order of 20,00 to 30,000 tonnes. Significant volumes of taro are now traded in Port Vila and Luganville municipal markets. An intensive survey of the Port Vila municipal market a decade ago found that 6 tonnes of Fiji taro (*Xanthosoma*) and 2 tonnes of aeland taro (*Colocasia*) were sold over a one week period (Greindl 1998). Considerable growth in domestic sales since that time could be expected given the population growth that has occurred in Vanuatu over the past decade.

Following the cessation of Samoa's taro exports to New Zealand in 2003, Vanuatu Government officials actively promoted the export of taro. However, Vanuatu has not been competitive in the export of taro to New Zealand when compared with Fiji because of high grower prices, poor transportation linkages combined with high transportation costs, and the absence of taro varieties similar to taro Niue. Onwueme (1999) notes that only one tonne of taro was exported to New Zealand in 1993. More recently, there have been efforts to sea freight Fiji taro (*Xanthosoma*) from Espirito Santo to Australia for direct transhipment to New Zealand. Vanuatu's taro exports peaked in 2005 at 101 tonnes shipped to markets in Australia, New Caledonia and Kiribati (Figure 2), including both *Colocasia* and *Xanthosoma* taro.

[5] Pousima Afeaki of Tinopai Farm reports the following exports of sato-imo taro to Japan: 2004 – 50,000 kg; 2005 – 8,830kg; 2006 – 5,976kg; 2007 – 2,970kg; 2008 – 2,710kg; 2009 – 3,880kg; 2010 – 5,005kg (pers. comm.)

- Fiji has both more frequent (6 vessels per month) and direct shipping to New Zealand, compared with 1 vessel every 4 to 6 weeks from Vanuatu that often transships through Australia.
- Sea freight rates to New Zealand from Fiji are significantly lower than for Vanuatu.
- Internal freight costs in Fiji are significantly lower than for Vanuatu. Fiji has a major advantage of being served by roll on/roll off (RoRo) ferries that enable fully laden trucks to bring taro from Taveuni to the export point. Without RoRo service in Vanuatu, it costs significantly more to ship taro from the outer-islands to Port Vila than it does to ship from Port Vila to New Zealand.
- In contrast to Fiji's main production areas for export taro that are free of taro beetle, most of Vanuatu's production areas are infested with taro beetle; any corm damaged by taro beetle, regardless of eating quality, cannot be exported in fresh form.
- Fiji export taro is the pink taro (Tausala ni Samoa), the traditional variety preferred by Samoans. Although Vanuatu offers a rich variety of high quality taro, the very narrow and specific taste requirements of the Samoan community tend to preclude them from the Samoan diet similar to Samoa's difficulty in developing a replacement for Taro Niue that was acceptable for Samoans living abroad.

FIGURE 2: VANUATU TARO EXPORTS 2004 TO 2008



Source: SPC Trade Statistics.

3.2.5 SOLOMON ISLANDS

Colocasia taro is far less important in the Solomon Islands today than it was in the past. Onwueme (1999) indicates that taro played a prominent part in the diet and cultural affairs (including traditional medicine) of Solomon Islanders for centuries. However, the importance of taro has declined in recent times due to a combination of factors, including taro beetle, taro leaf blight, the alomae/bobone virus complex, the greater ease of producing sweet potato, and the availability of low cost, imported rice as a taro substitute. Additionally, the demands of an increasing population have resulted in shorter fallow periods and lower yields because taro requires longer fallow period that result in optimum soil fertility. Alomae-bobone is a serious virus complex that can kill taro plants. Extensive surveys in the PICs have found this virus is present only in Papua New Guinea and the Solomon Islands (ACIAR 2008). Therefore, it is not surprising that there are almost no taro exports from the Solomon Islands.[6] What is surprising is that taro remains a priority crop in current market access seminars and discussions (pers. comm., Dale Hamilton) when the reality is that taro exports from the Solomon Islands are unlikely to be economically viable. Although transportation issues remain problematic, it may be possible to develop markets for frozen or processed taro to circumvent present quarantine barriers.

[6] Small quantities of fresh taro were exported from Solomon Islands to Australia (Sydney) by Solmoa in 2006 (1.2 tonnes) and 2007 (2.8 tonnes) (pers comm., Lex Thomson).

3.2.6 PAPUA NEW GUINEA

Although taro is believed to have originated in the Indo-Malaya region, PNG has the world's largest genetic diversity of taro, (Onwueme 1999). Taro (taro tru- *Colocasia esculenta*) is grown throughout PNG, but usually as a supplementary crop. Bourke and Harwood (2009) note that taro was once the most important food staple in much of the lowlands, and the most important food in the highlands before sweet potato was adopted . Sweet potato, the predominant food staple in PNG today, provides around two-thirds of the food energy from locally-grown food crops and is an important food for 65% of rural villagers (Bourke and Harwood 2009).

In comparison, the 1996 PNG Household Survey revealed that around 22% of the population consumed taro tru (*Colocasia*) and Chinese taro (in PNG *Xanthosoma* taro) (Bourke and Harwood 2009). Bourke and Vlassak (2004) estimated that, in 2000, PNG produced only 229,088 and 226,536 tonnes of *Colocasia* and *Xanthosoma* taro, respectively, compared with 2,871,851 tonnes of sweet potatoes.

Taro production has declined in PNG in recent times for essentially the same reasons production has declined in the Solomon Islands: taro beetle, taro leaf blight (for *Colocasia* taro), the existence of the alomae/bobone virus complex, the greater ease of producing sweet potato, and the availability of low-cost imported rice as a taro substitute. However, taro remains an important commodity in local produce markets. Although the volume of taro sold is not known, the total amount of fresh food sold in Port Moresby in 2005 was estimated at 15,000 tonnes (Bourke and Harwood 2009). There have been reports about supposed remunerative root crop export markets for PNG, particularly for taro in New Zealand (Post-Courier 2003, 2010). According to the recent article:

> ‘Pacific Islanders living in New Zealand who regularly visit the giant Auckland food market could soon be buying Papua New Guinea taro from the Markham Valley in the Morobe Province. This could happen if the trials being undertaken by New Zealand aid funded organisation Bris Kanda Incorporated and the women of the valley prove successful and sustainable on a commercial basis. Auckland market is where Pacific island countries like Samoa, Tonga, Fiji, Vanuatu and others export tonnes of garden produce from taro to yams, bananas, coconuts, sweet potatoes or kaukau and vegetables of all kinds to the huge demand of the thousands of Pacific islanders who live in that city and other parts of New Zealand. Similar markets are found in Sydney, Brisbane and other cities of Australia where growing numbers of Pacific Islanders live. Former agriculture minister Moses Maladina once tried to assist Milne Bay women export taro to New Zealand but his efforts were not successful. Mr Maladina was formerly PNG high commissioner to New Zealand and knows about the Auckland market. He is now back in government as minister assisting the prime minister. Taro is now following the footsteps of cocoa as the next economic agriculture project for people who once relied on betelnut as their main source of income.’

The reality is that taro from PNG Solomon Islands and Vanuatu could not compete with Fijian taro in the New Zealand market as shown by McGregor et al. 2004. Specifically:

> “Taro growing countries like PNG and Vanuatu, cannot compete with Fiji in supplying the New Zealand market. The wholesale price for taro in Auckland during 2003 ranged from $NZ1.80 to $NZ2.50kg (K3.75 to K5.20/kg) (South Pacific Trade Commission). With an importer's margin of around 10%, the landed price for taro in New Zealand ranges from the equivalent of K3.40 to K4.70 per kg. The cost of a reefer cooler container (12 tonnes) is Auckland is USD 1,720 (approx K5,930). With a sea freight cost is approximately K0.50/kg., these prices are decidedly unattractive when compared with taro prices on offer in PNG urban markets.”

No significant changes to improve PNG's competiveness in exporting taro to New Zealand have occurred since 2004, and the distinct prospect of Samoa re-entering the New Zealand market further diminishes any chance of PNG becoming competitive in the near future. Australia may offer better export markets for PNG taro because of the increasing expatriate PNG population in Australia, particularly in Queensland. However, the confirmed presence of the alomae/bobone virus complex in PNG will result in quarantine restrictions that remain a major constraint to market access.

04 THE EXPORT MARKETS FOR PACIFIC ISLAND TARO

4.1 NEW ZEALAND

4.1.1 DEMAND FOR TARO IN NEW ZEALAND

New Zealand has imported taro from the Cook Islands, Fiji, Niue, Tonga, Samoa, Australia, Korea, Philippines, Thailand, and Vietnam with Fiji being the main supplier. Current imports are around 6,000 tonnes with an annual landed value of around NZ 9 million. The main taro consumers are Pacific Islanders, with the Samoan community being the dominant consumer group. According to the 2006 population census, New Zealand's Samoan population was 131,000, up from 115,000 in 2001 (a 14% increase) (Table 16). This represented 47% of New Zealand's Pacific Island population and around 7% of New Zealand's total population. Cook Island Maori, Niueans, Fijians and, to a lesser extent, Tongans also have a strong preference for taro. In 2006, these expatriate communities had a total population of 141,000.

TABLE 16: NEW ZEALAND PACIFIC ISLANDER POPULATION*

Country	2001	2006	increase	% increase
Samoan	115,020	131,103	16,083	14%
Cook Island Maori	62,589	58,011	5,422	10%
Tongan	40,715	50,478	9,763	24%
Niuean	20,148	22,473	2,325	12%
Fijian	7,041	9,861	2,820	40%
Tokelaun	6,204	6,819	615	10%
Tuvaluan	1,965	2,625	660	34%
Total	**243,682**	**281,370**	**37,688**	**15%**

Statistics New Zealand and Ministry of Pacific Island Affairs (2010). Demographics of New Zealand's Pacific population

The overwhelmingly strong preference amongst Samoans is for pink *Colocasia* varieties. Prior to 1993, this consumer preference was met by Taro Niue grown in Samoa. Following the devastation of TLB in Samoa, ausala ni Samoa taro from Fiji met the demanding taste preference of Samoan consumers. The expectation is that new TLB resistant varieties developed in Samoa will become increasingly acceptable to Samoan consumers in New Zealand. Taro consumer preference among expatriate Samoans is overwhelmingly for pink *Colocasia* varieties.

4.1.2 THE NEW ZEALAND DOMESTIC INDUSTRY

Small quantities of Japanese taro are grown in the Pukekohe area in the North Island. There has also been some green house production of taro for leaves. However, given the temperate climatic conditions, New Zealand does not have a commercial taro industry and is unlikely to develop one in the foreseeable future.

4.2 AUSTRALIA

Australia both imports taro and has a domestic industry; a very similar situation to that found in Hawaii. However, unlike Hawaii and New Zealand, Australia's taro import quarantine regulations are far more restrictive.

4.2.1 DEMAND FOR TARO IN AUSTRALIA

TARO IMPORTS

Despite Australia's much larger population compared with New Zealand, taro importation is about half that of New Zealand. Australia imports about 3,000 tonnes of taro annually from more than 17 countries (PITIC 2008). Fiji (2,000 tonnes) is the largest supplier of taro, followed by Tonga, China, Taiwan, and Vietnam. Small quantities of *Xanthosoma* taro are imported occasionally from Vanuatu. Taro imports into Australia are largely *Colocasia* types and can be divided into two broad categories:

- 'Taro Pacific' (larger *colocasia* varieties from the Pacific) ;and primarily Tausala ni Samoa and Maleka Dina from Fiji that is imported either fresh or frozen.
- 'Taro Supreme' (Japanese taro, *Colocasia esculenta* var. *antiquorum*). The smaller corms of this *Colocasia* variety are imported peeled and frozen from China. Since 2006, *Colocasia esculenta* var. *antiquorum* has not been permitted entry into Australia as fresh corms.

The three main reasons for the volume of Pacific Island taro imports into Australia being about half that of New Zealand's taro imports are:

- The Pacific Islander population, especially the Samoan population[7], is much smaller in Australia.
- Australia has a growing domestic taro industry.
- Australia has very restrictive quarantine protocols on imported taro that cause both a substantial price increase and a marked decrease in taro quality.

The main retail outlets for taro in Australia are small Asian and Pacific Island specialty shops. Although a very small volume of taro is sold through the major supermarket chains of Coles and Woolworths, Woolworths has expressed interest in importing taro directly from the PICs.[8] Unfortunately, Woolworths first trial shipment from Fiji coincided with the period of high rejections in the first half of 2010.

[7] The 2006 Australian Population Census reports 39,992 Samoans living in Australia, compared with 131,103 living in New Zealand (www.censusdata.abs.gov.au). The 2006 Population Census showed the following numbers born in the Pacific Islands (Australian Government Department of Immigration and Citizenship):

- 15,240 Samoans
- 48,150 Fijians, of which 10,400 were indigenous Fijian
- 7,580 Tongans

[8] pers. comm. Cameron Carter Accredited fresh produce purchaser for Woolworths through the "Fresh Produce Group" ccarter@woolworths.com.au

4.2.2 THE DOMESTIC TARO INDUSTRY

INDUSTRY STRUCTURE

A significant taro industry has emerged in Australia over the past decade, predominantly on the wet tropical coast of north Queensland. Smaller production areas are found near Darwin, the Atherton Tableland, central and southern Queensland, and northern New South Wales. Rural Industries Research and Development Corporation (RIRDC) (2009) notes that industry statistics are very limited but estimates Australian production at between 1,000-1,500 tonnes with a wholesale value of about AUD 6 million. RIRDC (2009) estimates that there are about 150 growers nationally.

The main taro variety grown in Australia is 'Bun Long' (also known as Chinese taro in Australia). Bun Long is a purple-white fleshed *Colocasia* type that is consumed primarily by the Australia's Asian community and generally used as an ingredient in dim sum and in soup rather than as a tuber. Although 'Bun Long' is well suited for processing into chips, it is not a preferred variety of Pacific Islanders for fresh consumption. Thus, locally grown 'Bun Long' is not regarded as a substitute for taro imported from the PICs. This situation also occurs in Hawaii.

Smaller quantities of large corm 'Pacific Taro' (*Colocasia esculenta*) and small corm 'Taro Supreme'/Japanese taro (*Colocasia esculenta* var. *antiquorum*) are also produced. 'Pacific Taro' is a close substitute for taro imported from the PICs and is sold mainly as fresh produce directly to small specialty shops catering for Pacific Island consumers living in Australia (Daniells et al 2004). 'Pacific Taro' is grown by small commercial farm operations and in home gardens. Small quantities of *Xanthosoma* taro (cocoyam, American taro) are also grown in Australia.

According to RIRDC (2009) the Australian market for 'Pacific Taro' is too small to sustain a large number of commercial growers and recommends that emphasis should be on developing 'Taro Supreme' for export to Japan. 'Taro Supreme' production remains limited to a few commercial growers in Queensland and northern NSW that supply this taro only to domestic markets. Leading Australia taro grower, Peter Salleras, described the Australian industry in his presentation to the 3rd Taro Symposium in Nadi in 2003:

> "Our consumers have access to imported taro plus an estimated 1500 tonnes of local product. Most Australian production ......comes from between Tully and Babinda in the far north of Queensland. This area is recognized as the "super wet belt" of Queensland's wet tropical region ...... rainfall averaging 4000mm annually. Nevertheless, all commercial taro is irrigated. Growers have access to an efficient transportation system. Refrigerated banana trucks deliver freshly picked taro to southern city markets 3,000 to 4,000 kilometers away within 2 days. Although improved cultural practices will see larger individual growers emerge, the majority of growers currently work plots of 0.5 to 2 hectares. Our industry has seen a high turn over in growers finding it just too hard. Our major production limitation is labour cost. Even at $15/hour it is difficult to find people willing to endure hard hot work, made worse by the itchiness of taro sap. However, the high labour cost of large corm taro will diminish in the near future. Australian growers have an innovative mindset, so rapid technological advances are inevitable (p 144)."

The RIRDC New Plant Products Review Workshop (2003) nominated taro as a crop with "considerable potential and deserving of increased research and development investment" and a RIRDC-funded project, "Taro industry development: the first step", was developed in response to this need. The project's main components include (i) industry survey, (ii) compilation of taro information resource, (iii) taro information workshops on pests, diseases, weeds, crop nutrition and quarantine threats, (iv) field monitoring sites, and (v) taro industry research and development with emphasis on mechanization.

Mechanization was identified as crucial in making the industry more competitive against products from countries with lower labour costs. A specific RIRDC project 'Taro production mechanization and industry development' was implemented to develop mechanical harvesting and processing equipment that improve production efficiency.

The RIRDC (2009) study concluded at the completion of the project in 2006 that "most growers have relatively small areas of taro and are not capitalized enough to make big mechanization steps".

INDUSTRY REPRESENTATION

Despite its small size, the Australian taro industry has an active and vocal industry organisation. Taro Growers Australia (TGA) was formed in 2001 in northern Queensland. TGA has about 50 members, publishes the quarterly newsletter, "Taro Topics," and has a website (www.tarogrowers.vze.com). A particular focus of the newsletter and website has been on quarantine issues, and TGA has vigorously lobbied the AQIS and local parliamentary representatives to impose tighter restrictions on taro imports, particularly those from China.[9]

[9] Some extracts from the Taro Topics articles dealing with quarantine include:

- The importation of fresh taro into Australia predates the IRA process. Thus, there has been no formal process of review of quarantine risks with stakeholder input.
- According to BA, where importation already occurs any review of standards is referred to as a 'pest risk assessment'. The process does not appear to involve stakeholders. At the beginning of this process TGA did not know that import standards were apparently being reviewed.
- Neither AQIS nor BA has been able to provide TGA with a background document justifying the import standard requirements which appear on the AQIS website.
- BA has indicated that they will respond to "substantial scientific evidence" concerning their internal review of taro imports.
- Fresh taro was imported to Australia from China for almost three years despite taro leaf blight (*Phytophthora colocasia*e) being widespread in that country. Small quantities of corms were also imported from Samoa following the taro leaf blight epiphytotic.
- Some TGA representatives visited the southern markets in May 2003 and saw taro corms from Fiji that still had soil on them in contravention of the AQIS importation standards.
- On the same visit many imported corms had not been properly 'topped' and still possessed the apical growing point as well as prominent side 'eyes' on the corm, both of which would allow easy propagation. This is also in breach of import standards. There appears to be a lack of capacity to adequately police the standards.
- Serious quarantinable virus diseases of taro are present in Fiji, China, and elsewhere, which can be readily spread if any plants are propagated from imported corms. The import standard does not adequately address the risks associated with such propagation because it is almost impossible to remove all the eyes from corms from which plants can be propagated.
- The onus appears to be on the Australian industry to detect quarantine infringements.
- AQIS and BA were not prepared to immediately suspend imports while the taro industry waited for the outcome of the internal review process.
- There have been very strict AQIS controls in recent years on the entry of taro for propagation purposes with virus indexed tissue culture plants required for entry to Australia. The taro industry has been trying to import new varieties from overseas to diversify their markets but this has been difficult due to the prevalence of virus diseases overseas.
- The major taro pest, taro beetle (*Papuana* spp.) present in Fiji can be spread via fresh taro corms. However, this is not mentioned in the import standards. Alternative hosts notably include Musa spp (banana), Solanum tuberosum (potato), Saccharum officianarum (sugarcane), Ipomea batatas (sweet potato) as well as *Dioscorea* alata, Brassica spp., Crinium spp., Areca catechu, Cocos nucifera, Elaeas guineansis, *Dioscorea* rotundata, Coffea arabica, Camelia sinensis, Theobroma cacao, *Xanthosoma* saggitifolia, *Alocasia* spp., Cyrtosperma spp., Angiopteris spp. This omission could mean that a minor crop could severely impact on several other much more important industries.

THE AUSTRALIAN INDUSTRY'S PERCEIVED COMPARATIVE ADVANTAGE

According to RIRDC (2009), merchants indicate that fresh Pacific taro from north Queensland was of a superior quality compared with taro imported from Fiji. Thus, if Pacific taro could be produced at a competitive price, then a market two to three times greater than for 'Bun Long' would open up to producers. Daniells et al. (2004) identified the advantages Australian taro would have in supplying domestic markets:

- freshness and longer shelf life;
- no fumigation; and
- careful handling to minimize mechanical damage.

The first two of these advantages are a direct consequence of Australia's devitalisation quarantine requirements for imported taro.

4.3 UNITED STATES MARKET

In the United Sates 'dasheen' and 'taro' can be used interchangeably in common usage. USDA-APHIS usually uses dasheen, instead of taro, but also uses taro infrequently. This is likely a reflection of different writers of import regulations over time. The USA, as with Australia, imports and produces taro. However, in contrast to Australia, the importation of taro into the USA does not require devitalization.

4.3.1 DEMAND FOR TARO IN THE USA

The USA taro market is dominated by *Xanthosoma* known as malanga, the preferred taro of the Latin American community, whereas the preference for *Colocasia* is limited to the Samoan, other Pacific Island and Asian communities.

TARO IMPORTS

The USA is the world's largest taro importer by volume with about 50,000 tonnes imported annually (Table 4) from a wide diversity of sources. Imports to the U.S. include taro from the Pacific (Fiji), from the Caribbean (Dominica, Dominican Republic, Jamaica and Saint Vincent) and from Latin America (Brazil Costa Rica, Nicaragua and Ecuador). Imports include both *Xanthosoma* and *Colocasia* types that serve large and diverse consumer groups. Jim Hollyer, University of Hawaii, College of Tropical Agriculture and Human Resources, notes that "a very unique cultural crossover is occurring in the USA, started by the Los Angeles company, Montalvan's Sales, in the early 1990s. Montalvan's Sales found that Pacific Islanders in the Los Angeles area would eat taro that is imported from South America where it is cheaper and more available.[10]

[10] Extract from Jim Hollyer report prepared for this Scoping Study.

Table 17 shows the diversity of taro imports into the United States. During the single day of September 9, 2010, taro imports into the USA included *Xanthosoma* types (malanga) imported from Costa Rica, Nicaragua, and Ecuador and *Colocasia* types (eddoes) imported from Costa Rica, Nicaragua, and Ecuador, Jamaica, Brazil and Honduras.

TABLE 17: A SNAPSHOT OF TARO IMPORTS INTO SOUTHERN FLORIDA PORTS.

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MISCELLANEOUS TROPICAL FRUITS & VEGETABLES

CARIBBEAN BASIN IMPORTS - PORTS OF ENTRY SOUTH FLORIDA
Sales F.O.B. Shipping Point and/or Delivered Sales, Shipping Point Basis
Issued twice weekly -- Monday and Thursday.

CALABAZA: DEMAND MODERATE. MARKET **HIGHER**. Panama and Costa Rica, few Dominican Republic. 50 lb sacks 12.00-14.00 mostly 14.00 few lower

CHAYOTE: DEMAND FAIRLY LIGHT. MARKET ABOUT STEADY. Costa Rica. 40 lb cartons 11.00-13.00 mostly 11.00-12.00

COCONUTS: DEMAND FAIRLY LIGHT. MARKET **LOWER**. Dominican Republic. 65-70 lb sacks Dry 40s 20.00-22.00 mostly 20.00

GINGER ROOT: DEMAND MODERATE. MARKET ABOUT STEADY. Costa Rica, few Peru. 30 lb cartons 26.00-28.00 mostly 27.00

MALANGA: DEMAND FAIRLY LIGHT. MARKET **LOWER**. Costa Rica, Nicaragua, Ecuador. 40 lb cartons Blanca lge 20.00-22.00 mostly 20.00-21.00 few higher Lila lge 29.00-31.00 mostly 29.00-30.00 few higher and lower

TARO: DEMAND MODERATE. MARKET EDDOES **HIGHER**; DASHEEN MEDIUM **LOWER**. Costa Rica, Nicaragua, Ecuador, Jamaica, few Brazil and Honduras. 40 lb cartons Eddoes sml 30.00-32.00 mostly 30.00 few lower Dasheen (Coco, Islena) lge 56.00-58.00 mostly 56.00-57.00 few higher and lower 50 lb sacks Dasheen (Coco, Islena) med 20.00-22.00 mostly 21.00-22.00

Eggplant Bushel	54	2.50	14.50	7.66
Onions, Yellow Peck	78	5.00	12.00	8.90
Ornamental Corn Bunch	687	.35	1.90	.93
Ornamantal Gourds Each	2294	.05	2.00	.33
Peppers, Bell Type Bushel	312	1.00	14.00	8.27
1/2 Bushel	138	1.00	8.00	3.51
Potatoes 5 Lb	136	.00	1.50	1.23
Pumpkins,				
Howden Type Each	2103	1.00	3.50	1.69
Squash,				
Yellow Straightneck				
1/2 Bushel	88	2.00	16.00	10.43
Zucchini 1/2 Bushel	235	1.00	13.00	8.65
Tomatoes 10 Lb	907	2.50	14.00	7.20
Watermelon				
Red Flesh Seeded Each	608	.50	8.00	1.21

ADAMS COUNTY INDIANA FLOWER & PRODUCE AUCTION

PRICES TO GROWERS FOR THURSDAY, SEPTEMBER 9, 2010

	Volume	Prices Low	High	Weighted Avg Price
Cantaloups: Per Melon	406	.50	2.10	1.17
Honeydew: Per Melon	69	.60	1.00	.65
Watermelons:				
Red Flesh Seedless Type	746	.75	2.25	1.45
Variety not reported	650	1.00	3.00	2.18
Apples: 1/2 Bushel Carton	138	7.00	19.00	10.39

PACIFIC ISLAND IMPORTS

The USA imported 1,290 tonnes of taro from Fiji in 2009, of which 1,080 tonnes were shipped to the USA mainland and 210 tonnes were shipped to Hawaii (Table 9). There are no records of any other PICs exporting taro to the USA in that year.

CARIBBEAN IMPORTS [11]

Taro exports from the Caribbean region to the USA have ranged from about 3,000 to almost 9,000 tonnes over the past five years, with a value ranging from USD 9 million to USD 5 million (Tables 19 and 20). In 2009, about 4,800 tonnes of fresh taro was imported by the USA (including Puerto Rico[12]) from the Caribbean, of which 87 percent came from the Dominican Republic. The 2009 imports included both *Colocasia esculenta* and *Xanthosoma sagittifolium* (malanga) taro (both were classified by USDA-APHIS as dasheen). The most common cultivars grown and exported are called 'common taro' (purple/blue after cooking) or 'white' taro (white flesh).

[11] Drawn from Amanda Hamilton's report presented in Annex 2

[12] In 2006 some 60% of Dominican Republic exports to the United States were to Puerto Rico.

TABLE 18: VOLUME OF CARIBBEAN TARO EXPORTS TO THE USA, 2005 TO 2009 (TONNES)

Country	2005	2006	2007	2008	2009
Dominican Republic	8,545	4,138	2,641	2,749	4,153
Jamaica	187	472	526	302	474
St. Vincent & the Grenadines	164	152	132	22	93
Dominca	28	52	9	95	57
St. Lucia	0	0	0	6	8
Others	0	4	0	2	8
Total	**8,924**	**4,819**	**3,309**	**3,176**	**4,793**

Source: USITC 2010

TABLE 19: THE VALUE OF CARIBBEAN TARO EXPORTS, 2005-2009 (USD)

Country	2005	2006	2007	2008	2009
Dominican Republic	8,0066,108	3,866,985	2,374,836	3,436,754	5,038,974
Jamaica	404,020	762,402	773,053	674,476	985,718
St. Vincent & the Grenadines	177,815	168,757	96,840	39,987	89,231
Dominca	28,325	47,981	18,479	148,397	97,675
St. Lucia	0	0	0	11,178	15,157
Others	5,670	5,834	0	3,168	15,817
Total	**8,681,938**	**4,851,959**	**3,263,208**	**4,313,960**	**6,242,572**

Source: USITC 2010

4.3.2 THE USA DOMESTIC TARO INDUSTRY

While most of the taro consumed in the USA is imported, there is also a significant domestic taro industry. Taro production in the USA is commonly associated with Hawaii, where it was the traditional staple of native Hawaiians and other Pacific Islanders. Taro remains a culturally important crop in Hawaii. Additionally, there are significant taro plantings in Florida and, to a much lesser extent, California and Texas.

THE HAWAII INDUSTRY

Taro is a crop of considerable cultural significance to both indigenous Hawaiians and local people of various ethnic extractions. Taro production and consumption is highly varied and classified in terms of the production method and the end use (Figure 3). Production is broadly divided into flooded and upland, with flooded taro being the traditional *Colocasia* taro that is processed into Hawaiian poi.[13] Traditional upland *Colocasia* taro is also utilised for poi and sold to Polynesian consumers, and Chinese ('Bun Long' *Colocasia* type) and Japanese taros (*Xanthosoma* taro in Hawaii) are also grown in Hawaii. Augmenting locally-grown taro in Hawaii's markets is the Samoan type (mainly Tausala ni Samoa imported from Fiji) for sale to the Polynesian community.

[13] Poi, a viscous food, is made from cooked taro corms.

In 2008 there were 105 farmers growing taro, on a total of 182 ha – 173 ha were devoted to poi taro and 9 ha to upland Chinese taro (table 20). Nearly 2,000 tonnes of taro were produced, of which nearly 98% was processed into poi (flooded) or taro chips ('Bun Long'). The production of tradition flooded taro for poi is concentrated on the island of Kauai.

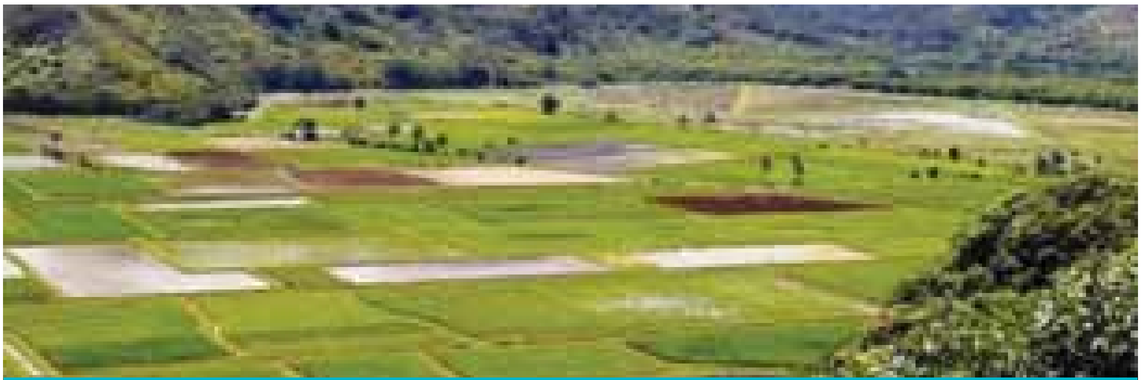
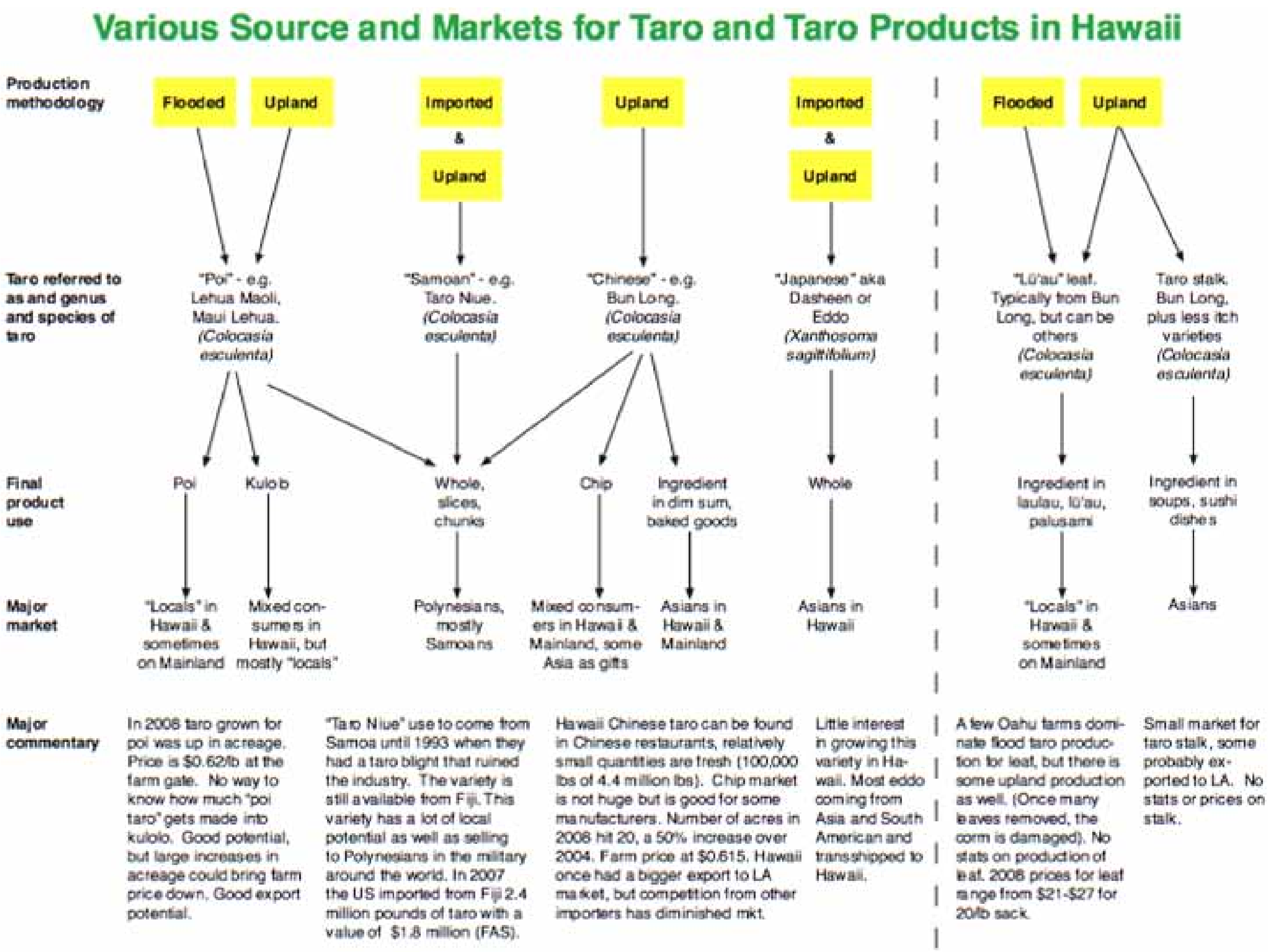


Figure 4: Flood taro production at Hanalei on the island of Kaua'i

FIGURE 3: VARIOUS SOURCE AND MARKETS FOR HAWAII'S TARO AND TARO PRODUCTS*



Source: Hollyer, James R., Sullivan, Jennifer L., Josephson, Margaret, et. al. 1997.

TABLE 20: HAWAII TARO STATISTICS, 2004 - 2008*

TARO: Number of farms, acreage, marketing, price, and value, by counties, 2004-2008

Year	Farms	Acreage in crop 1/			Marketings			Farm price			Value of sales
		Poi taro	Chinese taro	Total	Fresh	Processed	Total	Poi taro	Chinese taro	All	
	Number	*Acres*			*1,000 pounds*			*Cents per pound*			*$1,000*
STATE											
2004	130	360	10	370	100	5,100	5,200	54.0	53.8	54.0	2,808
2005	110	350	10	360	100	4,200	4,300	54.0	54.0	54.0	2,322
2006	105	360	20	380	100	4,400	4,500	56.8	65.5	57.0	2,565
2007	105	355	25	380	100	3,900	4,000	59.2	50.5	59.0	2,360
2008	105	370	20	390	100	4,300	4,400	62.0	61.5	62.0	2,728
Counties:											
Hawaii											
2004	30	50	10	60	100	400	500	60.0	53.1	57.5	288
2005	30	40	10	50	60	240	300	57.6	50.0	56.1	168
2006	25	55	10	65	70	220	290	61.0	65.5	62.1	180
2007	25	50	10	60	70	220	290	62.0	52.4	59.7	173
2008	25	45	5	50	30	160	190	65.0	65.0	65.0	124
Honolulu/Maui 2/											
2004	35	75	*	75	*	800	800	55.1	3/	55.1	441
2005	30	75	*	75	40	860	900	56.6	60.0	56.8	511
2006	35	80	10	90	30	880	910	62.5	65.5	62.6	570
2007	35	55	15	70	30	880	910	63.4	46.0	61.9	563
2008	35	75	10	85	50	740	790	70.5	60.0	69.8	552
Kauai											
2004	65	235	*	235	*	3,900	3,900	53.3	3/	53.3	2,079
2005	50	235	*	235	*	3,100	3,100	53.0	3/	53.0	1,643
2006	45	225	*	225	*	3,300	3,300	55.0	3/	55.0	1,815
2007	45	250	*	250	*	2,800	2,800	58.0	3/	58.0	1,624
2008	45	250	5	255	20	3,400	3,420	60.0	3/	60.0	2,052

1/ Survey conducted in November of each year. Does not include acreage used primarily for leaf production. 2/ County of Honolulu combined with Maui to avoid disclosure of individual operations. 3/ Not shown separately, but accounted for in State average. *=Less than 5,000 pounds or 5 acres.

Source: Hawaii Agricultural Statistics, 2009.

The cultural significance and political importance of taro in Hawaii is reflected in on-going controversy surrounding the introduction of genetically modified taro material. Manner and Taylor (2010) note that "In Hawai'i, given the significance of kalo in Hawaiian culture and the controversy over GM taro, Hawai'i and Maui Counties have banned the testing, propagation, introduction and cultivation of genetically modified crops". Thus considering these extreme sensitivities toward taro in Hawaii it is highly significant that the local authorities have not deemed it necessary to impose any particular quarantine restrictions on the importation of taro into Hawaii to protect against taro pest insects and diseases.

FLORIDA INDUSTRY

Surprisingly, Florida has a considerably greater taro growing area than that of Hawaii (Stevens, 2009). In the early 1900's, the USDA thought taro would be an excellent crop to grow in the swampy areas of Florida for sale to markets in the northern states (Barrett and Cook, 1910) as a starch food source in addition to potatoes and rice. However, non-Africans and non-islanders never acquired any preference for taro.

Dade County (south of the Miami) is the largest production area with 1170 ha in 1995, the last year taro area was recorded by the government (Stevens, 2009). The cultivars of taro (malanga, as it is known in Florida) include *Xanthosoma sagittifolium* (white, starchy, large corms) and malanga isleña ("island" taro of *Colocasia esculenta*). Each taro variety has different uses and consumer groups. Unlike Hawaii, there are no production figures available for taro grown on the USA Mainland because minor crops of only a few thousand acres are not represented in national agricultural statistics.

4.4 THE JAPAN MARKET

Japan is the 7th largest taro producing country and also the largest taro importer in value terms (Table 3). Sato-imo is the main taro that is widely consumed in Japan because this small corm *Colocasia* taro has cultural significance as a traditional food.[14] Domestic taro production has decreased in recent decades as imports have increased (Table 21) with China as the main source of Japan's taro imports.

TABLE 21: JAPAN PRODUCTION AND IMPORTS OF SATO-IMO TARO

	Domestic Production		Imports (tonnes)	
	Area (ha)	tonnes	Fresh	Frozen
1999	20,000	148,100	10,322	52,373
2000	18,800	138,300	20,345	56,159
2001	17,800	129,200	20,254	55,425
2002	17,100	123,900	24,887	49,660

Source: RIRDC (2009) Asian Vegetables

The low taro production period for both Japan and China occurs is during the summer months (May through August), which creates a period of significantly higher prices that can exceed 120 yen /kg c.i.f. (Vinning 2003 p, 62). Australian and Tongan taro exporters have been targeting this period of low Japan and China production.

[14] Peeled, plain-boiled sato-imo cormels are similar in appearance to peeled boiled potatoes, however, sato-imo has a distinctly stickier texture and a more "nutty", and even slightly sweet, taste (White et.al 2006). Sato-imo also has distinctly different texture and taste to the larger taros of Asia and the Pacific regions. The petioles (leaf stalks) of some cultivars are also eaten. Edible petioles are peeled and cooked often by boiling with soy sauce, or after dressing with vinegar, and also cooked as an ingredient in miso soup.

05 THE PEST DISEASE STATUS OF TARO EXPORTING AND IMPORTING COUNTRIES: A PRELIMINARY REVIEW OF THE AVAILABLE LITERATURE

Manner and Taylor (2010) highlight the overall susceptibility of taro to pests and pathogens. They argue that this susceptibility helps explain the traditional practice of cultivating taro in cleared gardens, intercropping, as well as the selection in some parts of the Pacific for paddy or flooded cultivation.

Manner and Taylor (2010) summarise the major diseases and pests found in taro as follows:

> Of the diseases found in taro, one of the most serious is *Phytophthora*[15] leaf blight that reduces corm development 30–100%. In Samoa, *Phytophthora* leaf blight destroyed the taro export market in 1993. This disease is especially a serious problem in the humid tropics where the rainfall is greater than 2,500 mm per annum and there is little season¬al variation. This disease has also led to the decline of Colo¬casia taro in parts of Papua New Guinea and the Solomon Islands (Jackson, 1980). Other serious diseases are *Pythium* rot, dasheen mosaic virus, and nematode diseases. Alomae-bobone complex is very serious and can lead to the death of the plants. It appears to be restricted to Papua New Guinea and Solomon Islands. The taro planthopper, *Tarophagus proserpina*, caterpillars, and the taro army worm are among the most serious and widely distributed pests (Mitchell and Maddison, 1983). Other serious pests of taro in the Pacific region are taro beetle (Pap¬uana spp.), whitefly (Bemisia spp.), taro hornworm (Hippo¬tion celerio L.), cluster caterpillar (Prodenia [Spodoptera] litura F), and spider mite (*Tetranychus* spp.) (Howel, 1982). Some of these pests transmit virus diseases, e.g., the taro planthopper that transmit *Colocasia* bobone virus and pos¬sibly a related virus, taro vein chlorosis rhabdovirus. Taro beetle is a significant problem in some of the islands of Fiji and Vanuatu. The impact of beetle feeding is considerable, as export markets do not tolerate any damage and more than 15% will make the crop unacceptable for local markets.

[15] *Phytophthora colocasia*e is mainly a foliar pathogen although postharvest storage rots also occur. Initial symptoms of the disease are small brown water-soaked flecks on the leaf which enlarge to form dark brown lesions, often with a yellow margin (Hunter et. al 2000). Secondary infections lead to rapid destruction of the leaf which may occur in 10-20 days or less in very susceptible varieties, such as taro Niue. The normal longevity of a healthy leaf is about 40 days. The disease significantly reduces the number of functional leaves and can lead to yield reductions of the magnitude of 50%. Inoculum in the form of spores is spread by wind-driven rain and dew to adjacent plants and nearby plantations. The disease can also be spread on taro planting material and the fungus has been reported as remaining alive on planting tops for about 3 weeks after harvest (Jackson, 1977). This is the most likely source of the disease in new countries and the means for its rapid spread within a country once established. Hunter et. al. describe the specific circumstances of the spread of leaf blight in Samoa.

It is believed that the rapid spread of the disease was encouraged by the movement of infected planting materials around the two main islands, Upolu and Savai'i. At this time there was a major replanting of taro underway in the aftermath of Cyclone Val and anything up to 10,000 plants could be planted by a single farmer in a one week period (Semisi, 1993). Various factors contributed to the rapid spread of the disease in Samoa. The area planted to taro Niue at the time was extremely large and effectively ensured a monocrop situation comprising a highly susceptible variety. There was a continuous and abundant source of taro for the disease because of the practice of many farmers to interplant on old plantations and stagger their cultivation. Combined with the movement of planting material and the ideal weather conditions that exist in Samoa for the disease it is not surprising that the disease reached epidemic proportions. feeding is considerable, as export markets do not tolerate any damage and more than 15% will make the crop unacceptable for local markets.

5.1 PACIFIC ISLAND TARO EXPORTING COUNTRIES

Carmichael et.al. (2008) TaroPest: An illustrated guide to pests and diseases of taro in the South Pacific provides the most recent information on Pacific Island taro pests and diseases. In addition to the comprehensive ACIAR-sponsonsored study, the Secretariat of the Pacific Community maintains a regional plant pest list database for all 22 Pacific Island countries and Territories (www.pld.spc.int/pld). Each country's National Plant Protection Organisation also maintains individual country databases.

The major pests and diseases associated with taro (*Colocasia esculenta*) corms in the Pacific Islands, are summarised in table 22. The most serious taro diseases identified by Carmichael et. al. (2008), are:

- **Taro leaf blight** (*Phytophthora colocasia*e) – found in American Samoa; Federated States of Micronesia; Guam; Northern Mariana Islands; Palau; PNG; Samoa; and Solomon Islands; but not found in Fiji, Tonga, Cook Islands and Vanuatu.
- **Corn soft rot** (*Pythium* spp.)– found throughout the Pacific
- **Alomae virus** – found in PNG and the Solomon Islands; but not found in Fiji, Samoa, Tonga, Cook Islands and Vanuatu.
- ***Colocasia* bobone disease** (?rhabdovirus)- found in PNG and the Solomon Islands; but not found in Fiji, Samoa, Tonga, Cook Islands and Vanuatu.

The most serious taro pests are Taro beetles (*Papuana* spp.) - widespread throughout PNG, with some species present in Vanuatu, Solomon Islands, Kiribati and Fiji (Viti Levu only).

From a quarantine perspective, the fungal disease taro leaf blight (*P. colocasia*e) and the virus diseases (Alomae and *Colocasia* bobone disease) are the most significant diseases. They are known to inflict 50 to 100% yield losses. None of these diseases have been identified in Fiji, Tonga and Vanuatu, while only TLB has been identified in Samoa, PNG and the Solomon Islands. Alomae and *Colocasia* bobone disease have only been identified in PNG and the Solomon Islands.

TABLE 22: THE MAJOR PEST AND DISEASES ASSOCIATED WITH TARO (*COLOCASIA ESCULENTA*) IN THE PACIFIC ISLANDS*

What is it?	Countries where it is recorded in taro (*Colocasia esculenta*)?	What does it do?
Bacteria		
Bacterial soft rot *(Erwinia chrysanthemi)* Is a bacterium that causes a soft rot to corms in the field and in storage.	Solomon Islands and Cook Islands	A bacterium that causes a soft rot of corms in the field and in storage.
Fungi		
Corm rot *(Athelia rolfsii)* It is a soil borne fungus that infects taro at soil level, causing corms and roots to rot and leaves to wilt.	Cook Islands, Fiji, French Polynesia, Federated States of Micronesia, New Caledonia, Palau, Samoa, Solomon Islands, and Tonga	Causes a post-harvest pinkish corm rot, infecting corms through wounds made when suckers are detached.

Taro leaf blight (*Phytophthora colocasiae*) Taro leaf blight is a major disease of taro, and where present in Pacific Island countries has often prevented farmers from successfully growing taro.	American Samoa; Federated States of Micronesia; Guam; Northern Mariana Islands; Palau; PNG; Samoa; and Solomon Islands	Usually, petioles are not attacked, but later collapse as the leaf blade is destroyed. However, in American Samoa and Samoa, petiole infection is common as the varieties are very susceptible to the disease. The fungus can also cause a post-harvest corm rot that is difficult to detect unless corms are cut open
Spongy black rot *(Lasiodiplodia theobromae)* Spongy black rot in taro corms, causing rots that are at first whitish cream and later blue black.Spongy black rot, *Lasiodiplodia theobromae*, in taro corms, causing rots that are at first whitish cream and later blue black.	American Samoa; Cook Islands; Fiji Islands; French Polynesia; Micronesia, Federated States of (FSM); New Caledonia; Papua New Guinea; Samoa; Vanuatu; Wallis & Futuna; Solomon Islands; Palau; Tonga	*Lasiodiplodia theobromae* causes a post-harvest rot of taro corms. It is frequently isolated in decayed corm tissues behind advancing rots caused by *Phytophthora colocasia*e and *Pythium* splendens. Even in the absence of other fungi, it enters corms through wounds made at harvest and causes their complete decay in 10-14 days.
Corm and leaf rot *(Marasmiellus stenophyllus)* Infects taro at the base of the plant, destroying leaves, corms and roots and commonly producing toadstools on the dying parts.	American Samoa, French Polynesia and Wallis & Futuna	Leaves collapse due to the development of large brown rots at the base of the plant associated with white fungal growth. The leaves are often stuck together by the fungal threads. Toadstools form in large numbers on the withered leaves at soil level. The fungus grows over the roots and kills them, and in the process soil particles become fastened to the roots.
Corn soft rot (*Pythium* spp.) A number of *Pythium* species have been isolated from the roots and corms of wilted plants in dry and wetland taro.	various *Pythium* species occur throughout the Pacific	In wetland taro, losses due to *Pythium* rot have been found to range from less than 10% to 100%, with 25% as a conservative average. By contrast, reports of losses in dryland plantings suggest that damage is only occasionally high.
Viruses		
Alomae. Three viruses are associated with alomae: *Colocasia* bobone disease rhabdovirus (CBDV), Taro vein chlorosis rhabdovirus (TaVCV) and Taro badnavirus (TaBV)	Solomon Islands and Papua New Guinea	Plants collapse rapidly and the leaves appear splayed (as if they are wilting). After this stage, growth ceases and plants rot from a systemic necrosis.
***Colocasia* bobone disease ? rhabdovirus (CBDV)** causes leaf distortions, sometimes severe, and is spread by a planthopper (*Tarophagus Proserpina*).	Papua New Guinea and Solomon Islands	In 'female' varieties CBDV causes severe stunting with distorted, thickened, brittle leaves which sometimes fail to unfurl. In Solomon Islands plants with these symptoms are said to have 'bobone'. Translated, this means 'the plant grows small'.

Dasheen mosaic virus (DsMV) Dasheen mosaic is caused by a virus that results in patterns of various colours, shapes and sizes on the leaf, and which may reduce corm yield; only in French Polynesia have severe distortions been reported. Vectors are aphids. An ACIAR-funded study, implemented by SPC in Fiji and Samoa is currently trying to quantify yield losses (if any).	Recent surveys have confirmed DsMV to be widespread in Pacific Island countries: American Samoa; Australia; Cook Islands; Federated States of Micronesia; Fiji; French Polynesia; Guam; Marshall Islands; New Caledonia; New Zealand; Papua New Guinea; Samoa; Solomon Islands; Tonga; Vanuatu	Plants show a variety of mosaic patterns. Invariably, plants recover from the symptoms, producing leaves healthy in appearance. Plants in French Polynesia have been reported with small, stunted and severely distorted leaves.
Taro badnavirus (TaBV). There is no accepted common name for this virus disease, although vein clearing has been suggested. Vectors are aphids	Widespread : American Samoa, Australia, Cook Islands, Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu, Federated States of Micronesia, Marshall Islands and New Caledonia	The virus is often latent. Where symptoms do occur, they appear as intermittent, indistinct areas of vein chlorosis, often near the leaf margin. Plants may be stunted, but eventually recover, producing apparently healthy leaves.
Taro Vein Chlorosis virus (TaVCV). The virus causes a chlorosis of the veins, often near the leaf margin. It's effect on corm yield is unknown, but there is a possibility that it complexes with other viruses to cause alomae, a lethal disease of taro. Vectors are aphids	Federated States of Micronesia, Fiji, New Caledonia, Palau, PNG, Solomon Islands, Tuvalu and Vanuatu	Leaves show a distinct vein chlorosis, more pronounced than the vein chlorosis sometimes associated with TaBV. The number of leaves showing symptoms varies, but in most cases it is three or four. Leaves formed subsequently appear healthy. By contrast to infection with CBDV galls are not present on the leaf blades and petioles, and plants are generally not stunted.
Nematodes		
Miti Miti Disease (*Hirschmanniella miticausa*). Miti miti disease is caused by a nematode, *Hirschmanniella miticausa*. It infects the roots and corms and plants may wilt.	PNG (Southern Highlands) and Solomon Islands (some islands)	The nematode causes a corm rot. Corms show irregular, 1-10 mm wide, zones of dry brown rot that originate from the base of the corm, at first confined to the vascular tissue. Healthy tissue alongside the rots is red and corms have the appearance of uncooked fatty meat. Often, the basal parts of the corms are completely decayed by secondary, brown, soft rots
Root Knot Nematode (*Meloidogyne* spp.) Root knot nematodes are commonly found associated with the roots of taro. However, surveys in the Pacific have found little evidence of damage.	Cook Islands, Fiji, Niue and PNG	Surveys of nematodes in Pacific Island countries suggests that *Meloidogyne* spp. damage to taro is relatively mild compared to other crops. Typically, roots are slightly swollen without knots, and only very rarely have swollen, deformed roots with galls been reported".

Lesion Nematode (*Pratylenchus coffeae*) Root lesion nematodes are commonly found associated with the roots of taro. However, only in Japan has the nematode been found to be the cause of a disease.	*Pratylenchus coffeae* has been recorded associated with taro in: American Samoa, Fiji and PNG	In Japan, *Pratylenchus coffeae* has consistently been found associated with root decay, reduced number of cormels, stunting and death. The problem appears to be exacerbated by continuous cropping of taro. By contrast, it is not clear whether this nematode damages taro in Pacific Island countries sufficiently to cause above-ground symptoms.
Insects		
Taro Beetles (*Papuana* spp.). Taro beetles are shiny black beetles (25 mm x 12 mm), which feed on taro corms	Taro beetles are native and wide-spread throughout PNG, and some species are present in Vanuatu, Solomon, Kiribati and Fiji (Viti Levu)	The adult beetles feed on the corms, tunneling inside. The impact is considerable: the export markets do not tolerate any damage; more than 15% damage makes them unacceptable for local market.

* Source: Carmichael et.al. (2008)

5.2 USA (HAWAII)

Information on taro pest and diseases in the United States is only readily available for Hawaii. This is largely due to the fact that taro is treated as a priority crop by the University of Hawaii, due to its cultural and commercial significance. Taro in Hawaii has a number of pest and disease problems that can reduce yield significantly. Table 24 gives a current list of major pest and disease problems on taro in Hawaii. Many of the taro pest and diseases found in the Pacific islands are also found in Hawaii. This list includes taro leaf blight (TLB). However, TLB has had less devastating impact in Hawaii than it has had in Samoa. The two most serious virus diseases, Alomae and CBDV are not present in Hawaii. It is highly significant that despite the absence of these viruses in Hawaii, USDA/APHIS and State of Hawaii quarantine authorities have not seen it necessary to impose devitalisation regulations on imported taro from the Pacific Islands. This is despite the fact that the Honolulu port of entry is in close proximity to the taro growing areas.[16]

TABLE 24: PEST AND DISEASE PROBLEMS FOR FLOODED AND UPLAND TARO IN HAWAII (2008)

Insect Pests	Severity comments**
apple snails (*Pomacea canaliculata*)	severe
banana moth larvae (*Opogona sacchari*)	not severe

[16] The taro growing area of Waihole on Ohau is just 20 km from the Honolulu port. The main taro growing area is at Hanalei on the island of Kaua'i, a 30 minute flight from Honolulu.

Chinese rose beetle (*Adoretus sinicus*)	severe
Crayfish	not severe
foliar aphids (melon aphid - *Aphis gossypii*, banana-aphid-*Pentalonia nigronervosa*)	not severe
Leafhoppers	not severe
Mealybugs	not severe
Slugs	not severe
spider mite (*Tetranychus* species)	not severe
taro delphacid (a plant hopper, *Tarophagus colocasia*e and *T. proserpina*)	severe
taro root aphid (*Patchiella reaumuri*)	severe
Whiteflies	not severe
Plant disease	
Bacterial soft rot (*Erwinia* species)	not severe
Black rot (*Ceratocystis fimbriata*)	not severe
Cladosporium leaf spot	severe
Dasheen mosaic virus	severe
Lime-induced chlorosis	not severe
Loliloli (characterised by a fairly large, transparent, and soft section of the lower corm area)	not severe
Marasmiellus corm dry rot	severe
Phyllosticta leaf spot	severe
Phytophthora leaf blight (taro leaf blight) – *Phytophthora colocasia*e	severe
Pocket rot (*Phytophthora* complex)	severe
Pythium rot (soft rot, P. myriotylum)	severe
Rhizopus rot	severe
Root-knot nematode (*Meloidogyne* sp.)	severe
Sclerotium blight (southern blight, *Sclerotium rolfsii*)	severe
Small hard rots or pits ("guava seed," kalakoa) - The cause of these small, hard pits is unknown	not severe

Derived from Evans et. al. 2008, Taro: Mauka to Makai, edition two. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. *Notes: * this is a mix of problems for flooded and upland taro production. ** Only those problems that are causing major loses are marked.*

5.3 AUSTRALIA

The main justification for the severe quarantine measures imposed on the importation of Pacific Island taro is the concern regarding the transmission of viruses and TLB. However, there is little published information available about these diseases in Australia. This contrasts to the situation in the Pacific Islands and Hawaii where extensive resources have been devoted to identify the incidence and distribution of viruses in taro (see Revill et.al 2005 et.al, Davis and Raubete 2010) and taro leaf blight (Carmichael et.al. 2008). For Australia, as with the USA mainland, there is limited information available on taro pests and diseases. This can be attributed to taro being a minor crop compared with its status in the Pacific Islands, Hawaii and in the Caribbean.

In response to SPC Biosecurity & Trade Facilitation Officer's request for a list of plant viruses affecting taro and other aroids, the Australian Department of Agriculture, Fisheries and Forestry (DAFF), indicated that this was the "weakest group for information and standards etc"(pers.comm., Robert Ingram). No list was made available and it was indicated that there was no official information on the pest and diseases occurring on taro *Colocasia esculenta* and other related edible aroids (pers.comm., Robert Ingram). The SPC Officer was informed that there was a working list drawn from "less than 500 Quarantine records and less than 4,000 specimen records from 10 databases". The DAFF response did make reference to Dasheen Mosaic Virus (DsMV), which is wide spread through tropical Australia and well documented. However, even with DsMV, little is known about its impact on taro yield. The vectors of Alomae and Bobone viruses is the plant hopper *Tarophagus proserpina*, while the taro aphids *Aphis craccivora*, *Aphis gossypii* and *Myzus persicae* are vectors of the other viroids and are present throughout tropical Australia (Mathews, 2003, Oika J 1985).

RIRDC (2009) confirms that corm rot and root rot are serious diseases of taro and an important constraint to production on the wet tropical coast of north Queensland. *Rhizoctonia solani* and *Fusarium solani* isolated from corm rot samples were proven to be pathogenic on taro corms forming rots. *Pythium* spp. was shown to cause severe root rot but along with *Erwinia chrysanthemi* did not cause corm rot in the glasshouse study.

5.4 CARIBBEAN TARO EXPORTERS[17]

In looking at the quarantine requirements for taro imports into the United States it is relevant to consider the taro disease status of the Caribbean, given that the region is a major supplier of taro to the United States. The quarantine pests identified in fresh taro consignments intercepted at USA entry ports from the major Caribbean exporters in 2009 are presented in Table 25.

[17] Drawn from Amanda Hamilton's full report on the Caribbean taro exporters presented in annex 2.

TABLE 25: MAJOR PESTS AND DISEASES IDENTIFIED FROM APHIS INTERCEPTIONS OF FRESH TARO FROM MAJOR CARIBBEAN EXPORTERS (2009)

Pest Type	APHIS Pest ID (Species/Family)	Common Name
Insect	*Diaphania nitidalis* (Crambidae)	pickle worm (snout moth)
	Aphodiinae sp. (Scarabaeidae)	scarab beetle
	Alleonemobius sp. (Gryllidae)	ground cricket
	Species of (Nitidulidae)	sap beetle
	Species of (Scarabaeidae) **	scarab beetle
	Species of (Micropezidae)	stilt-legged fly
	Xyleborus sp. (Scolytidae) **	bark beetle
	Species of (Pseudococcidae) **	mealy bug
	Species of (Sciaridae)	fungus gnat
	Miogryllus sp. (Gryllidae)	field cricket
	Thrips Palmi Karny (Thripidae)	melon thrip
	Species of (Noctuidae)	moth (owlet or millet)
	Spodoptera eridania (Cramer) (Noctuidae)	southern army worm
Mollusca	Species of (Veronicelidae)	leather leaf slug
	Bradybaena similaris (Ferussac)(Bradybaenidae)	Asian tramp snail
Disease	*Ceratocystis fimbriata* (Ellis & Halst) ** (Ceratocystidaceae)	fungal corm rot

Source: pers. comm., USDA internet searches to identify common names.
** Included on APHIS Regulated Plant Pest List (APHIS 2010[C]).
a Only a very small volume of product was intercepted due to the presence of mollusca.

The major quarantine issue associated with taro leaf exports has been the presence of aphids on leaves/stems from Trinidad & Tobago. According to Greg Robin of the Caribbean Agricultural Research and Development Institute (CARDI) overall there are currently no pests and diseases of major economic significance affecting taro production in the Caribbean region (pers. comm., 2010). Robin & Pilgrim (2003) report that in the early 2000s, sporadic outbreaks of a dasheen beetle (*Ligyrus ebenus*) were experienced in Dominica, St. Lucia and Trinidad & Tobago.[18] Both larvae and the adult beetle tunnel feed through the root of the taro and can cause considerable damage/destruction to the entire corm and kill young plants. It is notable that corm rot generally occurs in association with poor harvesting practices where fungal infections develop in areas where the corm has been physically damaged. Common soil borne fungal complexes associated with dasheen corm rot include *Pythium* splenderis, *Fusarium* sp., *Rhizoctonia* sp., and *Botryodiploidia theobromae*. The bacteria *Erwinia chrysanthemi* can also cause spoilage through secondary infection known as 'soft rot'. In an effort to prevent fungal attack and minimise corm rot, export specifications recommend that corms are harvested within two days prior to shipping and are treated with a fungicide (Ridomil) for exports outside the region. For intra-regional exports where corms are consumed in a shorter space of time, a bleach solution is recommended.

[18] Information delivered in presentations by Andrea Borrero (USDA-Mitigation Specialist) and Ganesh Gangapersard (NAMDEVCO) during the seminar 'Meeting USA Import Regulations for Fresh Fruits and Vegetables by Trinidad & Tobago Exporters' held on 4 August in Trinidad. The Ministry of Food Production, Land and Marine Affairs, together with USDA-APHIS and the National Agricultural Marketing and Development Corporation (NAMDEVCO) are working closely together to address this issue. These organisations recently hosted a seminar 'Meeting USA Import Regulations for Fresh Fruits and Vegetables by Trinidad & Tobago Exporters' to raise awareness amongst farmers/exporters of USDA-APHIS requirements for exportation of agricultural produce to the USA.

06 MARKET ACCESS AND QUARANTINE

The quarantine import protocol and its application for a particular market is a major factor determining the ability of Pacific island countries to maintain and expand taro exports to that market. The import protocols for the four major markets, together with their justification, application and impact on taro imports are discussed in this section.

6.1 TARO IMPORT PROTOCOLS AND THEIR APPLICATION

6.1.1 IMPORT REQUIREMENTS, RECENT HISTORY OF INTERCEPTIONS AND ACTIONS TAKEN

AUSTRALIA

Current phytosanitary measures for the importation of fresh taro are available on the AQIS ICON website (www.aqis.gov.au/icon32/asp/ex_querycontent.asp)

Import conditions:

- Import Permit & Phytosanitary Certificate & additional declarations
- Each consignment requires a quarantine entry certificate
- Specific requirements for taro : At least 15cm long and 7cm in diameter and weighing 300g or more, free from buds/shoots and shaggy hair
- Key condition: 'All consignments must be free of live insects, disease symptoms, trash, contaminant seeds, soil & other debris on arrival in Australia.'
- Additional declarations:
  - **a.** "The taro in this consignment is *Colocasia esculenta* and not *Colocasia esculenta* var. *antiquorum*."
  - **b.** "The tubers have been inspected and are topped and free from all foliage including petiole bases, and free from sprouting suckers and attached daughter corms, and are free from soil."
  - **c.** "The product is free from Potato Cyst Nematode (PCN) (*Globodera rostochiensis* and *Globodera pallida*) and potato black wart fungus (*Synchytrium endobioticum*)", or "PCN (*Globodera rostochiensis* and *Globodera pallida*) and potato black wart fungus (*Synchytrium endobioticum*) are not known to occur in the country of origin".

AQIS operational procedures:

- If live insects are detected, option of identification by AQIS entomologist, treatment, re-export or destruction.
- If live insects are detected, the consignment must be held at the importer's expense, an entomologist must be consulted and the consignment must be treated, where appropriate, by an AQIS approved method (i.e. Methyl Bromide fumigation[19] in the event of externally feeding insects being detected, pest specific treatments or corrective actions as listed under individual commodity cases) or the goods must be re-exported or destroyed at the importer's expense.
- If diseases/fungal pathogens are detected, option of identification by AQIS pathologist, treatment (if available), re-export or destruction.
- If unidentified plant material (including non-permitted seeds, trash, soil) are detected option of removal (if possible), re-export or destruction.

On-arrival inspection by an AQIS inspector at an approved inspection facility. Inspection is usually based on a 600 unit sample with an acceptance number of zero units infested with regulated pests. A very thorough inspection regime is applied utilising high powered microscopes (Figure 5).

[19] The Methyl Bromide rate required is $32 g/m^3$ for 3 hours at 21°C and above at Normal Atmospheric Pressure (NAP).

Figure 5: AQIS taro inspection in Sydney

PROTOCOL JUSTIFICATION

The general provisions to be "free of live insects, disease symptoms, trash, contaminant seeds, soil and other debris on arrival" are standard for imports of all fresh plant products into Australia from all source countries. There are specific devitalisation requirements for taro aimed at minimising the chances of imported taro being propagated and thereby supposedly reduce the risk of taro diseases (*Phytophthora* leaf blight and viruses) being introduced. The specific provisions to distinguish the larger corm 'Pacific taro' *Colocasia esculenta*, which is permitted from smaller corm 'Japanese taro' *Colocasia esculenta* var. *antiquorum* (CEvA) which is not permitted. Accordingly, the corms must be at least 15cm long or be at least 7cm in diameter at the widest point, and be at least 300gm in weight.

In December 2006, the importation of CEvA was prohibited by Biosecurity Australia (BA) after representation from the Australian industry that taro leaf blight could be introduced on fresh CEvA imported from China. BA argued that the existing devitalization (topping and removing eyes) provisions that were in place for *Colocasia esculenta* were not sufficient to devitalize CEvA because of the variety's "higher capacity to propagate" (BA's Notification of Emergency Measures to WTO Committee on Sanitary and Phytosanitary Measures -4 December 2006). In this Notification it was stated:

> ‘Available scientific literature indicates that *Colocasia esculenta* var. *antiquorum* has a high capacity to propagate even when topped and free from all foliage including petiole bases and therefore presents an increased risk of introducing pests and diseases of quarantine concernto Australia (see Annex 1 of this Scoping Study Report). ’

The prohibition of CEvA applies to all sources, not only China. As a consequence, Tonga, which was starting to develop a niche market for Japanese variety taro into Australia has been excluded from this market opportunity. From a quarantine perspective, the exclusion of Tongan CEvA does not appear justified given that Tonga is free of the TLB and the virus diseases (Alomae and *Colocasia* bobone diseases).

PROTOCOL APPLICATION AND IMPACT ON TARO IMPORTS

There has been a high incidence of AQIS interceptions of PIC taro entering Australia. Rob Duthie (Kalang Consultancy Services) presented a preliminary analysis of the DAFF pest and disease interception records for Fiji fresh taro entering Australia for three years of data (Jan 07 to Feb 10).[20] These records show that for an average of eight airfreight consignments per month, there are interceptions on 75 to 100% of these shipments. This has meant most shipments cleared had to have methyl bromide fumigation to move to market. Over the period January to September there were 69 taro samples with disease symptoms taken by AQIS for further investigation, of which 12 were taken to be regulated and requiring consignment re-export (Sydney presentation by AQIS officers to Fiji Quarantine delegation Oct 25th 2010). Until very recently, virtually all interceptions have related to arthropod pests. Mites have constituted the largest number of interceptions (1,053), of which the actionable quarantine pest taro mite (*Rhizoglyphus minutes*) made up for 196. The quarantine status of this pest is questionable since *R. minutes* is a saprophytic feeder and does not damage taro corms directly. Mealybugs made up 135 interceptions, including 90 mealybug that were actionable quarantine pests. There were 146 nematode and aphid interceptions, of which none were reported to be actionable quarantine pests. In addition

[20] Power Point presentation to ACIAR SPC/ACIAR/ MPI – Workshop to identify research needs for cleaner export pathways for Pacific Island commodities with particular reference to taro and cut flowers and foliage. ACIAR Small Research Activity No: 029. 2008 Holiday Inn, Suva, Fiji 03 August, 2010.

to insects, 61 consignments with seeds (mainly grass seeds) were intercepted. Over the three years ending February 2010, there have been few interceptions due to diseases. There were 14 cases of fungi[21] and one case of bacteria.[22] The sharp increase in rejections appears to be correlated with the aftermath of Tropical Cyclone Tomas. However, since March 2010, there has been a massive increase in rejections based on corm rots. The rejections from March to June 2010 are presented in table 23. Since June 2010, the number of rejections has significantly decreased, attributed to a combination of cooler weather and fewer and smaller consignments (given closer attention by exporters). Probably the most important factor was the dissipation of the adverse impact of TC Tomas. However, rejections do continue.[23]

TABLE 23: CONSIGNMENTS OF FIJI TARO REJECTED BY AQIS OVER THE PERIOD MARCH TO JUNE 2010*

Arrival date	Exporter	Volume (kgs)	Reason for rejection	Action taken by AQIS	Action taken by Fiji Biosecurity
10/3	Nezmark Dynamics	4,160	Significant rotting. Causal organism not identified (importer opted for re-export)	Re-exported	No report
15/3	Sai Yee Food Industries Ltd.	5,600	Significant rotting/fungal growth. Causal organism not identified (importer opted for re-export)	Re-exported	Pack house facility audited after the rejection and found to be compliant
10/3	Nezmark Dynamics	4,160	Significant rotting. Causal organism not identified (importer opted for re-export)	Re-exported	No report
15/3	Sai Yee Food Industries Ltd.	5,600	Significant rotting/fungal growth. Causal organism not identified (importer opted for re-export)	Re-exported	Pack house facility audited after the rejection and found to be compliant
26/3,12/5	Garden City Export Packers	8,620	Significant rotting/fungal growth. Causal organism not identified (importer opted for re-export)	Re-exported	Pack house facility audited twice after the rejection and found to be compliant

[21] *Cladosporium colocasiae* (2), *Fusarium* heterosporum (1)

[22] *Fusarium* heterosporum

[23] Rob Duthie reported on July 30th that in the previous week:

- Air-freighted consignment to Sydney consisting of ~300 bags (~6000kg)
- 6 bags inspected by AQIS
- Found were some rotten taro corms
- Resulted in AQIS rejection of entire consignment
- Most likely caused by fungal pathogen
- Assume that pathogen has gone for identification
- Outcome: Re-export to the cost of exporter

March, April, May	Kaiming Agroprocessing	16,000	Fungal growth and presence of grass seeds. Causal organism not identified (importer opted for re-export)	Re-exported	New pack house facility audited after the rejection and found to be compliant.
29/3,6/5,11/5	Bula Island Food Supplies	12,120	Significant rotting	Re-exported	No report
7/6	Bens Trading	14,000	Significant rooting/bacteria rot contamination. Causal organism not identified (importer opted for re-export)	Re-exported	Pack house facility audited twice after the rejection and found to be compliant
May	AgroMarketing	4,200	Fungal growth	Taro still in Australia	Pack house facility audited twice after the rejection and found to be compliant

* Source: Information supplied by Fiji Biosecurity from Fiji Biosecurity and Biosecurity Australia sources.

PROTOCOL COSTS AND CONSEQUENCES

The importation of 'large' corm taro(*Colocasia esculenta*) into Australia requires devitalisation - the top and bottom of the corm to be cut off, ('top and tailed') and all eyes (growing points) removed. Australia is the only taro importer that requires devitalisation. This robust physical quarantine treatment results in significant product loss (10-15% by weight), increased handling costs, reduced quality and increased risk. The significant reduction in shelf life means that PIC taro needs to be air-freighted, and not sea freighted, to Australia. Increased cost and poor quality substantially reduces the competitiveness of PIC taro on the Australian market.

The importation of 'small' corm taro (*Colocasia esculenta* var. *antiquorum*) is now prohibited, with the loss of a significant potential niche market for PIC exporters. Tonga, in particular, had started to develop this market prior to the prohibition.

Compliance to the Australia taro import protocol inflicts considerable physical damage to the corm (Figure 6). This damage severely impacts the quality and the shelf life of the product. Manner and Taylor (2010) highlight that injury incurred during harvesting predisposes the taro to pathogens in storage which will damage the product and reduce its shelf life. Amanda Hamilton in her report on Caribbean taro exports to the United States notes:

Figure 6: Devitalised Fijian taro prior to shipment to Australia

> ‘Dasheen corm rot generally occurs in association with poor harvesting practices where fungal infections develop in areas where the corm has been physically damaged. Common soil borne fungal complexes associated with dasheen corm rot include *Pythium* splenderis, *Fusarium* sp., *Rhizoctania* sp. and *Botryodiploidia theobromae*. Secondary infection known as 'soft rot' can also cause spoilage and is caused by the bacteria *Erwinia chrysanthemi*.’

Kader (1993) classifies taro, along with apples, lemons, pumpkins and mature potatoes, as a relatively low perishability product with a potential storage life of 8 to 16 weeks. Masalkar and Keskar (1998) point to the fact that corms can be stored for 4 to 5 months if harvested and handled carefully. Along with careful harvesting and handling, good air circulation and treating corms with fungicides can reduce storage rot caused by bacteria and fungi such as *Phytophthora colocasia*e, *Pythium* sp., *Botryodiplodia theobromae*, *Ceratocystis fimbriata*, *Corticium rolfsi*, *Aspergillus niger*, *Fusarium solani*, *Rhizopus* stolonifer, and *Sclerotium rolfsii* (Masalkar and Kaskar 1998).

Unfortunately, the physical damage inflicted on the taro corm by 'top tailing' transforms the product from a relatively low perishability product to a moderate to high perishabilty product. This high perishability is then often compounded by poor post-harvest handling practice and the occasional impact of an extreme cyclonic event. A consignment can held for two days, outside a cooler, awaiting a decision on clearance or re-export.

The increase in perishability due to devitalisation precludes sea freighting taro to Australia as a realistic marketing \option. The usual shipping route is Suva – Brisbane – Sydney – Melbourne and takes 4 to 5 days. It would take a further 2 ½ days to reach Sydney and a further 5 days to reach Melbourne.[24] The only option is to airfreight taro at a current outward rate of FJD1.50/kg, compared with FJD 0.25 to 0.30/kg for sea freight, if that was an option. Additional to the airfreight costs is the cost of trucking taro from Suva to the international airport at Nadi – an estimated FJD 0.10/kg.

The impact on shelf-life of the physical damage of the quarantine treatment is further compounded by the inevitable methyl bromide fumigation required on arrival due to insect interceptions. Thus there is little wonder that Daniells et al (2004) points to the advantages of Australian taro compared to that from the Pacific Islands, because:

- it is fresher when purchased by consumers and has a longer shelf life;
- it does not require fumigation; and
- it is carefully handled to minimise mechanical damage.

The AQIS import protocol requirement of devitalisation was seen mainly as a constraint to expanding the Australian market for Pacific Islands taro (McGregor et.al 2007). However, the devitalisation requirement has now become a major threat to the continued existence of the Australian market for Pacific Island taro. Over the four-month period March to June 2010, 65 tonnes of Fijian taro was rejected by AQIS and re-exported back to Fiji. The estimated total cost to exporters was nearly FJD600,000. This estimate is based on the following information supplied by Kaiming Agro Processing for a rejected 4 tonne airfreight shipment:

	FJD
Taveuni taro purchase (4,800 kgs @ $2.30/kg)	11,040
Freight to Suva (@ 10c/kg)	480
Labour costs (@ 20c/kg)	800
Customs entry and documentation	400
Cartage to Nadi airport (@ 17c/kg)	680
Outward airfreight ($1.50/kg)	6,000
Australia Customs and Quarantine charges	1,500
"Re-export" return freight (@ 3.65/kg)	14,500
Disposal of taro back in Fiji (@ 30c/kg)	1,200
Total cost	**36,600**
Cost per kg shipped	**FJD 9.15**

[24] Information provided by Williams and Gosling Lautoka.

The particular fungal and bacterial agents causing the rots have not been identified, despite repeated requests from the Fiji Quarantine Inspection Service (FQIS)[25] and SPC[26]. Thus without detailed research, it is not possible to determine to what degree these rots can be directly attributed to the devitalization requirement of the import protocol and to what extent they are attributable to other post-harvest handling factors. However, it is revealing that interception data for Fiji taro into New Zealand and the United States show no increase in rejections due to rots. Devitalisation is the factor that differentiates the handling of taro destined for Australia compared with that shipped to other markets.

THE COMPOUNDING IMPACT OF TROPICAL CYCLONE TOMAS ON ROTTING TARO ENTERING THE AUSTRALIAN MARKET

Devitalisation was in place for more than a decade prior to early 2010 with little incidence of interceptions due to rots. Thus other compounding factors were likely at play. TC Tomas, which severely impacted the island of Taveuni in mid-March 2010, is identified as the most likely compounding factor that led to the sharp increase in taro rots experienced in taro exported to Australia.

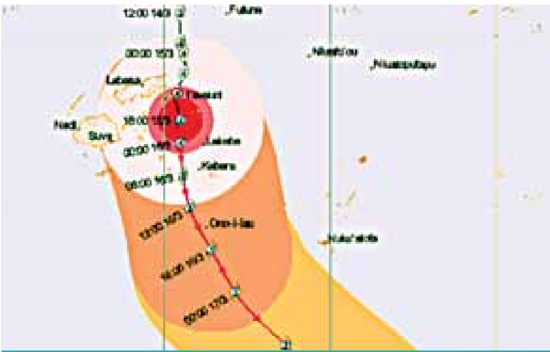


Figure 7: The track of TC Tomas over Taveuni March 15-16 2010

Figure 8: Taro on Taveuni immediately after TC Tomas

TC Tomas was a very slow moving Category 4 system (maximum winds averaging 180kmph and gusting up to 230 km/hr within 60 km of the centre) (Figure 7). The thin leaves and stems of the dalo plant are susceptible to tearing in strong winds (Figure 8). For a category 4 cyclone, losses approaching 100% can be expected for mature (> 5 month) taro planted as a monoculture, unless harvested almost immediately. Even when the tuber survives, the quality is likely to be poor and not marketable. When leaves are damaged by the cyclone, the plant starts putting out more suckers or new leaf growth to counter the loss of leaf area. The starch starts breaking down to support the new growth resulting in watery corms and poor starch quality – referred to as dalo rauka. Mr Rohit Lal, Taveuni's experienced agricultural officer, provided the following estimates of dalo losses on Taveuni as a result of TC Tomas:

- 1-3 months since planting (approximately 30% of the total crop) – full recovery expected
- 3-5 months since planting (approximately 40% of the total crop) – the plant will recover and the corms will survive, however will be of poor quality (peanut shape and poor taste) and cannot be marketed.
- 6-7 months(approximately 30% of the crop) – the corm is marketable if harvested immediately, otherwise it will rot and there will be a 100% loss.

Immediately after TC Tomas, farmers began desperately harvesting dalo, with the amount available quickly exceeding the absorptive capacity of the market and interisland shipping infrastructure (Figure 9).

[25] At the AQIS meeting with FQIS and SPC officials it was revealed that *Erwinia chrysanthemi* had been isolated from a taro leaf sample intercepted in Brisbane. It was indicated that *E. chrysanthemi* is a major concern to the pineapple industry. However, *E. chrysanthemi* is already well established in Australia (Cother and Gilbert 1990 and Stirling 2004) .

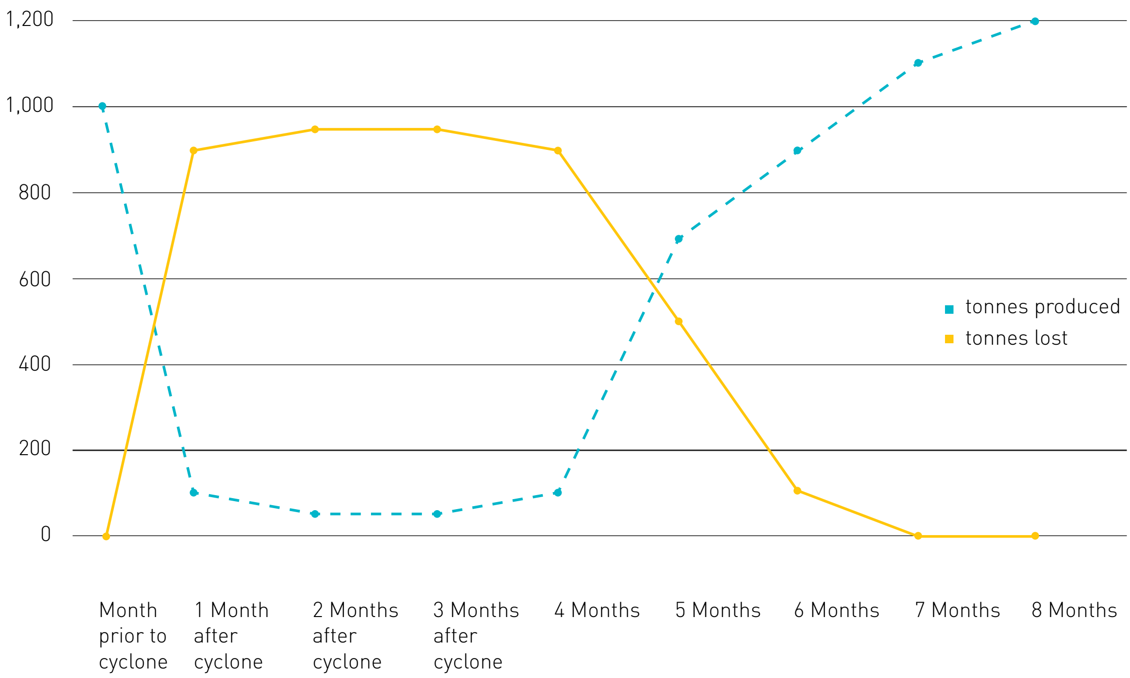
[26] SPC has expressed a willingness to meet the cost of disease identification.

Figure 9: Large volumes of taro at an exporter's shed on Taveuni one week after TC Tomas

For a three-month period following TC Tomas, excessive amounts of immature and watery corms with poor starch quality were being shipped out of Taveuni. For four to five months onwards, the cyclone farmers were under severe financial pressure to harvest immature taro, even though this taro had not been affected by the cyclone [27]. It is hardly surprising that such taro, when combined with physical damage inflicted by devitalisation, experienced such a high incidence of fungal rots. The development of rots are likely to be further encouraged by the transfer of taro from a cooler container to an ambient temperature airfreight container together with the practice of packing taro in clear plastic bags for shipment to Australia (Figure 6). The consignment can then be required to wait at an ambient temperature for several days awaiting clearance or otherwise. The damage caused by TC Tomas is now starting to dissipate and Taveuni taro production patterns are returning to normal (Table 24). Thus the level of rotting taro experienced in Australia can be expected to return to pre March 2010 levels.

TABLE 24: PROJECTED TARO PRODUCTION FROM TAVEUNI FOLLOWING TC TOMAS*

	Month prior to cyclone	1 month after cyclone	2 months after cyclone	3 months after	4 months	5 months	6 months	7 months	8 months	Total
Tonnes produced	1,000	100	50	50	100	500	900	1,100	1,200	5,000
Tonnes lost	0	900	950	950	900	500	100	0	0	4,300



Source: McGregor 2010

[27] When taro is harvested at full maturity, the corms can withstand some degree of improper handling and slow physiological reactions to removal of eyes and detopping. Immature corms are likely to deteriorate faster and have poorer eating quality.

NEW ZEALAND [28]

THE LEGISLATION UNDERPINNING THE PHYTOSANITARY MEASURES FOR THE IMPORTATION OF FRESH TARO

There are two pieces of legislation underpinning the official phytosanitary requirements for imported fresh produce into New Zealand (viz. The Biosecurity Act (BSA) and the Hazardous Substances New Organisms Act (HSNO)). In 2005, the interception of nematodes on Fiji taro, that had previously been considered as non-regulated pests (i.e. saprophytic/non-pathogenic species of no quarantine concern), were being considered as possible 'new organisms' under the HSNO Act. In essence, this meant that technical decision-making provisions under the BSA were being over-ridden by a new interpretation of 'new organism' provisions of HSNO. Other import pathways were also being affected by similar decision-making criteria (e.g. interceptions of 'live' organisms on irradiated fresh produce from Australia).

In simple terms, the cross-over between the two Acts, and the new interpretations associated with this, resulted in a regime of over-regulation and distorted technical decisions in terms of managing border interceptions. Unfortunately, Fiji taro was a victim of this scenario with significant and ongoing trade consequences due to interpretations associated with taro mite and nematode interceptions. Since the 2005 legislative issues arose, both the BSA and the HSNO ACT have been changed to better facilitate decision-making around the unintentional entry of new organisms possibly associated with imported risk goods (i.e. the incidental entry of new organisms is managed primarily under the BSA) and the deliberate introduction of new organisms (i.e. managed primarily under the HSNO Act). Unintentional and incidental entry of organisms such as nematodes accompanying taro consignments should come under the BSA.

Previously, the discovery of regulated arthropod pests on an imported consignment resulted in the justified mandatory fumigation with methyl bromide. In some cases, the contingency action for the interception of high-risk regulated pests would be more severe. For example, the interception of live fruit flies would result in reshipment or destruction of the consignment and suspension of the offending pathway until satisfactory remedial action had been carried out. Technical decisions associated with organisms of low or no risk (e.g. non-parasitic/saprophytic species – do not feed off vegetative tissue) were made on the basis of their ability to enter, establish and cause economic harm. The HSNO interpretations pertaining to (possible) 'new organisms' associated with imported fresh produce significantly changed this technically based approach to one of enforced risk management from a legislative based approach.

TARO MARKET ACCESS PROBLEMS ASSOCIATED WITH MITES AND NEMATODES

MITES:

In late 2001, the New Zealand MAF discovered mites on taro from Fiji. As a consequence, over the next three to four years 70–80% of taro consignments from the Pacific required fumigation. Following a request from Fiji, SPC sponsored a comprehensive pest risk assessment of mites known to be associated with taro from the Pacific Island countries. In June 2003, a report by Landcare Research NZ Ltd., concluded that it was highly unlikely the tropical taro mite (*R. minutus*) could enter and establish in New Zealand. Furthermore, in the unlikely event that it did survive, the probability of causing any damage to New Zealand's horticulture crops was assessed to be extremely low [29] to near zero. As a result of the Landcare report, and the more recent changes to the BSA and HSNO Acts, NZ MAF have now re-categorised this pest from a regulated pest (i.e. requiring specific phytosanitary measures and on-arrival action if intercepted) to a non-regulated pest (i.e. requiring no measures). This is clearly a significant change, which means that no measures are technically justified nor are they imposed for *R. minutus.* However, this decision has not resulted in any significant change from a trade facilitation perspective due to the ongoing issues associated with nematodes and other contaminating pests (e.g. 'hitchhiker' pests).

[28] See annex 3 for the full report prepared by Kevin Nalder
[29] Zhi Qiang Zhang, 2003. Tropical taro mite (*Rhizoglyphus minutes*). Landcare Research, a report prepared for the Secretariat of the Pacific Community, June.

NEMATODES

With the subsidence of concern about mites, New Zealand's quarantine focus on taro shifted to nematodes and other incidental 'hitch-hiker' pests (e.g. slugs, snails and ants). The application of a more stringent inspection regime, utilising high-powered microscopes, results in the inevitable discovery of nematodes on almost every shipment of taro. Microscopic nematodes reside in soil and will always be found on tubers and root crops. However, the border quarantine officers cannot currently distinguish between parasitic/regulated species (i.e. species that feed off live plant tissue and are not found in New Zealand) and non-parasitic/saprophytic species (i.e. not of quarantine importance and should not require action).[30] Consequently, on-arrival fumigation continues to be enforced for any nematodes discovered by quarantine inspectors "because of HSNO". Sometimes a re-inspection after fumigation is undertaken and if residual live nematodes are found, a second fumigation was undertaken – the double fumigation scenario has become less of an issue in recent times. Fumigation, together with the costs of pest identifications, significantly increases exporting costs and the price to consumers. More importantly, fumigation substantially reduces the shelf life and marketability of the product, particularly if a second fumigation is undertaken.

New Zealand nematologist, Dr Gordon Grandison, had recommended to MAF Biosecurity that inspectors be trained to determine if a nematode is parasitic (potentially of quarantine significance) or non-parasitic (not of quarantine significance). The implication is that non-parasitic nematodes would be cleared immediately without further identification or fumigation. These recommendations were not adopted. This was due to the fact that no species identification information is readily available for the intercepted nematodes in questions so they could not be ruled out as being "new organisms" and therefore subject to the provisions of HSNO. However, Fiji taro exporters report in recent times that demands for fumigation by NZ MAF is slightly less frequent and the requirement for double treatments is rare. This is seen to be due to improvements in cleaning by exporters and the less demanding inspection regimes in response to vigorous challenges made by New Zealand importers.Yet despite recent improvements in de-facto market access for taro and positive changes to the underlying legislation, the technical and operational decision-making has not improved.

CURRENT PHYTOSANITARY MEASURES FOR THE IMPORTATION OF FRESH TARO IMPORTS

The current phytosanitary measures for the importation of taro (*Colocasia esculenta*) into New Zealand have been in place for many years. These measures are specified in the document MAF Biosecurity New Zealand Standard 152.02: Importation and Clearance of Fresh Fruit and Vegetables into New Zealand.

The current measures are considered as 'basic' measures and have not been subject to any systematic technical review for many years. This is despite the pathway being identified as a high priority for review by NZ MAF and affected industry parties immediately after the nematode issues arose in 2005. For unknown reasons, this pathway has lost its priority review status. This is identified as an area where official Fiji National Plant Protection Organisation (NPPO) to Australia NPPO communications could result in beneficial changes in the phytosanitary measures applied to taro. The recent change in status of taro mite (*Rhizoglyphus minutus*) from a regulated pest requiring fumigation, to a non regulated pest requiring no actions, is a significant change for a single pest. However, without a similar change in status for nematodes it cannot be considered in the context of a re-alignment of pathway measures with contemporary phytosanitary practices and standards. New Zealand fresh taro import conditions:

- New Zealand, unlike Australia, has no size restriction for imported taro and there is no requirement to remove buds and shoots.
- All consignments must be free of visually detectable quarantine pests specified. There is no specific list of regulated/non-regulated organisms associated with taro from Fiji in accordance with more recently released country/commodity import health standards.

[30] Most nematode species are nonparasitic and thus harmless. The key issue is the type of nematodes that are being found on Pacific Island country taro. An earlier FAO study identified three parasitic nematodes on taro in Fiji (Orton Williams 1980).According to New Zealand nematologist, Dr Gordon Grandison, the root-knot and lesion nematodes will only survive under tropical conditions. Dr Grandison believes that it is unlikely New Zealand Biosecurity officials are finding parasitic nematodes at border inspections. Saprophytic (non-parasitic) feeding nematodes are distinguishable from parasitic nematodes (under a microscope of sufficient power) by the absence of a 'buccal spear ' used to 'attack' plant tissue.

A de-facto list can, however, be determined based on recent interception data. These are:

- Nematodes not identified to species level and in almost all consignments considered a 'regulated' pest in the absence of species-specific identification.
- Snails (miscellaneous species) – usually regulated and requiring action.
- Ants (miscellaneous species) - usually regulated and requiring action.
- Millipedes/centipedes - usually regulated and requiring action.
- Beetles, worms and spiders - usually regulated and requiring action.

NZ MAF operational procedures:

- On-arrival inspection by an NZ MAF inspector at an approved inspection facility. Inspection is usually based on a 600 unit sample with an acceptance number of zero units infested with regulated pests.
- Contingency treatment actions for the interception of regulated (or unidentified) pests. The normal contingency treatment for Fiji taro is methyl bromide, typically for nematode interceptions (e.g. 48 grams for 4 hours at 10-160ºC).

PROTOCOL APPLICATION AND IMPACT ON TARO IMPORTS

There is a range of organisms commonly intercepted on taro from Fiji. In most cases, there are several species intercepted on the same consignment (e.g. usually nematodes and mites and often ants, snails or other 'hitchhiker' pests). This means that there is a high probability of one (or more) of the intercepted pests being considered as regulated and therefore requiring action. Some of the incidental pests are not directly associated with the product (e.g. ants) and could be managed through improved packaging, handling and storage risk management practices.

INTERCEPTIONS

Kevin Nalder, as a part of this scoping study, undertook a short data collection exercise covering three months (viz. April, May June 2010) of taro imports from Fiji. The exercise looked at:

- MAF Inspection details (i.e. time/costs per consignment).
- Interception details (i.e. pests intercepted and regulatory status).
- Diagnostic costs per consignment.
- Treatment costs per consignment.

A total of 30 consignments were analysed. The results of this exercise are summarised in Table 25.

TABLE 25: MAIN INTERCEPTIONS ASSOCIATED WITH TARO SHIPMENT FROM FIJI TO NEW ZEALAND – MAY TO JUNE 2010

Type of interception	Identification	Comments
Nematode	Not to species level	Almost all consignments considered "regulated" in the absence of species specific identification and consignment fumigated
Mites	Usually *Rhizoglyphus minutus* Possibly other *Rhizoglyphus* spp.	Non regulated (non actionable)
Vinegar flies	*Drosophilla* spp.	Non regulated (no action)
Snails	Miscellaneous species	Usually regulated and requiring action
Ants	Miscellaneous species	Usually regulated and requiring action
Millipedes/centipedes	Miscellaneous species	Usually regulated and requiring action
Other Miscellaneous pests	Beetles, worms, spiders	Usually regulated and requiring acting

Given the situation where there are multiple interceptions associated with a single consignment, there is a high probability of justified treatment on-arrival actions by NZ MAF. The situation of unjustified treatment for *R. minutus* has largely disappeared; however, treatment is still justified for other reasons mainly for nematodes. In relation to nematodes, the absence of accurate species data, and the associated technical arguments, constrains any robust case for change. If the current pathway could be "cleaned up" of other incidental pests (e.g. snails, ants etc), then there is a good case for reduced measures for the most regularly intercepted pests associated with Fiji taro (i.e. mites and nematodes).

INTERCEPTIONS DUE ROTS AND DISEASE

The survey (April – June 2010) encountered no interceptions due to rots and other diseases. The period of the New Zealand survey, coinciding with the period immediately following TC Tomas, and the high occurrence of interceptions and rejections of taro to Australia due to rots and disease. The taro sent to the two markets is sourced from the same location, packed in the same packing sheds and shipped by the same exporters. The only apparent difference is that taro sea freighted to Australia is subject to devitalisation (removal of the tops and eyes – Figure 10), while the taro sea freighted to New Zealand is not (Figure 11). This provides strong prima facie evidence that the root cause of the rots occurring in taro being exported to Australia is the quarantine treatment required. It is also thought that plastic bags used to pack taro shipped to Australia are also a contributing factor (Figures 4 and 10).

Produce Processing Ltd is Fiji's longest standing taro exporting company. A decade of exporting records of the company were examined as a part of this study. Over this period there were no rejections, or even interceptions, due to the detection of rots or disease. It is significant that Produce Processing is no longer willing to export taro to Australia, as the risks are assessed as too high. The reason for this is "the high risk involved due to Australia's devitalisation requirement".[31]

Figure 10: Devitalised taro ready for air freighting to Australia

Figure 11: Taro ready for shipment to New Zealand with the eyes and tops in tact

PROTOCOL COST AND CONSEQUENCES

MAF INSPECTION COSTS

Costs and fees associated with NZ MAF inspection activities are applied under the Biosecurity Cost Regulations. The Biosecurity Cost Regulations have been under review and were changed on 1 July 2010. This will mean that the current costs are likely to increase as the changes are implemented at the front line. The costs of MAF BNZs border inspections are set through the Biosecurity Cost Regulations and implemented by way of an hourly charge. The actual costs for the selection and inspection of a 600 unit sample from each consignment of taro from Fiji are reasonably predictable and consistent. Although there are some variables associated with each inspection, the average cost per inspection can be established at $300-$350 per consignment. Kevin Nalder indicates that NZ MAF are looking at systems for applying reduced inspection frequencies for import pathways with a demonstrable history of compliance and increased interventions (and therefore costs) for non-complying import pathways. This will have an impact on taro exports from Fiji in the future.

[31] pers. comm. Arthur Mar Managing Director Produce Processing Ltd.

DIAGNOSTIC COSTS PER CONSIGNMENT

There are currently two service providers offering border diagnostics (viz. MAF Diagnostic Laboratory and AsureQuality). The fees differ depending on the nature of each submission and any commercial arrangements that may apply between the service provider and the importer concerned. Given the wide range of organisms that are commonly found on Fiji taro, and the different cost structures for each of the service providers, it is difficult to get a firm diagnostic costing that can be accurately assigned on a per consignment basis. The range can be from zero (i.e. nil interceptions) to $1,000+ for a heavily infested consignment with multiple pest species associated. It is worth noting that interceptions of nematodes are now not routinely sent for laboratory analysis – with exporters opting for fumigation rather than incur the identification cost. If this policy changes, then the compliance costs will clearly increase.

FUMIGATION

The direct costs for fumigation in New Zealand are around $NZ180-220 per container. The indirect costs associated with the fumigation are probably more significant but difficult to quantity. For example, the loss of quality and reduced shelf life are more "costly" in terms of flow-on impacts. Given the current near 100% fumigation regime, any reduction would result insignificant direct and indirect savings (possibly in the range of $NZ400 - 500 per container). Produce Processing Ltd budgets $2.50 per bag (30kgs) of taro shipped to New Zealand to cover the average cost of inspection, diagnostics and fumigation.

UNITED STATES [32]

A REGULATORY OVERVIEW OF THE IMPORTATION OF TARO (DASHEEN [33]) INTO THE UNITED STATES [34]

The United States Department of Agricultures' Animal and Plant Health Inspection Service (USDA-APHIS approves the importation of three genera of taro into the USA: *Colocasia* spp., *Alocasia* spp., and *Xanthosoma* spp. The universal APHIS term for taro is dasheen. There are 70 countries approved to export taro corms to the United States. These are largely made up of countries from the Caribbean region, Central America and the Pacific Islands. There are no specific quarantine treatments specified for taro by USDA-APHIS. However, taro imports are subject to inspection at the port of entry and must comply with all general requirements for imported fruit and vegetables under the Code of Federal Regulations (7 CFR 319.56-3).[35]

With the exception of Mexico and Thailand, only Caribbean countries are approved to export taro leaf, as well as corm to the USA. The remaining countries on the approved list for the importation of taro (including Fiji, Samoa and the other Pacific Island countries listed) can only supply corm.

Taro imports to the USA from the Dominican Republic are subject to reduced inspection rates under the protocol of the National Agriculture Release Program (NARP).[36] NARP was introduced in January 2007, as an extension of the Border Cargo Release (BCR) program, which was established to expedite the entry of high-volume, low-risk commodities entering the USA from Mexico. NARP expands the BCR program to include some agricultural commodities from other foreign countries, as well as Mexico. The Dominican Republic is the only country with NARP-approval to import dasheen to the USA.[37]

[32] See annex 4 for the detailed report prepared by Dr John (Jack) Armstrong

[33] "Dasheen" and "taro" can be used interchangeably in common usage. USDA-APHIS usually uses "dasheen," instead of "taro," but infrequently also uses "taro," probably reflecting different writers of import regulations over time. "Dasheen" is used uniformly throughout this section.

[34] This sections draws heavily on the inputs of Dr John (Jack) W. Armstrong and Amanda Hamilton.

[35] Federal Regulation (7CFR 319.56-3) available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=446e2e3a8627eeda6f4802db874c91dc&tpl=/ecfrbrowse/Title07/7cfr319_main_02.tpl

[36] APHIS 2010

[37] USA-Customs and Border Protection (CBP) 2010

APHIS conducts a commodity pre-clearance inspection program[38] in Jamaica, which covers 31 commodities, including taro. Pre-clearance inspection activities conducted in Jamaica by APHIS officials help to expedite the importation of agricultural commodities into the USA. Table 26 summarises APHIS inspection procedures for fresh taro imports and possible treatment options. This applies to taro imports from the Caribbean region and all other APHIS approved countries (including PICs).

TABLE 26: USDA APHIS INSPECTION PROCEDURES FOR FRESH TARO IMPORTS

Quarantine Issue	Details	Likely Treatments
Soil	presence of soil on corms	• rejected and re-exported • fumigated with methyl bromidea
Insects (Internal/External)	covers dasheen pests and 'hitch-hikers' detected either in/on corms, leaves or stem	• low risk quarantine pests – fumigated with methyl bromideb,c • high risk quarantine pests – destroyed or rejected/re-exported • non-quarantine pests – released
Plant disease	covers pathological & physiological diseases of corms, leaves or stems	• dasheen mosaic virusc – released or fumigated with methyl bromide • other non-quarantine diseases - released • **corm rots – rejected if deemed unmarket able**

Source: USDA-APHIS, pers. comm., courtesy of Jack Armstrong

a Treatment for corms - 64 g/m3 (4 lbs) MB per 93m3 (1,000ft3) for 4 hours at 4.44°C (40°F) or above.

b Treatment for leaves/stem - 64 g/m3 (4 lbs) MB per 93m3 (1,000ft3) for 2 hours at 4.44°C (40°F) or above.

c The only dasheen-related disease of concern to the USA is Dasheen mosaic virus, which affects stems/leaves, not corms. Fumigation with methyl bromide is likely to be the prescribed treatment rather than destruction or rejection, as the virus seems only to be prohibited if found on ornamental Aroids, not dasheen leaf/stem imported for consumption.

Comments on inspector's discretion

All decisions for rejection/return, treatment and release, or release without action are made by the individual inspector(s) who use their own judgment based on a number of factors and issues. For example, if the inspector finds a major actionable quarantine pest in a shipment of one box of dasheen, the shipment can be released after the box is inspected and no more of that pest is found. However, the same pest found in a shipment too large to inspect all of the dasheen can result in rejection/return or fumigation. Dr Jack Armstrong notes that some of the key issues inspectors may consider include (but are not limited to):

- Is the interception an actionable pest? (i.e rejection/return or fumigation is the only action that can be taken regardless of circumstances).
- Is the interception a general agricultural pest, a taro pest, or an obvious hitchhiker? (e.g., a single actionable pest found in a shipment that obviously does not belong with dasheen and all the dasheen can be inspected)
- How many of the pests were found in the shipment?
- How big is the shipment? - Can the entire shipment be inspected?
- What is the past experience with the specific pest interception?
- What is the risk of introduction?
- Can the issue be ameliorated on site? - e.g., can a lump of dirt be removed and incinerated?
- What is the history of interceptions for that exporter?

[38] APHIS 2010b. APHIS preclearance programs enable foreign countries to conduct offshore agricultural commodity preclearance inspections, treatments and/or mitigation measures, under the direct supervision of APHIS personnel, in accordance with APHIS phytosanitary procedures.

TARO PEST INTERCEPTIONS

10 years (2000-10) of inspection data for USDA APHIS PPQ for taro imports of all types [39] into the United States from all sources revealed a total of 1,567 pests were intercepted (see annex 3 for a complete listing of these interceptions). Of the total number of interceptions, 519 were classified as actionable involving 69 individual pests [40] (table 27). The remainder are classified as non-reportable interceptions and were duly released into marketing channels without further action. This represents an exceptionally low level of quarantine interceptions, considering that during the period under review nearly 500,000 tonnes of taro was imported into the United States, which would have been carried on some 40,000 sea freight containers.

The most common pests requiring quarantine action (fumigation) were weevils (90) and mealy bugs (88). In total, over a 10 year period there were only 17 disease interceptions with *Colocasia* taro shipments to the USA. Of these, six were actionable (Table 28). The most frequent disease interception was anthracnose (*Colletotrichum gloeosporioides*) found on taro leaves, which was not actionable. The rarity of taro disease interception in the USA is in marked contrast to the situation that has been prevailing for Fiji's taro exports to Australia. The United States nematode interceptions on taro is also revealing, considering the current problems faced with Pacific Island taro with respect to nematodes on exports to New Zealand. Over the 10 year period, there was only 7 nematode pest interceptions of which only 2 were considered actionable pests (table 29).

TABLE 27: USDA APHIS PPO INTERCEPTIONS OF ACTIONABLE PESTS ASSOCIATED WITH *COLOCASIA* TARO CORMS, 2000 TO 2010*

Actionable quarantine pest	# of interceptions
Acrolophidae: *Acrolophus sp.* (species of grass tube worms)	1
Agromyzidae: Family of leaf miner flies	2
Anthocoridae: Family of flower bugs, minute plant bugs	2
Aphididae: *Aphis sp* . (species of bean aphids)	2
Brentidae: *Cylas sp* . (species of sweetpotato weevils)	2
Cecidomyiidae: Family of gall midges or gall gnats	18
Chrysomelidae: Alticinae (Subfamily of flea beetles)	4
Chrysomelidae: Family of leaf and flea beetles	3
Cicadellidae: Typhlocybinae (Subfamily of sharpshooters)	1
Cicadidae: Family of cicadas	1
Coreidae: Family of leaf-footed bugs	1
Crambidae: *Cacographis osteolalis* (NCN; a species of pyralid moth)	1
Crambidae: Family of grass moths	4
Curculionidae: *Anchonus sp.* (NCN; species of cucurlionid weevils)	3
Curculionidae: Cyclominae (Subfamily of curculionid weevils)	1
Curculionidae: Family of weevils	83
Curculionidae: *Faustinus sp.* (tomato weevil)	1
Curculionidae: Molytinae (Subfamily of flightless weevils)	10
Cydnidae: *Dallasiellus alutaceus* (NCN; a species of burrowing bug)	1
Dryophthoridae: *Metamasius sp* . (species of palm and cane weevils)	4
Elateridae: *Aeolus sp.* (NCN; species of click beetles)	3
Elateridae: *Conoderus sp* . (species of click beetles and wireworms)	3
Elateridae: *Dipropus sp.* (species of clickbeetles)	2
Elateridae: Family of click beetles and wireworms	2
Formicidae: *Pheidole sp.* (NCN; species of ants)	2
Gryllidae: *Amphiacusta caraibea* (NCN; a species of cricket)	1
Gryllidae: *Anaxipha sp.* (species of trig crickets)	4
Gryllidae: *Argizala sp.* (NCN; species of crickets)	1
Gryllidae: *Miogryllus sp* . (NCN; species of crickets)	9
Gryllidae: *Pteronemobius sp* . (species of field cricket)	1
Hymenoptera: Order of bees, wasps, yellowjackets, hornets, bumblebees, ants	2
Lepidoptera: Order of butterflies, moths, and skippers	23

[39] Dasheen species on which interceptions occurred:
Alocasia cucullata
Alocasia macrorrhizos
Alocasia species (the *Alocasia* was not identified to the specific or varietal levels)
Colocasia esculenta
Colocasia esculentum var. *antiquorum*
Colocasia species (the *Colocasia* was not identified to specific or varietal levels)
Xanthosoma brasiliense
Xanthosoma hastifolium
Xanthosoma sagittifolium
Xanthosoma violaceum

[40] Checking the records at each port of entry is the only source of information of what, if any, action was taken. It is assumed, however, that fumigation is the action taken for insects.

Lygaeidae: Family of lygaeid bugs, seed bugs, chinch bugs	3
Lygaeidae: *Ochrostomus puchellus* (NCN; a species of seed bug)	1
Margarodidae: Family of cottony cushion scales	2
Meloidae: *Epicauta sp.* (NCN; species of blister beetles)	1
Miridae: *Eurychilella sp.* (species of plant bugs)	10
Noctuidae: *Copitarsia sp.* (species of cutworm moths)	1
Noctuidae: *Plusiinae sp.* (species of semi-loopers and measuring [inch] worms)	2
Pemphigidae: *Patchiella reamuri* (NCN; a species of gall-forming aphid)	1
Pentatomidae: *Euschistus sp.* (species of brown shieldbugs [brown stinkbugs])	1
Pseudococcidae: Family of mealybugs	88
Psyllidae: *Diaphorina citri* (Asian citrus psillid)	1
Pyralidae: Family of bee moths, snout moths, corn borers, flour moths, cactus moths, etc	10
Rhinotermitidae: Family of subterranean termites	1
Rhyparochromidae: *Heraeus sp.* (species of dirt-colored seed bugs)	2
Rhyparochromidae: *Myodocha sp.* (NCN; species of dirt-colored seed bugs)	2
Scarabaeidae: *Cyclocephala sp.* (rhinoceros beetle)	21
Scarabeidae: Dynastinae (Subfamily of rhinoceros beetles)	3
Scarabeidae: *Dyscinetus sp.* (species of dung or leaf chafer beetles)	8
Scarabeidae: Melononthinae (Subfamily of scarab beetles [grass grubs])	2
Scarabeidae: Rutelinae (Subfamily of leaf chafer beetles)	1
Scarabeidae: *Stenocrates sp.* (NCN; speceis of scarab beetles)	2
Scarabeidae: *Strategus sp.* (species of ox beetles)	1
Scarabeidae: *Pyllophaga sp.* (species of June beetles [June bugs])	7
Scarabidae: *Tomarus sp.* (species of sugarcane and other root grubs)	6
Syrphidae: *Copestylum sp.* (species of flower flies)	1
Tenebrionidae: *Blapstinus sp.* (species of darkling ground beetle)	21
Termitidae: *Nasutitermes ephrata* (NCN; a species of termite)	2
Tineidae: *Opogona sp.* (species of tineid moths)	4
Tipulidae: Family of crane flies	3
Tortricidae: Family of tortrix moths	7
Zygaenidae: Family of smokey moths	1
Tetranychidae: *Tetranychus sp.* (spider mites)	18
Anguinidae: *Ditylenchus sp.* (species of stem and bulb nematodes)	1
Ampullariidae: *Pomacea sp.* (species of apple snails)	2
Veronicellidae: *Veronicella cubensis* (Cuban slug)	13
Poaceae: *Rottboellia cochinchinensis* (itchgrass, corngrass)	2
Total number of specific pests	**69**
Total number of interceptions	**519**

* NCN = common name not known

TABLE 28: DISEASE INTERCEPTIONS WITH *COLOCASIA* TARO SHIPMENTS TO THE UNITED STATES, 2000 – 2010.

Part ofplant*	Disease intercepted	Frequency	Actionable (Y/N)
C, L, P/C	Ceratocystidaceae: *Ceratocystis fimbriata* (black rot, moldy rot)	4	N
L	Coelomycetes: *Camarosporium sp.* (NCN; species of endophytic fungi causing shoot and panicle blights)	1	Y
L, P/C	Coelomycetes: *Colletotrichum gloeosporioides* (anthracnose)	5	N
L	Coelomycetes: *Phoma sp.* (species of endophytic fungi causing leaf spot, fruit spot, fruit rot)	1	Y
L	Hypomycetes: *Cercospora sp.* (species of endophytic fungi causing leaf spots and plant rots)	1	Y
P/C	Hypomycetes: *Fusarium sp.* (species of endophytic fungi causing blights)	2	Y
P/C	Mycosphaerellaceae: *Mycosphaerella sp.* (species of endophytic fungi causing leaf spot diseases)	1	Y
L	Pythiaceae: *Phytophthora colocasiae* (taro leaf blight)	1	N
L	Ramalinaceae: Family of lichenized ascomycets (sac fungi)	1	N
		17	

* code: C-corm; F=flower;L=leaf;S=steam;P/C = plant/cargo - no plant part was identified likely to be "hitch-hicker" pest.

EXPORTER COMPLIANCE WITH USDA APHIS REQUIREMENTS

USDA-APHIS Plant Protection and Quarantine requirements for the importation of fresh taro into the USA are not considered to be overly onerous by Caribbean exporters.[41]

The vast majority of fresh taro imports from the Caribbean are inspected at the USA entry port and then released, with only very small volumes intercepted for quarantine pest concerns. Table 30 provides a general summary of APHIS interceptions of fresh taro imported from the major Caribbean taro exporters in 2009.[42] For the Dominican Republic, the most significant fresh taro exporter in the region, only 3% of the total volume imported was intercepted, mostly for insect pests. If these were regulated pests, the consignment is then fumigated and then released. Only 1% of taro imported from Jamaica was intercepted (leaf only), also due to insect pests. There were no interceptions of taro imports from St. Vincent & the Grenadines, Dominica and St. Lucia.

Pacific Island taro exporters to USA share the same experience. For the two years 2008-09, Fiji's Quarantine Inspection Service (FQIS) records show 1,645 tonnes of taro shipped to the USA Mainland and 279 tonnes shipped to Hawaii. This represents around 190 sea freight containers. Official records indicate no interceptions over this period. The major constraints in shipping to the United States relate to the long voyage time involved (Suva to Los Angeles is around 12 to 13 days). This long travel period has been compounded more recently by the additional time required to clear containers due to security regulations. It now takes up to a week to clear sea freight containers at West Coast ports.[43] The re-export of taro shipped to the USA from the Caribbean or the Pacific Islands is a rare event. FIQS has no record of such an occurrence.

TABLE 30: APHIS PORT ENTRY INTERCEPTIONS OF FRESH TARO FROM MAJOR CARIBBEAN TARO EXPORTERS (2009)

Country	Total Volume Imported (MT)	% Intercepted	Reason for Interception
Dominican Republic	4,153	3% a	Insects (80%) Disease (20%)
Jamaica	474	1% b	Insects (100%)
St. Vincent & the Grenadines	93	0%	-
Dominica	57	0%	-
St. Lucia	8	0%	-

Source: USITC (2010), USDA pers. comm.
a Interceptions of corm and leaf - *Colocasia esculenta*, *Xanthosoma* sp. and *Alocasia* sp.
b Interceptions of leaf - *Xanthosoma* sp.

The excellent phytosanitary record of Caribbean exporters in shipping to the United States can also be attributed to improved product handling. In 2000, in an effort to increase the quality of taro corms produced for export from the Organization of Eastern Caribbean States (OECS), export specifications were developed and published to guide farmers in meeting phytosanitary requirements for corms in the USA and UK markets. These specifications have been largely applied by exporters in most CARIFORUM member countries (Greg Robin, pers. comm.).OECS export crop specifications for the USA market are presented in Table 31. It is particularly notable that the 'top tailing' required for Pacific Islands taro to export to Australia would represent a major violation of the trimming standard set by Caribbean exporters – **'Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh'.**

[41] Greg Robin, pers. comm.
[42] The regulated pests that were intercepted have been confined to scarab beetle (species of Scarabaeidae), bark beetle (*Xyleborus* sp. Scolytidae), and mealy bug (species of *Pseudococcidae*; and the disease fugal corm rot (*Ceratocystis Fimbriata*)
[43] Per comm., Arthur Mar, Produce Processing.

Table 31: OECS Dashen Specifications for the USA market

Variety:	White dasheen
Cleanliness:	Washed clean
Appearance:	Cylindrical in shape
Corm Flesh:	White
Maturity:	Corms should be seven months old
Trimming:	**Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh**
Packaging:	Pack in nylon, mesh bags. Bags must have air holes and should contain 25 kg (50 lbs)a
Sizing:	Minimum corm weight – 1.2 kg (3 lb) Maximum corm weight – 3.0 kg (6 lb)
Decay:	No surface mould or corm softening is allowed
Damage:	No conditions specified
Port-harvest Treatment:	No post-harvest treatments should be applied

Source: Robin, G. (2000)

a Some exporters also package taro corms in 18kg (40lb) cartons, with a plastic liner (Jethro Greene, pers. comm.).

b While it is recommended that no post-harvest treatments be applied, some exporters treat taro corms with Ridomil to prevent fungal attacks (Greg Robin, pers. comm.). Ridomil is not classified as a restricted use pesticide in the USA, but is no longer actively registered by the USA-Environmental Protection Agency for use within the USA (PAN 2010).

JAPAN

A REGULATORY OVERVIEW OF THE IMPORTATION OF TARO INTO JAPAN

The exporters of fresh taro to Japan are required to provide a phytosanitary certificate stating that the produce is free from soil and insects. This also requires a special declaration that the crop was inspected during the growing season by approved officers and found to be free from burrowing nematode (*Radopholus similis*)and have been inspected for the presence of *R. similis* during the growing season, and that the soil in which they are grown has been inspected for the presence of *R. similis*.

TONGA'S EXPERIENCE IN EXPORTING TARO TO JAPAN

China is by far the largest source of sato-imo (*Colocasia esculentum* var. *antiquorum*) imports into Japan. Both Australia and Tonga also export small volumes of this small corm taro to Japan.

In 2004, Tongan company Tinopai (through its subsidiary company Lau Lava Ltd) began commercial exports of fresh sato-imo to Japan and continues to export an average of 4.5 tonnes annually. Tinopai targets the off-season market (May to July). The taro is packed in nylon netting sacks of 10kg each and shipped by sea in 20-foot refrigerated containers.

Japan Quarantine requirements are for all taro (including sato-imo) imports to be free from soil and insects plus certification that the taro was grown in an area free from the burrowing nematode (*R. similis*). Japan Quarantine does not require taro to be topped and does not differentiate between different varieties of taro.

Tinopai experienced only one interception by the Japanese quarantine authorities. This occurred in first trial shipment in 2004. At the request of the Japanese importer, Tinopai shipped Sato-imo in cardboard cartons. Despite chilling, the long shipping time from Tonga to Japan (5 weeks with transhipping) resulted in mould and rot had appearing on the taro when it arrived in Japan. After interception, Japanese Quarantine cleared the shipment subject to removal of the mouldy/rotten taro by the importer. Tinopai subsequently switched from cartons to nylon netting sacks and there were no further mould problems or interceptions.

6.1.2 A REVIEW OF THE JUSTIFICATION OF CURRENT TARO IMPORT PROTOCOLS AND THEIR APPLICATION

AUSTRALIA

Daniels (2004) lists the particular quarantine concerns to the Australian taro industry to be the threat of taro leaf blight, taro beetle and exotic virus diseases entering Australia via insufficient enforcement of AQIS guidelines for the import of taro corms for sale /consumption. Daniels reports that growers and Queensland Department of Primary Industry staff that visited Brisbane, Sydney and Melbourne markets in April-May 2003 "found evidence of shipments being contaminated with soil and the corms having viable 'eyes' that could be propagated from".

In response to these industry concerns, Australia has in place severe quarantine protocol requirements based on devitalization and prohibition:

- Devitalization (can't be propagated) of Pacific Island large corm taro (*Colocasia esculenta*)
- Prohibition of the importation of small corm taro (*Colocasia esculenta* var. *antiquorum*)

No other taro importing country has found it necessary to include either of these requirements in their taro import protocol. These importers include the United States (including Hawaii) and Japan, who have significantly larger taro industries than Australia.

The consequences of this import protocol for Pacific Island exporters are:

- Higher reject rates due to the secondary impact of corm rots induced by the physical damage inflicted by devitalization;
- Reduced product quality and shelf life;
- Substantially lower cost sea freighting is not feasible due to reduced shelf life and;
- No prospect of developing a niche market for small corm taro.

Overall, the devitalisation protocol makes the export of taro to Australia a marginal and highly-risky business with little prospect of expansion.

JUSTIFICATION FOR DEVITALISATION

The reason for devitalisation is to substantially reduce the probability of imported taro being propagated and thereby introduce diseases such as taro leaf blight and damaging viruses.

ISSUES AND QUESTIONS

- The justification for the Australian taro devitalisation requirement, when this is not required by other countries that import Pacific Islands taro and have more significant domestic industries.
- The justification for devitalisation of taro from Fiji as a measure to stop the spread of potentially damaging virus, considering:
  - **a** Fiji does not have the serious viruses of concern (alomae/bobone virus complex– these viruses have only been recorded in PNG and the Solomon Islands)
  - **b** The Pacific Islands, including Fiji have been subject to extensive recent disease surveys under the auspices of ACIAR.
  - **c** The Australian taro producing areas have not been subject to such intensive disease surveys
  - **d** Dasheen mosaic virus (DsMV) while present in Fiji and other Pacific Islands is widespread in Australia.
- The justification for devitalisation of taro from Fiji as a measure to stop the spread of taro leaf blight, considering:
  - **a** *Phytophthora colocasia*e, mainly a foliar pathogen, is less likely to be spread through infected corms. Currently there is no concrete evidence that TLB is spread through infected corms, particularly given that exported corms are washed free of soil and debris.[44]
  - **b** More research is required to determine how taro leaf blight is spread.
  - **c** Taro leaf blight (TLB) is not recorded in Fiji– in the Pacific Islands, TLB is only recorded in PNG; Samoa; and the Solomon Islands
  - **d** The Pacific Islands, including Fiji, have been subject to extensive TLB surveys. The Australian taro producing areas have not been subject to such intensive surveys.
- The efficacy of the current devitalisation procedures in terms of propagation, considering it is technically difficult to propagate taro corms even if the eyes are not removed. Taro can be propagated vegetatively by splitting and producing minisetts for planting. The split corms need to be treated with wood ash or air dried to reduce moisture in sterile environments and placed in nurseries for propagation (Tom Okpul, pers comm.). However this requires skilled personal and the suitable environment for propagation (Tom Okpul, Taro Breeder, PNG University of Technology, pers comm.)[45] Whole corms need to treated, as improper handling can cause rot causing organisms such as *Pythium* and *Erwinia* which will infect the minisetts.
- The role devitalization plays in the high incidence of corm rots experienced with Fiji taro imported into Australia. New Zealand and the United States experience significantly lower incidence of rots when the same taro is shipped by the same exporters. The only apparent difference is devitalization.
- The scientific justification for the specific ban on *Colocasia esculenta* var. *antiquorum*. Is there a demonstrable difference between *Colocasia esculenta* (large corm taro) and *Colocasia esculenta* var. *antiquorum* (small corm taro) in terms of propagation and the impact of devitalisation?

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[44] This conclusion is based on discussions with Graeme Jackson, Robert Fullerton (Landcare Research, NZ) and Tony Gunua (plant pathologist SPC).

[45] Losalini Toganivalu, (Principal Research Officer Fiji Ministry of Agriculture), reports that experiments conducted of the propagation of taro from eyes enjoyed no success.

- The justification for the proposition that taro purchased in Melbourne and Sydney by Pacific Islanders would find its way to the taro growing areas of far North Queensland, where it would be successfully propagated. The likelihood of such an event would seem to be exceptionally low. Thus why does a blanket devitalisation protocol apply to taro, regardless of port of entry?

It is recommended that Fiji be considered a pest free/low pest prevalence area for taro given that the country is free of TLB and the major viral diseases 'Alomae' and 'Bobone' complex. This should also apply to other PICs such as Samoa and Vanuatu. Such a status would be in keeping with WTO International Phytosanitary Standards (ISPM) Nos.4, 8, 22 and 29 (Annex 6). Fiji and other taro exporting countries would need to officially request Biosecurity Australia for such consideration.

NEW ZEALAND

Pacific Island taro imports into New Zealand are not subject to the same devitalisation requirements as imports into Australia. Thus taro exports to New Zealand do not face the same degree of barrier to entry, as they do for Australia. However, exporters to New Zealand do face almost a 100% fumigation regime, which significantly increases marketing cost and reduces product quality. These fumigations are largely the result of the interception of nematodes.

JUSTIFICATION FOR FUMIGATION

Nematodes will invariably be found on root crop tubers regardless of how well they are cleaned. The vast majority of nematodes discovered on Pacific taro pose no danger to New Zealand agriculture. The burrowing nematode, Radopholus similis, a nematode of particular quarantine concern is not reported on Pacific Island taro (Carmichael, et.al 2008). However, nematodes subject to fumigation are currently classified together as a regulated pest. Until recently, this was also the case with the tropical mite (*R. minutes*), which was classified as a regulated pest and subject to mandatory fumigation. As the result of a concerted applied research effort, the tropical taro mite has now been reclassified as a non-regulated pest and not subject to mandatory fumigation. Fiji, in collaboration with the New Zealand importers, mounted a successful case-for- change with respect to the taro mite. The same approach now needs to be applied to nematodes. The intercepted nematodes associated with Fiji taro need to be identified, and if proven to be of low or no risk they should re-categorised as a non regulated pest, not requiring fumigation. Research resources need to be devoted to this purpose.

07 PROSPECTS FOR EXPANDING TARO EXPORTS IF QUARANTINE PROTOCOLS WERE REFORMED AND PATHWAYS IMPROVED

The main markets for Pacific Island taro are New Zealand and Australia. The competitiveness of this taro in these markets is significantly reduced by:

- The quarantine protocols; and,
- The production and marketing pathways that are currently in place.

A reform of the export protocols and improvements in the production and marketing pathway would lay the foundation for a substantial expansion exports to these markets.

7.1 SCOPE FOR EXPANDING NEW ZEALAND'S TARO CONSUMPTION AND MARKETS

Per capita consumption of taro amongst Pacific Islanders living in New Zealand is only around 20 kilograms per annum; a fraction of the consumption levels in Samoa and even Fiji. If taro consumption was doubled, per capita consumption would still be less than a modest 1 kilogram per week. Despite a strong cultural preference for taro there has been no market expansion over the past five years. Per capita consumption has fallen significantly especially when the high growth rate of the Pacific Island population is taken into account (15% over the period 2001 to 2006). The lack of growth in taro consumption can be explained by the relatively low incomes of Pacific Islanders as a group, the exceptionally high price of taro relative to other starch sources (potatoes, rice, and wheat flour), and the generally poor quality of the taro available. Excessive fumigation requirements contributes to the high prices and poor quality of taro sold in New Zealand. It is estimated that current inspection, diagnostics and fumigation adds an average $2.50 to $3 per 30 kg bag of taro exported. To this has to be added the cost of reduction in shelf life due to fumigation and resultant declining quality and acceptance.

However, the cost savings from a substantial reduction in the frequency of New Zealand fumigation is probably not sufficient to make a major impact on the competitiveness of Pacific Island taro. The gains from quarantine protocol reforms would have to be supplemented by improvements in the efficiency of the export industries themselves. For the Fiji industry, and Taveuni in particular, this involves:

- The restoration of land productivity – to improve yields and corm size
- Better handling to reduce corm bruising and damage and improve keeping quality
- Improved packing to reduce damage and post harvest diseases
- Improvements in the cool/cold chain by expansion of Taveuni's electricity grid.

7.2 SCOPE FOR EXPANDING THE AUSTRALIAN TARO MARKET

There are three main reasons for Pacific Island taro imports into Australia being around half that of New Zealand. Australia has:

1. A much smaller Pacific Islander, and in particular Samoan, population;
2. Its own domestic taro industry; and,
3. Highly restrictive quarantine treatment on imported taro – which substantially increases price and decreases quality.

Reform of the quarantine protocol would have a substantial impact on the competiveness of fresh Fijian taro sold in Australia. The increase in perishability due to devitalisation precludes sea freighting taro to Australia as a realistic marketing option. Airfreight increases the cost of freight by some FJD 1.25/kg, which is more than the farm gate price for taro. To this has to be added other costs associated with devitalisation:

- Loss of product (10 to 15% of the product is removed in the "top & tailing" process)
- Increased labour costs incurred in devitalisation
- Substantial reduction in shelf life
- The high cost of "re-exporting" when a consignment is rejected due to rots and disease.

When all these factors are taken into account, the additional cost due to the devitalisation protocol is estimated to be in the vicinity of FJD 3/kg. Thus a reform of Australia's quarantine protocol for the importation of Fiji taro would in itself lead to a large increase in the competitiveness of imported Fijian taro. These gains would be further enhanced by improvements in the efficiency of the Fiji industry as recommended above.

08 SOME PROPOSED IMPROVEMENTS IN THE TARO PRODUCTION AND MARKETING PATHWAYS

Reform of the taro export protocols for Australia and New Zealand is a necessary requirement for a substantial expansion in PIC taro exports. However, if the PIC taro export industries are to take full advantage of any protocol reforms, major improvements are also required in the taro production and marketing pathway.

8.1 THE CURRENT TARO PATHWAY

The FACT Project's Sanfred Smith, a long time Taveuni based agricultural officer, describes the current marketing chain for export taro (pers. com. June 24th 2010)

- Farmers pull out the taro, throw into piles, clean them and shove into bags trying to get the maximum of 25-30 corms into a bag.[46] Then this is basically man handled by throwing the bags onto pickup trucks which travel down car killing roads to the processing shed (middle buyer-MB).
- At the MB's shed the taro is unpacked by lifting the bottom end of the bag and strewn onto the floor, this operation itself takes only about 5 seconds.
- Then the taro is graded and repacked. Then it is loaded onto the waiting truck if there is a boat on the day other otherwise the taro may stand there for a day or two. After loading the truck travels to the boat and then spends approximately another 12-14hrs on a Roll on Roll off ferry en-route to Suva.
- Once in Suva the truck goes to the exporters shed for processing. There are about 300 50-60kg bags per truck. Once the taro gets to the exporters shed, it is unloaded onto concrete floors after being stacked on each other for the previous 18-20 hrs or so. The number of labourers range between 5-12 to unload, and these workers try to complete the unloading quickly, at the direction of barking supervisors.
- The taro is then processed manually and washed in a tumble washer type machine (several exporters have this machine). Then once ready it is re-packed again into clean bags and packed into refer containers...again in the container the taro bags are slammed onto the container floor and of each other trying to fit in 13 tonnes.

  The Report 'Fiji Agricultural Marketing: A Policy Framework' also discusses the inadequacies of the Taveuni taro pathway
- The poor keeping quality of Taveuni taro is in part due to the inherent nature of Taveuni soils. However, there are controllable factors that seriously impinge on the shelf-life and quality. It can take up to three days from the time Taveuni taro is harvested before it reaches an exporters cooler in Suva. The taro may have been rolled down a hill in a polybag and loaded on a horse and taken to the side of the road to await collection, where it might wait hours exposed to the elements. It will then be taken, often on a rough road, to a packing shed (no cooler) to be prepared for shipment to Suva. It will be loaded on truck 10 bags high for shipment to Suva. The uncovered truck may be required to wait hours at the wharf before it is loaded on the vessel. Thus, there is little wonder that there are complaints from the market on the keeping quality of Taveuni taro (McGregor and Gonemaituba 2002 p, 29).

Figure 12: Maximum taro stuffed into a bag

Figure 13: Taveuni taro being prepared for shipment for transhipment to Suva

Figure 14: Over-packed bags carted by horse

Figure 15: Taro bags packed 10 high for transport to Suva

The same Marketing Policy Framework Report also lists the following inadequacies of marketing infrastructure for taro (p, 9):

- Poor access roading to most root crop growing areas – resulting in increased costs and poor handling.
- No handling facilities at Taveuni wharf.
- No basic shelters for farmers to hold root crops awaiting collection.
- Fiji Electricity Authority (FEA) power on Taveuni - uneconomic to run coolers for holding taro prior to shipment to Suva.
- Inadequate port facilities in Savusavu preclude direct shipping from Vanua Levu to export markets – substantially increases the cost of exporting from Vanua Levu.

[46] Freight charges are set at rates per bag providing an incentive to cram as many corms as possible into the bag.

Commercial taro producers in other PICs face a similar set of handling issues, which can be compounded if they don't have Fiji's advantage of 'roll on – roll off' shipping. Vanuatu based root crop scientist, Vincent Lebot, notes "The problem with the high cost of taro in Vanuatu and in the PICs is the poor handling between the field and the market place. In Vanuatu corms are placed in bags before shipping and this results in up to 30% of damage, sometimes more (especially from Pentecost) and the result is an increased price demanded by the growers. If we could supply some sort of boxes (in light wood?) where the corms would be placed in a vertical position, in the field before transport, this would reduce the damage and the farmer could reduce his price" (pers. comm. Vincent Lebot).

8.2 RECOMMENDATIONS FOR PATHWAY IMPROVEMENTS

Exporters are aware of the current interceptions and taking measures to improve on handling. Exporters are collaborating with quarantine officials to improve processing and handling in an effort to reduce rejection rates. Having examined the current taro export pathway, resources should be allocated to improve the export market pathway. The current ACIAR SRA 2008/029 study 'Cleaner export pathways for Pacific crops – Definition of quarantine environment for targeted commodities' identified short term and long term inputs to improve the export pathway. The researchable issues discussed in Section 9 are longer term while in the short term there is an urgent need for training and awareness amongst stakeholders especially farmers, buyers and buying agents, transport providers, exporters, agricultural extension officers and quarantine inspectors. The ACIAR SRA makes a number of recommendations for improving Fiji taro production and marketing pathways. These are in the areas of:

- Training of taro farmers, buyers, buying agents, transporters, pack house workers and quarantine staff. When interviewed these stakeholders stressed that they have not received any training in proper taro handling, quality and grading systems. It is recommended that the completion of such training be a condition for securing an export license.
- To increase corm size and yields taro needs to be grown in rotation, which includes an extended fallow period. In the commercial production areas of southern Taveuni this is often not the case. Land constraints in some locations has meant that taro is being cultivated for up to 15 years on the same piece of land or at best a fallow period of two years.[47] Green manure, longer fallow period and organic fertilizers are now being investigated to maintain and improve production and quality.[48]
- Good quality planting material. It was evident from field visits that smaller sized planting material are used regularly due to shortage of larger sized material. The taro yield is determined by size of the planting material therefore the minimum standard size stalk should be about 3-5 cms in diameter.

Figure 16: Mucuna bean incorporated into cropping systems in Tonga are being trialled on Taveuni

[47] The experience of Eric Narayan at Waimigara Southern Taveuni is typical (Pers. com. Nov 5th 2010). He owns a 5 acre free hold farm that was purchased when the large copra estate was subdivided in 1986 and started to plant Tausala taro for export in 1993. Eric is regarded as one of the best farmers in the area. He plants taro in rotation with kava, which allows for 1 ½ year fallow period for taro. For the first decade of taro operation he was able harvest 1,000 taro corms a month yielding 1.5 tonnes of which there were virtually no rejects. However, in recent years his production from 1,000 corms has fallen to ¾ tonne of which 25% are rejected due to size. He applies the full regime of recommended inorganic fertilizer.

[48] ACIAR Project in collaboration with the Department of Agriculture and the NGO Teitei Taveuni, is working on reversing the trend of declining soil productivity with crop production on Taveuni. Effort is focused around using the green manure mucuna bean together with soil amendments such as "bio brew". A farmer field school (FFF) methodology is being adopted in this applied research program.

- Information on taro standards in color illustration guides. These guides will inform farmers and buying agents on the shape, sizes and rejects which can be used for other purposes such as domestic consumption, frozen and taro chips.
- Proper handling during harvesting, grading and transportation from the farm to the exporter pack houses is required. Taro is a somewhat perishable commodity and the corms should be handled delicately to minimize corm damage. Soft rots and dry rot causing pathogenic organisms such as *Pythium* and *Erwinia* often take advantage of the damaged corms using the wounds from poor handling. Bags of taro should not be thrown onto the truck, from the horseback and when packing for transportation into bags, the corms should not be forced into the bags.
- Cool storage facilities at each pack house need to be cleaned regularly with antiseptic and temperature be maintained with minimal fluctuations. Authorized personnel only should enter these facilities ensuring hygiene of the cooling facility and the workers.
- Cool storage facilities on Taveuni await the availability of FEA power. Currently it can be up to 3 days before taro enters a cooler when it reaches Suva.
- Improved pack house conditions are necessary to minimise contamination after processing and packaging. Pack houses need to have cement floors and taro should be stored in plastic crates after cleaning and washing.[49] Trays containing washed corms should be left on benches to let the water drip dry for 15-30 minutes before packaging. Excessive moisture creates a suitable environment for pathogenic organisms. The packaging area must be cleaned regularly, preferably at the end of the day. All waste from the peelings should be removed immediately and either buried or taken away from the vicinity of the pack house.
- Fiji's existing pack house standard needs to be enforced more stringently. Exporters should be assisted to improve pack houses through having a generally cleaner environment each with cement pavements, placement of benches, and regular removal of waste from the cleaning process which should be buried far away from the pack houses. All workers should follow strict hygiene rules. The publication 'System's approach to fresh produce exports – training manual' by SPC in collaboration with Fiji MPI in 2008 should be consulted.[50] This publication offers the standard for all pack houses. It is recommended that meeting of these standards should also become a requirement for obtaining a taro export license.

There are important lessons to be learnt from the Caribbean experience in improving the quality of export taro. Export specifications were developed by Organisation of Eastern Caribbean States (OECS) to guide farmers in meeting phytosanitary requirements for corms in the USA and UK markets (Table 32). After harvesting, taro farmers are encouraged to 'out grade' corms that are undersized, double and triple headed, mechanically damaged, soft, insect damaged and diseased. At export packing houses, a second and final grading is conducted to ensure any sub-standard corms missed during field selection or damaged during the cleaning process are not packed for export (Robin and Pilgrm 2003). This is not happening in most Fiji taro packing sheds. These specifications have been published and widely distributed to farmers and exporters in CARIFORUM member countries. According to CARDI's Greg Robin, these standards are now generally undertaken by the exporters and have resulted in an improvement in export quality (pers. comm.).

[49] Plastic crates can be sourced from Natures Way Cooperative at Nadi airport.
[50] Improved communication is necessary considering the highly experience Taveuni Ministry of Agriculture Officer in Charge was not aware of such a document.

TABLE 32: ORGANISATION OF EASTERN CARIBBEAN EXPORT TARO SPECIFICATIONS FOR THE USA AND UK MARKETS

Specifications	USA Market	UK Market
Variety:	White dasheen	Any variety meeting specifications
Cleanliness:	Washed clean	Unwashed but free of soil clods
Appearance:	Cylindrical in shape	Rounded and symmetrical; no elongated or deformed corms allowed; double-headed corms allowed, but these must weigh more than 1 kg (2.5 lb). No trip or quadruple-headed corms allowed.
Grading:	No specifications listed	Mixed: 25% by weight – large corms, 50% by weight – medium corms, 25% by weight – small corms.
Corm Flesh:	White	No specifications listed
Maturity:	Corms should be seven months old	Corms should be at least six months old
Trimming:	Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh	Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh
Packaging:	Pack in nylon, mesh bags. Bags must have air holes and should contain 25 kg (50 lbs)	Pack in white, banana-type cartons with stapled base plate, pack 18kg (40lb) net, an extra 1kg (2 lb) should be placed in the carton to allow for shrinkage. Plastic liner should completely wrap the corms. Cartons should be clean and dry.
Sizing:	Minimum corm weight – 1.2 kg (3 lb) Maximum corm weight – 3.0 kg (6 lb)	Minimum corm weight – 0.5 kg (1 lb) Maximum corm weight – 4.0 kg (8 lb)
Decay:	No surface mould or corm softening is allowed	No surface mould or corm softening is allowed
Damage:	No conditions specified	Small cormel attachment scars and tail cuts are acceptable
Port-harvest Treatment:	No post-harvest treatments should be applied	Dasheen may be harvested up to 2 days before shipment date. Corms should be treated with Ridomil MZ58 (14g in 5 gallons of water for 5 seconds), within 6 hours of harvest.

Source: Robin, G. (2000)

09 IDENTIFICATION AND PRIORITISATION OF RESEARCHABLE ISSUES FOR TARO TO IMPROVE MARKET ACCESS.

Taro research priorities to improve market access are divided into two broad categories: Those relating to:

- Reform of taro quarantine import protocols
- Improvements to the taro production and marketing pathway

9.1 REFORM OF THE TARO QUARANTINE IMPORT PROTOCOLS

AusAID's Pacific Horticultural and Agricultural Market Access Program (PHAMA) is scheduled to commence implementation in January 2011. PHAMA has been designed as a structured, strategic approach for assisting PICs gain, maintain and improve access to key markets for selected high-value Pacific products. Thus it is expected that there will be a substantial pool of resources available to fund applied research activities with the purpose of facilitating market access for priority commodities. It is anticipated that taro would be one such priority commodity, with research directed at the reform of the taro import protocols for Australia and New Zealand expected to be a priority. The final prioritisation of the applied research needs to facilitate the reform of this import protocol will depend on the outcome of the taro PRA currently being undertaken by Biosecurity Australia. However, the expectation is that the PRA will recommend a continuation of the status quo with respect to the taro import protocol.[51] This Scoping Study identified a number of research priorities to facilitate the reform of taro import protocols.

9.1.1 AUSTRALIA

Identified research priorities:

- The conclusive identification of the rots and their causal agents found on taro exported to Australia.
- The transmission mechanism fungi and viruses through corms. The main biosecurity concern for Australia is that these diseases are transmitted through the corm. However, there is no reliable data or information available to verify that the taro leaf blight can be spread from taro corms that have been washed free of soil and other plant debris.
- The effect of the viruses of quarantine concern on taro yields.
- The efficacy of the current devitalisation procedures in terms of propagation. This would include determining the differences in propagability between *C. esculenta* var *esculenta* and *C.esculenta* var *antiquorum*.
- A comprehensive taro pest and disease survey for Australia.
- Quantification of the relationship between the devitalization protocol and taro rots.

9.1.2 NEW ZEALAND

Improving New Zealand import protocol reform for taro will require a series of inter-related applied research activities, including:

- Identification of the nematode species (and possibly other pests) commonly associated with taro and intercepted in New Zealand.
- An updated "pest risk profile" based on the above research.
- Risk assessment on each species to determine the regulatory status of nematodes associated with Fiji taro in a New Zealand context. This would include an assessment on their ability to enter, establish and spread (i.e. to test the hypothesis that Fiji nematode species are tropical species and could not survive in New Zealand and/or that they are saprophytic and of no quarantine concern).
- A review of the current practices for managing "hitchhiker" pests routinely intercepted in New Zealand. This would include recommendations for change (possibly working closely with exporter-importer combinations with higher levels of current compliance).
- A well thought out government to government communication strategy to ensure that National Plant Protection Organisation officials in both countries are aware of, and have ownership of, the various project streams if and when change is required.

[51] Presentation by Rob Duthie (Kalang Consultancy Services) 'Current quarantine issues in export of fresh taro and foliage to Australia' ACIAR/SPC Workshop 'Developing cleaner export pathways for Pacific Commodities – definition of quarantine environment for targeted commodities' Suva August 2nd.

9.1.3 JAPAN

To export taro to Japan requires a special declaration that the crop was inspected during the growing season by approved officers and found to be free from burrowing nematode (*R. similis*) and have been inspected for the presence of *R. similis* during the growing season, and that the soil in which they are grown has been inspected for the presence of *R. similis*. Research resources are needed to identify taro growing areas interested in exporting to Japan as being free of the burrowing nematode.

9.2 IMPROVEMENT OF THE TARO PRODUCTION AND MARKETING PATHWAY

The ACIAR SRA project No: 2008/029 is currently in the process of identifying and prioritising researchable issues on obtaining cleaner export pathways. Another ACIAR funded project is investigating soil improvement measures for taro cultivation. There is a need for a collaborative effort to identify and prioritise researchable issues on taro in the Pacific. Some identified research priorities for improving taro marketing pathway include:

- Alternative packaging and transportation from the field to the pack houses, e.g. plastic bin trays as opposed to the current polypropylene bags. This is needed to identify any suitable alternative material and methods for use as packaging and transportation of taro to minimise damage while being transported. Alternative packaging materials for airfreight consignments.
- Identifying suitable disinfectants to reduce corm rots in storage and during transportation. For instance dipping in 1% sodium hypochlorite solution is recommended, however this has not been tested after the de-eyeing and removal of tops.
- Allowing roots to dry and so 'seal' the wounds caused by divitalization procedures, as a possible means to reduce invasion by pathogens.
- Improved packhouse handling procedures.
- Improve transportation handling procedures.

BIBLIOGRAPHY

APHIS (2010) USDA-APHIS Dasheen Commodity Summary: Approved Countries, USDA. https://epermits.aphis.usda.gov/manual/index.cfm?action=commSummCountryP&COMMOD_ID=297&dspNavBar=1

APHIS (2010 b) Website: Plant Import – Preclearance Activities, USDA. http://www.aphis.usda.gov/import_export/plants/plant_imports/preclearance_activities.shtml

APHIS (2010c) Website: Regulated Plant Pest List, USDA. http://www.aphis.usda.gov/import_export/plants/plant_imports/downloads/RegulatedPestList.pdf

Author unknown (2008) Baseline Review of Non-Traditional Commodities Produced in the Caribbean ACP Countries, Report produced for the ALL ACP Agricultural Commodities Programme, December 2008.

Australian Government. Rural Industries Research and Development Corporation (RIDC) (2009). Taro Industry Development in Australia: The First Step. RIDC Publication no 09/066

Australian Centre for International Agricultural Research (ACIAR), 2008. Taro Pest: An illustrated guide to pests and diseases of taro in the South Pacific. Canberra, Australia.

Afeaki Pousima (2009). Potential for Export of Retail Packs of Frozen Root-Crops from Tonga to New Zealand: A Supply Chain Study. FAO SAPA Office. Samoa

Australian Government/Rural Industries Research and Development Hand Book (2004). 04/125.

Australian Government/Rural Industries Research and Development Corporation (2009). Taro Industry Development in Australia: The First Steps. Publication No 09/066. Project no PRJ – 0000603.

Bourke,R.M. and Harwood, T. (eds) (2009). Food and Agriculture in Papua New Guinea. ANU E Press, The Australian National University, Canberra

Caribbean Agriculture and Research Development Institute (2006) 'Reinstating Callaloo to the USDA APHIS Preclearance List in Jamaica', Information Leaflet – IPM CRSP Project (PSC# JA/015/06), Jamaica.

Daniels Jeff. (2004) Taro – Tapping the Full Potential of a Minor Australian Crop.Department of Primary Industries & Fisheries Queensland.

Carmichael, A., Harding R., Jackson G., Kumar S., Lal S.N., Masamdu R., Wright J. and Clarke A.R. 2008. TaroPest: an illustrated guide to pests and diseases of taro in the South Pacific. ACIAR Monograph No. 132, 76 pp.

Chan, E. (1994).The impact of taro leaf blight on the Samoan economy and agricultural activity. Western Samoa Farming Systems Project, Ministry of Agriculture, Forestry, Fisheries and Meteorology, Samoa. 8 pp.

Cother, E. J. and R.L. Gilbert. Presence of *Erwinia chrysanthemi* in two major river systems and their alpine sources. Journal of Applied Microbiology. Vol 69, Issue 5, pages 729-738, Nov. 1990.

Davis R.I. and Raubete T.K. (2010) Records of pathogenic viruses and virus-like agents from 22 Pacific island countries and territories. Journal of Australian Plant Pathology. Vol: 39 Issue: 3 April 2010.

Evans, D. (ed.). 2008. Taro: Mauka to Makai. A Taro Pro¬duction and Business Guide for Hawai'i Growers. Sec¬ond Edition. College of Tropical Agriculture and Human Resources, University of Hawai'i, Honolulu.

FAO. 2008a. FAOSTAT. FAO Statistics Division. http://fao-stat.fao.org/site/535/DesktopDefault.aspx?PageID=535 [accessed June 12, 2010]

FAO. 2008b. FAOSTAT. FAO Statistics Division. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor [accessed June 12, 2010]

James, F. (2009) 'CARICOM Fresh & Processed Produce Market Opportunities', Presentation for the Caribbean Fresh & Processed Produce Value Chain "Kick Off" Workshop under the 'Promoting CARICOM/CARIFORUM Food Security: Phase II Project', Port of Spain, Trinidad & Tobago, 5-8 May, 2009.

Glean, A., Seeram, H. and Rampersaud, R. (2009) Clustering for competitive value chains in agriculture. Inter-American Institute for Cooperation on Agriculture (IICA), Trinidad and Tobago.

Greindl Delphine (1998). Le Marche Municipal de Port Vila, Orstrom, Vanuatu

IICA (2009) Annual Report 2009: IICA's Contribution to the Development of Agriculture & Rural Communities in the Dominican Republic (translated from Spanish), IICA – Santo Domingo, Dominican Republic.

Government of Samoa. Samoa National Export Strategy 2008, Task 7, Baseline Data Analysis.

Ha'unga Petelo and Pita Taufatofua (2010). Agriculture for Growth: learning from experience in the Pacific – Case Study 4 (Tonga), Root Crops, Cassava and Yams. FAO SAPA, Samoa

Hollyer, James R., Sullivan, Jennifer L., Josephson, Margaret, et. al. 1997. Taro Mauka to Makai, a Production and Business Manual for Growers of Taro in Hawaii. College of Tropical Agriculture and Human Resources, University of Hawaii.

Hunter Danny, Kirifi Pouono and Semisi Semisi. The Impact of Taro Leaf Blight in the Pacific Islands with special reference to Samoa.

Jackson, G. V. H. (1977). Taro Leaf Blight. South Pacific Commission Advisory Leaflet 3. SPC, Suva, Fiji. 4 pp.

Jackson, G.V.H. 1980. Diseases and Pests of Taro. South Pa¬cific Commission, Noumea, New Caledonia.

Kitinoja Lisa and Kader Adel (2003). Small- Scale Post Harvest Handling Practices: A Manual for Horticultural Crops (4th Edition). University of California, Davis Post Harvest Technology Research and Information Centre.

Pacific Islands Trade and Investment Commission (PITIC). 2008. Exporting Taro from the Pacific Islands. Sydney.

Manner, H.I., and M. Taylor. 2010. Farm and Forestry Production and Marketing Profile for Taro (*Colocasia esculenta*). In: Elevitch, C.R. (ed.). Specialty Crops for Pacific Island Agroforestry. Permanent Agriculture Resources (PAR), Holualoa, Hawai'i. http://agroforestry.net/scps.

Masalkar, S.D., and B.G. Keskar. 1998. Other roots, tubers and rhizomes. In: Salaunkhe, D.K., and Kadam, S.S. (eds.), Handbook of Vegetable Science and Technology: Production, Composition, Storage, and Processing. pp. 141–170. CRC Press, Boca Raton.

Mathews, PJ, (2003), Taro Planthoppers (*Tarophagus* Spp.) in Australia and the Origins of Taro (*Colocasia Esculenta*) in Archaeology in Oceania, Vol. 38, 2003

McGregor Andrew (2007). The export of horticultural and high-value agricultural products from the Pacific islands. Pacific Economic Bulletin Volume 22 Number 3 October 2007 Asia Pacific Press.

McGregor Andrew with Kyle Stice and Livai Tora (2010). Tropical Cyclone Tomas: Agriculture and Food Security Assessment and Recommendations for Rehabilitation. Report prepared for AusAID

McGregor Andrew, Robert Lutulele and Brian Wapi (2004) The Papua New Guinea Horticulture Sector Study, DAL/ Secretariat of the Secretariat of the Pacific Community.

McGregor Andrew and Waisiki Gonemaituba (2002) Fiji Agricultural Marketing: A Policy Framework. Ministry of Agriculture

Oika, J.J. and Uchida, J.Y. 1985. Taro root and corm rot caused by *Pythium* myriotylum. Phytopathology 75(1):1316.

Oika J (1986). Taro Diseases, University of Hawaii

Onwueme Inno (1999). Taro Cultivation in Asia and the Pacific. Food and Agriculture Organisation of the United Nations RAP Publication 1999/16

Pursglove, J.W. 1975. Tropical Crops: Monocotyledons. Vol¬ume 1 and 2 combined. ELBS edition. Longman, Group Ltd., London.

Paulson, D. D., and Rogers, S. (1997). Maintaining subsistence security in Western Samoa. Geoforum 28, 173-187.

Pouono, K., Unasa, U., and Clarke, T. (1994). Report of a taro trip to PNG and the Solomon Islands(cited in Saena Tuia, 1997).

Revill P.A., G.V.H. Jackson, B.G.J. Hafner, C.I. Yang A.M.K., Maino D.M.L. and Dowling A.L.C. (2005) Incidence and distribution of viruses of Taro.Journal of Australian Plant Pathology. Vol: 34 Issue: 3 Sept 2005

Robin, G.C (2000) A Guide to Producing and Handling Export Quality Dasheen in the OECS, Caribbean Agricultural Research and Development Institute (CARDI), Dominica.

Robin, G. & Pilgrim, R. (2003) Guide in Producing and Handling Export Quality Dasheen in the Caribbean, CD-ROM, IICA & Caribbean Agricultural and Research Development Institute (CARDI).

Robin, G. (2006) 'Developing systems for sustainable production of export grade dasheen (*Colocasia esculenta* (L.) Schott var. *esculenta*) in Dominica'. Paper prepared for the Caribbean Food Crops Society 42nd Annual Meeting, Puerto Rico, July 9-15, 2006.

Salleras Peter (2003). Taro Production in Australia.3rd Taro Symposium: Nadi.

Saena Tuia, V. (1997).In-vitro multiplication of taro (*Colocasia esculenta* var *esculenta* L. Schoot).M. AgrSc. The University of the South Pacific, 109 pp.

SPC/MPI (2008) 'System's approach to Fresh produce exports – a training manual'.

Stirling A. M. The causes of poor establishment of ginger (Zingiber Officianale) in Queensland Australia. Plant Pathology, 2004, 33. Pp.203-210

USA-Customs and Border Protection (2010) Website: National Agriculture Release Program (NARP).

USDA (2010) Fresh Fruits and Vegetables Import Manual. APHIS – Plant Protection and Quarantine.

United States International Trade Commission (USITC) (2010) Interactive Tariff and Trade Data Web. http://dataweb.usitc.gov/scripts/user_set.asp

Vinning, G. (Compiler). 2003. Select Markets for Taro, Sweet Potato and Yam: A Report for the Rural Industries Research and Development Corporation. RIRDC Publi¬cation No. 03/052. Kingston, ACT, Australia. http://cata¬logue.nla.gov.au/Record/997163 [accessed June 12, 2010]

Vanuatu Land Use Planning Project (1999). Land Use Profile: Root crops and self-sufficiency farming systems. Vanuatu Land Use Planning Office, Port Vila.

Vinning Grant and Young Joann (2003). Pacific Taro Markets: Issues and Challenges 3rdTaro Symposium: Nadi.

White Daniel , David Midmore, David Hicks, Vong Nguyen, Eric Coleman, Suzie Newman and Phillip Wilk (2006). A growers' guide to Japanese small-corm taro (sato-imo) in Australia. A report to the Australia Government Rural Industries Research and Development Corporation.

Zhi Qiang Zhang, 2003. Tropical taro mite (*Rhizoglyphus minutes*). Landcare Research, a report prepared for the Secretariat of the Pacific Community, June.

ANNEXES

ANNEX 1: SCOPING STUDY TERMS OF REFERENCE

The Consultant will, in collaboration with Roy Masamdu, and in close consultation with other SPC LRD staff and the Fiji NPPO:

1. Provide an overview of quarantine issues relating to fresh exports of taro from Pacific Islands to major markets (Australia, NZ, USA, and Japan). This should include, a listing of import requirements and, and where information is available and accessible a recent history of interceptions and actions taken for each country.

2. Compare the current taro import protocols and their application for all major markets. This will include an evaluation of the justification for these protocols and their application.

3. Review the available literature on the disease status of taro in the Pacific islands and the importing countries.

4. Examine the contribution of the export taro industry to Pacific island economies and to the livelihoods of rural people.

5. Report on the importance of the taro industry in the target importing countries.

6. Analyze the impact of current export protocols and their application on the level and viability of taro exports.

7. Evaluate prospects for expanding exports if more favourable protocols were in place.

8. Provide guidance for the setting of priorities for the allocation of resources to improve market access for taro. This will include guidance on the identification and prioritization of researchable issues for taro. This should include recommendation for applied research in post-harvest handling in taro supply chains to help meet export protocols.

9. The draft findings of the scoping study will then be presented to the FACT Project Steering Committee Meeting in September, 2010 in Nadi, Fiji.

ANNEX 2: NOTIFICATION OF BA EMERGENCY MEASURES FOR *COLOCASIA ESCULENTA* VAR. *ANTIQUORUM*

WORLD TRADE

ORGANIZATION

G/SPS/N/AUS/199/Rev.1
4 December 2006
(06-5810)

Committee on Sanitary and Phytosanitary Measures Original: English

NOTIFICATION OF EMERGENCY MEASURES REVISION

01	**Member to Agreement notifying:** AUSTRALIA **If applicable, name of local government involved:**
02	**Agency responsible:** Biosecurity Australia (BA)
03	**Products covered (provide tariff item number(s) as specified in national schedules deposited with the WTO; ICS numbers should be provided in addition, where applicable):** Fresh corm taro (*Colocasia esculenta*) for human consumption, particularly *Colocasia esculenta* var. *antiquorum*.
04	**Regions or countries likely to be affected, to the extent relevant or practicable:** All countries exporting taro to Australia.
05	**Title, language and number of pages of the notified document:** Nil
06	**Description of content:** Nil
07	**Objective and rationale: [ ] food safety, [ ] animal health, [X] plant protection, [ ] protect humans from animal/plant pest or disease, [ ] protect territory from other damage from pests**
08	**Nature of the urgent problem(s) and reasons for urgent action:** Imports of fresh corm taro *Colocasia esculenta* var. *antiquorum* into Australia for human consumption were suspended from all countries under Emergency Measure G/SPS/N/AUS/199 (06-3352), pending further investigation. Import conditions for *Colocasia esculenta* have now been amended to ensure the suspension on the importation of *Colocasia esculenta* var. *antiquorum* can be effectively enforced. Available scientific literature indicates that *Colocasia esculenta* var. *antiquorum* has a high capacity to propagate even when topped and free from all foliage including petiole bases and therefore presents an increased risk of introducing pests and diseases of quarantine concern to Australia. A review of the available scientific literature has identified certain morphological distinctions between the two main recognised varieties of *Colocasia esculenta*, *Colocasia esculenta* var. *esculenta* and *Colocasia esculenta* var. *antiquorum*. Import conditions for *Colocasia esculenta* have been amended to include certain morphological characteristics with the objective of excluding importation of *Colocasia esculenta* var. *antiquorum*. This will enable effective enforcement of the suspension on the importation of *Colocasia esculenta* var. *antiquorum*.

In addition to existing phytosanitary certification requirements, imports of fresh taro for human consumption must comply with morphological characteristics of *Colocasia esculenta* var. *esculenta*. Specifically, the taro must:

- be at least 15 cm long; and/or
- at least 7 cm in diameter at the widest point; and
- at least 300 gm in weight; and
- free of lateral buds or shoots; and
- lack shaggy hairs.

Under interim arrangements, existing import permits will be revoked and re-issued and product in-transit will be permitted under existing permits.

These measures will remain in place pending the outcome of further risk assessment of pests and diseases associated with the import of fresh corm taro.

09. **International standard, guideline or recommendation:**
[ ] Codex Alimentarius Commission, [ ] World Organization for Animal Health (OIE), [X] International Plant Protection Convention, [ ] None If an international standard, guideline or recommendation exists, give the appropriate reference and briefly identify deviations:

10. **Relevant documents and language(s) in which these are available:** Nil

11 **Date of entry into force/period of application (as applicable):** Immediate

12 **Agency or authority designated to handle comments: [X] National notification authority, [ ] National enquiry point, or address, fax number and E-mail address (if available) of other body:**
Contact: The Australian SPS Notification Point
GPO Box 858
Canberra ACT 2601
Australia
E-mail: **sps.contact@daff.gov.au**

13. **Texts available from: [ ] National notification authority, [ ] National enquiry point, or address, fax number and E mail address (if available) of other body:**

ANNEX 3: REPORT ON CARIBBEAN TARO EXPORTS TO THE UNITED STATES *Prepared by Amanda Hamilton

INTRODUCTION

The following brief focuses on the experience of countries in the Caribbean region (CARIFORUM[52] member countries) exporting taro to the United States and serves as a contribution to a scoping study commissioned by the Secretariat of the Pacific Community (SPC) : 'Scoping study on market access issues for Pacific Islands taro '.

The primary aim of the scoping study is to facilitate changes to Australia's (and to a lesser extent, New Zealand's) overly strict quarantine requirements relating to taro imports from Pacific Island Countries. A comparative analysis is being conducted of quarantine requirements of major markets for fresh taro (i.e. Unites States, Japan, Australia and New Zealand) to potentially support a case that Australia's excessive quarantine protocols could serve as a non-tariff barrier to trade under the World Trade Organisation's (WTO) Sanitary and Phytosanitary (SPS) Agreement.

In contrast to difficulties faced exporting fresh taro to Australia, exporters supplying the United States market reportedly face comparatively fewer issues complying with the USA Department of Agriculture (USDA) – Animal & Plant Health Inspection Service (APHIS) quarantine protocols. Hence, the consultant has been tasked with providing a short overview on the Caribbean region's experience exporting fresh taro to the USA market, covering:

- Taro exports from Caribbean to USA (volumes, species, major markets etc.);
- USDA-APHIS quarantine requirements for Caribbean taro imports;
- Issues faced by Caribbean taro exporters meeting USDA APHIS requirements; and
- Disease status of West Indian taro.

This brief is largely based on discussions with agricultural specialists and taro industry representatives from the Caribbean region, complemented with a review of available literature and data analysis. Valuable input was also provided by fellow members of the scoping study team concerning USDA-APHIS quarantine requirements.[53]

[52] CARIFORUM member countries: Antigua & Barbuda, Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Suriname and Trinidad & Tobago.
[53] Jim Hollyer, John Armstrong.

DATA CONSTRAINTS

Difficulty was faced sourcing up-to-date,accurateand complete data for Caribbean taro production and export volumes from regional information sources. As such, only limited data is presented and should be treated as indicative only. Lack of access to quality data is a long-standing and regionally-recognised issue across numerous agricultural sectors in the Caribbean.

TARO PRODUCTION AND EXPORTS IN THE CARIBBEAN REGION

Taro (mostly commonly referred to as 'dasheen')[54] is an important staple crop grown throughout the Caribbean region. Unlike other root crops grown in the region, the entire plant is consumed. The corm (called 'ground provisions') has been a traditional source of carbohydrate, while the green leaves are used as a vegetable and are the key ingredient in a popular Caribbean soup dish called 'callaloo'[55] (also 'callalou').

*Colocasia esculenta*and *Xanthosoma sagittifolium* are commonly grown in the Caribbean region and both are classified as 'dasheen'.[56] The most common cultivars grown and exported are 'common' (purple/blue after cooking) and 'white' (white flesh) taro. Dominican Republic is the largest commercial taro producer in the region (around 31,000 tonnes in 2009).[57] Jamaica, Dominica and St.Vincent and the Grenadines are the largest commercial producers of taro corm in the English-speaking Caribbean (Table 1). Trinidad and Tobago is the largest producer of taro leaves. Haiti has also been a significant producer of taro, but predominately for subsistence purposes (estimated 40,000 MT in 2005).[58] Throughout the region, taro is mostly grown by small farmers. At the time of preparing this brief, there were no reliable estimates available of total annual regional taro production, with estimates varying significantly from 25,000 to as high as almost 200,000MT.

TABLE 1 TARO PRODUCTION FOR SELECTED CARIBBEAN COUNTRIES (2004-2006, MT)

Country	2004	2005	2006
Jamaica	9,750	8,656	10,993
St. Vincent & the Grenadines	2,500	3,818	3,954
Trinidad & Tobago	4,322	4,408	n.a.

Source: Adapted from Glean et. al. 2009

The main export markets for fresh taro are Caribbean communities in the United States, Europe (mostly United Kingdom, also Holland) and Canada.[59] Taro is exported both on a spot market and contract basis. Estimates of the volume of taro exported from the Caribbean region vary markedly from around 4,000 – 22,000 MT per annum. [60]

[54] Also referred to as cocoyam, tannia, eddoe, malanga, yautia.
[55] In Jamaica, vegetable amaranth (Amaranthus spp.) is named 'callaloo', rather than taro leaves. Hence, in Jamaican crop production statistics 'callaloo' represents vegetable amaranth production and 'dasheen' includes taro corms and stems. In the 1990's, vegetable amaranth was removed from Jamaica's USA preclearance list due to the number of pest interceptions greatly exceeding the acceptable limit (CARDI 2006).
[56] For statistical reporting purposes, *Colocasia* sp. and *Xanthosoma* sp. are not reported separately.
[57] IICA 2009
[58] Author unknown 2008
[59] Robin & Pilgrim 2003
[60] Various data sources

Taro exporters from the region have benefited from 'piggy-backing' on the banana shipping system to North America & Europe. It is reported that taro exports from Jamaica and the Windward Islands (includes Dominica and St. Vincent & the Grenadines) are only competitive in European markets due to the availability of low-cost shipping and the viability taro production would be substantially affected if this competitively priced shipping route were no longer available.[61]

Taro is also exported intra-regionally between Caribbean countries (around 3,000MT annually). Trinidad & Tobago is the largest importer (at least 90 per cent), with smaller volumes imported by Barbados and Antigua & Barbuda.[62]

Over the last ten years, the Governments of Caribbean countries have actively embarked on an agricultural diversification program to reduce the reliance on banana production and exports. This program has included renewed emphasis on root crops, including taro.[63] This increased regional focus on crop diversification, coupled with increasing demand from Caribbean ethnic communities in overseas markets has resulted in at least a five-fold increase in taro exports from the region.[64]

CARIBBEAN TARO EXPORTS TO THE USA

Over the past five years, taro exports from the Caribbean region to the USA market have ranged from around 3,000 to almost 9,000 MT (Table 2). In 2006, export volumes declined markedly (45 per cent) from 8,924Mt to 4,819 MT. In 2009, around 4,800 MT of fresh taro was imported by USA markets.

TABLE 2 TOTAL VOLUME OF CARIBBEAN TARO EXPORTS TO THE USA (2005-2009) (MT)

Country	2005	2006	2007	2008	2009
Dominican Republic	8,545	4,138	2,641	2,749	4,153
Jamaica	187	472	526	302	474
St. Lucia	0	0	0	6	8
Others	0	4	0	2	8
Total	**8,924**	**4,819**	**3,309**	**3,176**	**4,793**

Source: USITC 2010

[61] Author unknown 2008
[62] James 2009
[63] Glean et. al. 2009.
[64] Robin 2006

The total value of fresh taro exports to the USA market was USA $6.2 million in 2009 (Table 3). USA export earnings for the Dominican Republic was USA $5.0 million and USA $1.2 million for the major English-speaking Caribbean exporters.

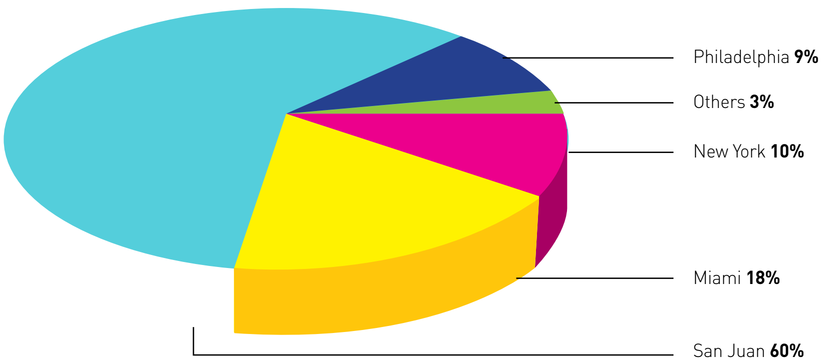
TABLE 3 TOTAL VALUE OF CARIBBEAN TARO EXPORTS TO THE USA (2005-2009) (USD)

Country	2005	2006	2007	2008	2009
Dominican Republic	8,066,108	3,866,985	2,374,836	3,436,754	5,038,974
Jamaica	404,020	762,402	773,053	674,476	985,718
St. Vincent & the Grenadines	177,815	168,757	96,840	39,987	89,231
Dominca	28,325	47,981	18,479	148,397	97,675
St Lucia	0	0	0	11,178	15,157
Others	5,670	5,834	0	3,168	15,817
Total	**8,681,938**	**4,851,959**	**3,263,208**	**4,313,960**	**6,242,572**

Source: USITC 2010

Fresh taro is shipped regularly by sea and air freight to USA markets. Over the past five years, around 60 per cent of fresh taro has been imported through San Juan annually. On the USA mainland, Miami has been the most significant entry port accounting for 18 per cent (Figure 1). The main entry ports for fresh taro imports from the English-speaking Caribbean countries (excludes Dominican Republic) are Miami (almost 70 per cent) and New York (almost 30 per cent). The Dominican Republic exports large volumes to San Juan in Puerto Rico (at least 80 per cent) and Philadelphia on the mainland.

Source: USITC 2010



USA QUARANTINE REQUIREMENTS FOR CARIBBEAN TARO IMPORTS[65]

USDA-APHIS approves the importation of three genera of taro into the USA: *Colocasia* spp., *Alocasia* spp., and *Xanthosoma* spp. The universal APHIS term for taro is dasheen. The majority of countries in the Caribbean region are on the USDA-APHIS list of approved countries to import dasheen into the USA.[66] There are no specific quarantine treatments specified for taro by APHIS, however, taro imports are subject to inspection at the port of entry and must comply with all general requirements for imported fruit and vegetables under the Code of Federal Regulations (7 CFR 319.56-3).[67]

With the exception of Mexico and Thailand, only Caribbean countries are approved to export taro leaf, as well as corm to the USA. The remaining countries on the approved list for the importation of taro (including Fiji, Samoa and the other Pacific Island countries listed) can only supply corm. Taro imports to the USA from the Dominican Republic are subject to reduced inspection rates under the protocol of the National Agriculture Release Program (NARP).[68] NARP was introduced in January 2007, as an extension of the Border Cargo Release (BCR) program which was established to expedite the entry of high-volume, low-risk commodities entering the USA from Mexico. NARP expands the BCR program to include some agricultural commodities from other foreign countries, as well as Mexico. Dominican Republic is the only country with NARP-approval to import dasheen to the USA.[69]

APHIS conducts a commodity preclearance inspection program [70] in Jamaica, which covers 31 commodities, including taro. Preclearance inspection activities conducted in Jamaica by APHIS officials help to expedite the importation of agricultural commodities into the USA. Table 3 summarises APHIS inspection procedures for fresh taro imports and possible treatment options. This applies to taro imports from the Caribbean region and all other APHIS approved countries (including Pacific Island countries).

[65] Information in this section relating to USDA-APHIS entry requirements for taro was sourced from APHIS officials by Jack Armstrong and kindly provided to the consultant.
[66] USDA 2010. Approved countries: Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Cayman Islands, Curacao, Dominica, Dominican Republic, Guadeloupe, Guyana, Haiti, Jamaica, Martinique, Montserrat, Netherlands Antilles, St. Barts, St. Kitts & Nevis, St. Lucia, St.Vincent & the Grenadines and St. Martin.
[67] Federal Regulation (7CFR 319.56-3) available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=446e2e3a8627eeda6f4802db874c91dc&tpl=/ecfrbrowse/Title07/7cfr319_main_02.tpl
[68] APHIS 2010
[69] USA-Customs and Border Protection (CBP) 2010
[70] APHIS 2010b. APHIS preclearance programs enable foreign countries to conduct offshore agricultural commodity preclearance inspections, treatments and/or mitigation measures, under the direct supervision of APHIS personnel, in accordance with APHIS phytosanitary procedures.

TABLE 3 APHIS INSPECTION PROCEDURES FOR FRESH TARO IMPORTS

Quarantine Issue	Details	Likely Treatments
Soil	Presence of soil on corms	1) Rejected and re-exported 2) Fumigated with methyl bromidea
Insects (Internal/External)	Covers dasheen pests and 'hitch-hikers' detected either in/on corms, leaves or stem	1) Low risk quarantine pests – fumigated with methyl bromide[b,c] 2) High risk quarantine pests – destroyed or rejected /re-exported 3) Non-quarantine pests – released
Plant disease	Covers pathological & physiological diseases of corms, leaves or stems	1) Dasheen mosaic virus[c] – released or fumigated with methyl bromide 2) Other non-quarantine diseases - released 3) Corm rots – rejected if deemed unmarketable

Source: USDA-APHIS, pers. comm., courtesy of Jack Armstrong

a Treatment for corms - 64 g/m^3 (4 lbs) MB per 93m^3 (1,000ft^3) for 4 hours at 4.44°C (40°F) or above.

b Treatment for leaves/stem - 64 g/m^3 (4 lbs) MB per 93m3 (1,000ft^3) for 2 hours at 4.44°C (40°F) or above.

c The only dasheen-related disease of concern to the USA is Dasheen mosaic virus, which affects stems/leaves, not corms. Fumigation with methyl bromide is likely to be the prescribed treatment rather than destruction or rejection, as the virus seems only to be prohibited if found on ornamental Aroids, not dasheen leaf/stem imported for consumption.

In 2000, in an effort to increase the quality of taro corms produced for export from the Organization of Eastern Caribbean States (OECS), export specifications were developed and published to guide farmers in meeting phytosanitary requirements for corms in the USA and UK markets. These specifications have been largely applied by exporters in most CARIFORUM member countries.[71] OECS export crop specifications for the USA market are presented in Table 4. A comparison of export crop specifications for the USA and UK markets is provided in Appendix 1.

[71] Greg Robin, pers. comm..

TABLE 4 OECS EXPORT CROP SPECIFICATIONS FOR THE USA MARKET

Variety:	White dasheen
Cleanliness:	Washed clean
Appearance:	Cylindrical in shape
Corm Flesh:	White
Maturity:	Corms should be seven months old
Trimming:	Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh
Packaging:	Pack in nylon, mesh bags. Bags must have air holes and should contain 25 kg (50 lbs)[a]
Sizing:	Minimum corm weight – 1.2 kg (3 lb) Maximum corm weight – 3.0 kg (6 lb)
Decay:	No surface mould or corm softening is allowed
Damage:	No conditions specified
Port-harvest Treatment:	No post-harvest treatments should be applied[b]

Source: Robin, G. (2000)

a Some exporters also package taro corms in 18kg (40lb) cartons, with a plastic liner (Jethro Greene, pers. comm.).

b While it is recommended that no post-harvest treatments be applied, some exporters treat taro corms with Ridomil to prevent fungal attacks (Greg Robin, pers. comm.). Ridomil is not classified as a restricted use pesticide in the USA, but is not longer actively registered by the USA-Environmental Protection Agency for use within the USA (PAN 2010).

After harvesting, taro farmers are encouraged to 'out grade' corms that are undersized, double and triple headed, mechanically damaged, soft, insect damaged and diseased. At export packing houses, a second and final grading is conducted to ensure any sub-standard corms missed during field selection or damaged during the cleaning process are not packed for export.[72]

[72] Robin & Pilgrim (2003)

ISSUES MEETING USDA-APHIS QUARANTINE REQUIREMENTS

USDA-APHIS Plant Protection and Quarantine requirements for the importation of fresh taro into the USA are not considered to be overly onerous by Caribbean exporters.[73] The vast majority of fresh taro imports from the Caribbean are inspected at the USA entry port and then released, with only very small volumes intercepted due to quarantine pest concerns.

Table 5 provides a general summary of APHIS interceptions of fresh taro imported from the major Caribbean taro exporters in 2009. For Dominican Republic, the most significant fresh taro exporter in the region, only 3 per cent of the total volume imported was intercepted, mostly for insect pests. Only 1 per cent of taro imported from Jamaica was intercepted (leaf only), also due to insect pests. There were no interceptions of taro imports from St. Vincent & the Grenadines, Dominica and St. Lucia.

TABLE 5 APHIS PORT ENTRY INTERCEPTIONS OF FRESH TARO FROM MAJOR CARIBBEAN TARO EXPORTERS (2009)

Country	Total Volume Imported (MT)	% Intercepted	Reason for Interception
Dominican Republic	4,153	3% a	Insects (80%) Disease (20%)
Jamaica	474	1% b	Insects (100%)
St. Vincent & the Grenadines	93	0%	-
Dominica	57	0%	-
St. Lucia	8	0%	-

Source: USITC (2010), USDA pers. comm.
a Interceptions of corm and leaf - *Colocasia esculenta*, *Xanthosoma* sp. and *Alocasia* sp.
b Interceptions of leaf - *Xanthosoma* sp.

Quarantine pests identified in fresh taro consignments intercepted at USA entry ports from the major Caribbean exporters in 2009 are presented in Table 6.

[73] Greg Robin, pers. comm.

TABLE 6 MAJOR PESTS AND DISEASES IDENTIFIED FROM APHIS INTERCEPTIONS OF FRESH TARO FROM MAJOR CARIBBEAN EXPORTERS (2009)

Pest Type	APHIS Pest ID (Species/Family)	Common Name
Insect	*Diaphania nitidalis* (Stoll) (Crambidae)	pickle worm (snout moth)
	Aphodiinae sp. (Scarabaeidae)	scarab beetle
	Alleonemobius sp. (Gryllidae)	ground cricket
	Species of (Nitidulidae)	sap beetle
	Species of (Scarabaeidae) **	scarab beetle
	Species of (Micropezidae)	stilt-legged fly
	Xyleborus sp. (Scolytidae) **	bark beetle
	Species of (Pseudococcidae) **	mealy bug
	Species of (Sciaridae)	fungus gnat
	Miogryllus sp. (Gryllidae)	field cricket
	Thrips palmi Karny (Thripidae)	melon thrip
	Species of (Noctuidae)	moth (owlet or millet)
	Spodoptera eridania (Cramer) (Noctuidae)	southern army worm
Mollusca	Species of (Veronicelidae)	leather leaf slug
	Bradybaena similaris (Ferussac)(Bradybaenidae)	Asian tramp snail
Disease	*Ceratocystis fimbriata* (Ellis & Halst) ** (Ceratocystidaceae)	fungal corm rot

Source: USDA pers. comm., internet searches to identify common names
** Included on APHIS Regulated Plant Pest List (APHIS 2010c)
a Only a very small volume of product was intercepted due to the presence of mollusc

One current exception is Trinidad & Tobago, who has experienced increased frequency of USDA-AHPIS interceptions of fresh agricultural produce to the USA over the past year. In the past 3 months (April –June 2009) an estimated 10-15 per cent of shipments of fresh agricultural produce to the USA have been rejected due to high pest level risks. A variety of pests have been found in bodi, taro leaf, hot pepper, eggplant and anthurium (ornamental plant) consignments. The major quarantine issue associated with taro leaf exports has been the presence on aphids (insect pest) on leaves/stems. Aphids have reportedly been very prevalent in Trinidad & Tobago in recent months due to an extended dry spelling during the first half of year.[74]

The Ministry of Food Production, Land and Marine Affairs, together with USDA-APHIS and the National Agricultural Marketing and Development Corporation (NAMDEVCO) are working closely together to address this issue. These organizations recently hosted a seminar 'Meeting USA Import Regulations for Fresh Fruits and Vegetables by Trinidad & Tobago Exporters' to raise awareness amongst farmers/exporters of USDA-APHIS requirements for exportation of agricultural produce to the USA.

DISEASE STATUS OF WEST INDIAN TARO[75]

There are currently no pests and diseases of major economic significance affecting taro production in the Caribbean region.[76] In the early 2000's, sporadic outbreaks of a dasheen beetle (*Ligyrus ebenus*) were experienced in Dominica, St. Lucia and Trinidad & Tobago. Both larvae and the adult beetle tunnel feed through the root of the taro and can cause considerable damage/destruction to the entire corm and kill young plants. Physiological damage in the form of striations (brown corky fibrous string-like effect) sometimes occurs in the corm flesh and is associated with water stress during the dry season.

[74] Information delivered in presentations by Andrea Borrero (USDA-Mitigation Specialist) and Ganesh Gangapersard (NAMDEVCO) during the seminar 'Meeting USA Import Regulations for Fresh Fruits and Vegetables by Trinidad & Tobago Exporters' held on 4 August in Trinidad.
[75] Information contained within this section is sourced from Robin & Pilgrim (2003).
[76] Greg Robin, pers. comm.

Dasheen corm rot generally occurs in association with poor harvesting practices where fungal infections develop in areas where the corm has been physically damaged. Common soil borne fungal complexes associated with dasheen corm rot include *Pythium* splenderis, *Fusarium* sp., *Rhizoctania* sp. and *Botryodiploidia theobromae*. Secondary infection known as 'soft rot' can also cause spoilage and is caused by the bacteria *Erwinia chrysanthemi*. In an effort to prevent fungal attack and minimise corm rot, export specifications recommend that corms are harvested within 2 days prior to shipping and are treated with a fungicide (Ridomil) for exports outside the region, or a bleach solution for intra-regional exports where corms are consumed in a shorter space of time. The consultant was unable to source information concerning the current status of dasheen mosaic virus in the Caribbean region and its impact on taro leaf production.

ACRONYMS

APHIS	Animal and Plant Health Inspection Service
BCR	Border Cargo Release Program
CARDI	Caribbean Agriculture and Research Development Institute
CARIFORUM	Caribbean Forum of African, Caribbean and Pacific States
IICA	Inter-American Institute for Cooperation on Agriculture
NAMDEVCO	National Agricultural Marketing and Development Corporation
NARP	National Agriculture Release Program
OECS	Organisation of Eastern Caribbean States
PAN	Pesticide Action Network
PPQ	Plant Protection and Quarantine
SPS	sanitary and phytosanitary
UK	United Kingdom
USA	United States
USDA	United States Department of Agriculture
WTO	World Trade Organisation

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REFERENCES

APHIS (2010) USDA-APHIS Dasheen Commodity Summary: Approved Countries, USDA. https://epermits.aphis.usda.gov/manual/index.cfm?action=commSummCountryP&COMMOD_ID=297&dspNavBar=1

APHIS (2010b) Website: Plant Import – Preclearance Activities, USDA. http://www.aphis.usda.gov/import_export/plants/plant_imports/preclearance_activities.shtml

APHIS (2010c) Website: Regulated Plant Pest List, USDA. http://www.aphis.usda.gov/import_export/plants/plant_imports/downloads/RegulatedPestList.pdf

Author unknown (2008) Baseline Review of Non-Traditional Commodities Produced in the Caribbean ACP Countries, Report produced for the ALL ACP Agricultural Commodities Programme, December 2008.

Caribbean Agriculture and Research Development Institute (2006) 'Reinstating Callaloo to the USDA APHIS Preclearance List in Jamaica', Information Leaflet – IPM CRSP Project (PSC# JA/015/06), Jamaica.

James, F. (2009) 'CARICOM Fresh & Processed Produce Market Opportunities', Presentation for the Caribbean Fresh & Processed Produce Value Chain "Kick Off" Workshop under the 'Promoting CARICOM/CARIFORUM Food Security: Phase II Project', Port of Spain, Trinidad & Tobago, 5-8 May, 2009.

Glean, A., Seeram, H. and Rampersaud, R. (2009) Clustering for competitive value chains in agriculture. Inter-American Institute for Cooperation on Agriculture (IICA), Trinidad and Tobago.

IICA (2009) Annual Report 2009: IICA's Contribution to the Development of Agriculture & Rural Communities in the Dominican Republic (translated from Spanish), IICA – Santo Domingo, Dominican Republic.

Pesticide Action Network (2010) Website: Pesticide Action Network (PAN) Pesticide Database. http://www.pesticideinfo.org/

Robin, G.C (2000) A Guide to Producing and Handling Export Quality Dasheen in the OECS, Caribbean Agricultural Research and Development Institute (CARDI), Dominica.

Robin, G. & Pilgrim, R. (2003) Guide in Producing and Handling Export Quality Dasheen in the Caribbean, CD-ROM, IICA & Caribbean Agricultural and Research Development Institute (CARDI).

Robin, G. (2006) 'Developing systems for sustainable production of export grade dasheen (*Colocasia esculenta* (L.) Schott var. *esculenta*) in Dominica'. Paper prepared for the Caribbean Food Crops Society 42nd Annual Meeting, Puerto Rico, July 9-15, 2006.

USA-Customs and Border Protection (2010) Website: National Agriculture Release Program (NARP).

USDA (2010) Fresh Fruits and Vegetables Import Manual. APHIS – Plant Protection and Quarantine.

United States International Trade Commission (USITC) (2010) Interactive Tariff and Trade Data Web.http://dataweb.usitc.gov/scripts/user_set.asp

APPENDIX 1
OECS EXPORT CROP SPECIFICATIONS FOR THE USA AND UK MARKETS

Specifications	USA Market	UK Market
Variety:	White dasheen	Any variety meeting specifications
Cleanliness:	Washed clean	Unwashed but free of soil clods
Appearance:	Cylindrical in shape	Rounded and symmetrical; no elongated or deformed corms allowed; double-headed corms allowed, but these must weigh more than 1 kg (2.5 lb). No trip or quadruple-headed corms allowed.
Grading:	No specifications listed	Mixed: 25% by weight – large corms, 50% by weight – medium corms, 25% by weight – small corms.
Corm Flesh:	White	No specifications listed
Maturity:	Corms should be seven months old	Corms should be at least six months old
Trimming:	Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh	Trim leaves to within two inches from where the stem joins the fleshy part of the corm, do not cut into the corm flesh
Packaging:	Pack in nylon, mesh bags. Bags must have air holes and should contain 25 kg (50 lbs)	Pack in white, banana-type cartons with stapled base plate, pack 18kg (40lb) net, an extra 1kg (2 lb) should be placed in the carton to allow for shrinkage. Plastic liner should completely wrap the corms. Cartons should be clean and dry.
Sizing:	Minimum corm weight – 1.2 kg (3 lb) Maximum corm weight – 3.0 kg (6 lb)	Minimum corm weight – 0.5 kg (1 lb) Maximum corm weight – 4.0 kg (8 lb)
Decay:	No surface mould or corm softening is allowed	No surface mould or corm softening is allowed
Damage:	No conditions specified	Small cormel attachment scars and tail cuts are acceptable
Port-harvest Treatment:	No post-harvest treatments should be applied	Dasheen may be harvested up to 2 days before shipment date. Corms should be treated with Ridomil MZ58 (14g in 5 gallons of water for 5 seconds), within 6 hours of harvest.

Source: Robin, G. (2000)

ANNEX 4: AN OVERVIEW OF RECENT QUARANTINE ISSUES RELATING TO FRESH TARO EXPORTS FROM FIJI TO NEW ZEALAND

*Prepared by Kevin Nalder

NEW ZEALAND LEGISLATION

There are two pieces of legislation underpinning the official phytosanitary requirements for imported fresh produce into New Zealand (viz. The Biosecurity Act (BSA) and the Hazardous Substances New Organisms Act (HSNO)). In 2005, the interception of nematodes on Fiji taro, that had previously been considered as non-regulated pests (i.e. saprophytic/non-pathogenic species of no concern) were being considered as possible "new organisms" under the HSNO Act. In essence, this meant that technical decision-making provisions under the BSA were being over-ridden by a new interpretation of "new organism" provisions of HSNO. Other import pathways were also being affected by similar decision-making criteria (e.g. interceptions of "live" organisms on irradiated fresh produce from Australia).

In simplistic terms, the cross-over between the two acts, and the new interpretations associated with this, resulted in a regime of over-regulation and distorted technical decisions in terms of managing border interceptions. Unfortunately, Fiji taro was a victim of this scenario with significant and ongoing trade consequences due to interpretations associated with taro mite and nematode interceptions. Since the 2005 legislative issues arose, both the BSA and the HSNO ACT have been changed to better facilitate decision-making around the unintentional entry of new organisms possibly associated with imported risk goods (i.e. the incidental entry of new organisms is managed primarily under the BSA) and the deliberate introduction of new organisms (i.e. managed primarily under the HSNO Act).

Previously, the discovery of regulated arthropod pests on an imported consignment resulted in the justified mandatory fumigation with methyl bromide. In some cases, the contingency action for the interception of high risk regulated pests would be moe severe. For example, the interception of live fruit flies would result in reshipment or destruction of the consignment and suspension of the offending pathway until satifactory remedial action had been carried out. Technical decisions associated with organisms of low or no risk (e.g.saprophytic nematodes) were made on the basis of their ability to enter, establish and cause economic harm. The HSNO interpretations associated with (possible) "new organisms" associated with imported fresh produce significantly changed this technically based approach to one of enforced risk management from a legislative based approach.

In late 2001, the New Zealand MAF discovered mites on taro from Fiji. As a consequence, over the next three to four years 70–80 per cent of taro consignments from the Pacific required fumigation. Following a request from Fiji, SPC sponsored a comprehensive pest risk assessment of mites known to be associated with taro from the Pacific island countries. In June 2003, a report by Landcare Research NZ Ltd. concluded that it was highly unlikely the tropical taro mite (*Rhizoglyphus minutus*) could enter and establish in New Zealand. Furthermore, in the unlikely event that it did survive, the probability of causing any damage to New Zealand's horticulture crops was assessed to be extremely low[77] to near zero. As a result of the Landcare report, and the more recent changes to the BSA and HSNO Acts, NZ MAF have now re-categorised this pest from a regulated pest (i.e. requiring specific phytosanitary measures and on-arrival action if intercepted) to a non-regulated pest (i.e. requiring no measures). This is clearly a significant change which means that no measures are technically justified for *R. minutus.* However, this decision has not resulted in any significant change from a trade facilitation perspective due to the ongoing issues associated with nematodes and other contaminating pests (e.g. "hitchhiker" pests). The decision does however highlight that it is possible, and indeed desirable,

ISSUES ASSOCIATED WITH NEMATODES

With the subsidence of concern about mites New Zealand' s quarantine focus on taro shifted to nematodes and other incidental "hitch-hiker" pest (e.g. slugs, snails and ants). The application of a more stringent inspection regime, utilizing high-powered microscopes, results in the inevitable discovery of nematodes on almost every shipment of taro. Microscopic nematodes reside in soil and will always be found on tubers and root crops. However, the border quarantine officers cannot currently distinguish between parasitic/regulated species (i.e. species that feed off live plant tissue and are not found in New Zealand) and non-parasitic/saprophytic species (i.e. not of quarantine importance and should not require action).[78] Consequently, on-arrival fumigation continues to be enforced for any nematodes discovered by quarantine inspectors "because of HSNO".

Sometimes a re-inspection after fumigation is undertaken and if residual live nematodes are found, a second fumigation was undertaken – the double fumigation scenario has become less of an issue over recent times. Fumigation, together with the costs of pest identifications, significantly increases exporting costs and the price to consumers. More importantly, fumigation substantially reduces the shelf life and marketability of the product, particularly if a second fumigation is undertaken.

New Zealand nematologist, Dr Gordon Grandison, had recommended to MAF Biosecurity that inspectors be trained to determine if a nematode is parasitic (potentially of quarantine significance) or non-parasitic (not of quarantine significance). The implication is that non-parasitic nematodes would be cleared immediately without further identification or fumigation. These recommendations were not adopted. This was due to the fact that no species identification information is readily available for the intercepted nematodes in questions so they could not be ruled out as being "new organisms" and therefore subject to the provisions of HSNO. However, Fiji taro exporters report in recent times that demands for fumigation by NZ MAF is slightly less frequent and the requirement for double treatments is rare. This is seen to be due to improvements in cleaning by exporters and the less demanding inspection regimes in response to vigorous challenges made by New Zealand importers. Yet despite recent improvements in defacto market access for taro and positive changes to the underlying legislation the technical and operational decision-making has not improved.

[77] Zhi Qiang Zhang, 2003. Tropical taro mite (*Rhizoglyphus minutes*). Landcare Research, a report prepared for the Secretariat of the Pacific Community, June.

[78] Most nematode species are nonparasitic and thus harmless. The key issue is the type of nematodes that are being found on Pacific island country taro. An earlier FAO study identified three parasitic nematodes on taro in Fiji (Orton Williams 1980). According to New Zealand nematologist, Dr Gordon Grandison, the root-knot and lesion nematodes will only survive undertropical conditions. Dr Grandison believes that it is unlikely New Zealand Biosecurity officials are finding parasitic nematodes at border inspections. Saprophytic (non-parasitic) feeding nematodes are distinguishable from parasitic nematodes (under a microscope of sufficient power) by the absence of a 'buccal spear ' used to 'attack' plant tissue.

In summary, the New Zealand legislation has been suitably changed and now allows for improved technically based biosecurity decisions (cf. enforced legislative decisions). Although the technical case-for-change for *R. minutus* has been successful, further technical data and improved risk management systems will be required to facilitate positive change in Fiji's favour for the combination of issues currently facing taro exports to New Zealand. This will also need to be combined with a tactically smart government to government submissions strategy.

The successful outcome from the case-for-change for taro mite means that the focus of any new initiatives should be targeted to other areas using a similar approach. For example, if the commonly intercepted nematodes associated with Fiji taro can be identified to species level, proven to be of low or no risk and then subsequently re-categoised, this would create huge savings on fumigation costs in New Zealand. In parallel to this, a suitable risk management plan to manage the other commonly intercepted "hitchhiker" pests would also be required.

The examples of tropical taro mites and nematodes associated with Pacific islands' taro demonstrate the importance of conducting basic taxonomic research to assist in facilitating trade and contributing to successful phytosanitary issues resolution. As noted by New Zealand's Landcare Research, "the case of the taro mite shows that correct pest identification is the key to accessing correct information and vital for decision making. Small investments in basic research can lead to large benefits in Pacific island trade and economic development."[79] The taro mite example shows that a sound technical base can create the foundation for positive change – the same could and should apply to the current nematode scenario.

SPECIFIC MEASURES FOR TARO TO NEW ZEALAND

The current phytosanitary measures for the importation of taro (*Colocasia esculenta*) into New Zealand have been in place for many years. These measures are specified in the document entitled MAF Biosecurity New Zealand Standard 152.02: Importation and Clearance of Fresh Fruit and Vegetables into New Zealand. The current measures are considered as "basic" measures and have not been subject to any systematic technical review for many years. This is despite the pathway being identified as a high priority for review by NZ MAF and affected industry parties immediately after the nematodeissues arose in 2005. For unknown reasons, this pathway has lost its priority review status.

Note: This is an area where some official NPPO – NPPO communications initiated from the Fiji end would assist.

As mentioned above, the change in status of taro mite (*Rhizoglyphus minutus*) is a significant change for a single pest but this cannot be considered in the context of a re-alignment of pathway measures with contemporary phytosanitary practices and standards. Required actions for taro to New Zealand The "basic" measures are based on:

(i) A phytosanitary certificate with the following additional declaration: The taro in this consignment have been inspected in accordance with appropriate official procedures and found to be free of visually detectable quarantine pestsspecifiedNote1 by New Zealand Ministry of Agriculture and Forestry.
(ii) On-arrival inspection Note 2 by an NZ MAF inspector at an approved inspection facility.

[79] Landcare Research, 2004. 'Of mites and quarantine: a story of two crop', Tetaiao Newsletter, 3 (May).

(iii) Contingency treatment actions Note 3 for the interception of regulated (or unidentified) pests.

Note 1: There is no specific list of regulated/non-regulated organisms associated with taro from Fiji in accordance with more recently released country: commodity import health standards. A de-facto list can however be determined based on recent interception data (see table below).

Note 2: On-arrival inspection is usually based on a 600 unit sample with an acceptance number of zero units infested with regulated pests.

Note 3: The normal contingency treatment for Fiji taro is methyl bromide, typically for nematode interceptions (e.g. 48 grams for 4 hours at 10-160 C).

CURRENT ISSUES

A short data collection exercise covering three months (viz. April, May June 2010) of taro imports from Fiji looked at:

- MAF Inspection details (i.e. time/costs per consignment).
- Interception details (i.e. pests intercepted and regulatory status).
- Diagnostic costs per consignment.
- Treatment costs per consignment.

A total of 30 consignments were analysed.The results of this exercise are summarized as follows:

MAF INSPECTION COSTS.

Costs and fees associated with NZ MAF inspection activities are applied under the Biosecurity Cost Regulations. The Biosecurity Cost Regulations have been under review and were changed on 1 July 2010. This will mean that the current costs are likely to increase as the changes are implemented at the front line.

The costs of MAF BNZs border inspections are set through the Biosecurity Cost Regulations and implemented by way of an hourly charge. The actual costs for the selection and inspection of a 600 unit sample from each consignment of taro from Fiji are reasonably predictable and consistent. Although there are some variables associated with each inspection, the average cost per inspection can be established at $300-$350 per consignment.

It is also worth noting that NZ MAF are looking at systems for applying reduced inspection frequencies for import pathways with a demonstrable history of compliance and increased interventions (and therefore costs) for non-complying import pathways. This will have an impact on taro exports from Fiji in the future.

DIAGNOSTIC COSTS PER CONSIGNMENT

There are currently two service providers offering border diagnostics (viz. MAF Diagnostic Laboratory and AsureQuality). The fees differ depending on the nature of each submission and any commercial arrangements that may apply between the service provider and the importer concerned. Given the wide range of organisms that are commonly found on Fiji taro, and the different cost structures for each of the service providers, it is difficult to get a firm diagnostic costing that can be accurately assigned on a per consignment basis. The rangecan be from zero (i.e. nil interceptions) to $1,000+ for a heavily infested consignment with multiple pest species associated. It is worth noting that interceptions of nematodes are not now routine ly sent for laboratory analysis – this is a considerable saving for importers. If this policy changes, then the compliance costs will clearly increase.

PEST INTERCEPTIONS AND REGULATORY STATUS

There are a range of organisms commonly intercepted on taro from Fiji. In most cases, there are several species intercepted on the same consignment (e.g. usually nematodes and mites and often ants, snails or other "hitchhiker" pests). This means that there is a high probability of one (or more) of the intercepted pests being considered as regulated and therefore requiring action. Some of the incidental pests are not directly associated with the product (e.g. ants) and could be managed through improved packaging, handling and storage risk management practices. Table 1 summarises the main interceptions with associated comments.

TABLE 1: MAIN INTERCEPTION ASSOCIATED WITH TARO FROM FIJI

Type of interception	Identification	Comments
Nematode	Not to species level	Almost all consignments Considered "regulated" in the absence of species specific identification
Mites	Usually *Rhizoglyphus minutus* Possibly other *Rhizoglyphus* spp.	Non regulated (non actionable)
Vinegar flies	*Drosophilla* spp.	Non regulated (no action)
Snails	Miscellaneous species	Usually regulated and requiring action
Ants	Miscellaneous species	Usually regulated and requiring action
Millipedes/centipedes	Miscellaneous species	Usually regulated and requiring action
Other Miscellaneous pests	Beetles, worms, spiders	Usually regulated and requiring acting

Given the situation where there are multiple interceptions associated with a single consignment, there is a high probability of justified on-arrival actions by NZ MAF. The situation of unjustified treatment for *R. minutus* has largely disappeared, however, treatment is still justified for other reasons. In relation to nematodes, the absence of accurate species data, and the associated technical arguments, constrains any robust case for change. If the current pathway could be "cleaned up" of other incidental pests (e.g. snails, ants etc), then there is a good case for reduced measures for the most regularly intercepted pests associated with Fiji taro (i.e. mites and nematodes).

IMPROVING MARKET ACCESS IN THE FUTURE

Improving market access for the future will require a series of inter-related activities including:

(i) Identification of the nematode species (and possibly other pests) commonly associated with taro and intercepted in New Zealand.

(ii) An updated "pest risk profile" based on the above research.

(iii) Risk assessment on each species to determine the regulatory status of nematodes associated with Fiji taro in a New Zealand context. This would include an assessment on their ability to enter, establish and spread (i.e. to test the hypothesis that Fiji nematode species are tropical species and could not survive in New Zealand and/or that they are saprophytic and of no quarantine concern).

(iv) A review of the current practices for managing "hitchhiker" pests routinely intercepted in New Zealand. This would include recommendations for change (possibly working closely with exporter-importer combinations with higher levels of current compliance).

(v) A well thought out government to government communication strategy to ensure that National Plant Protection Organisation officials in both countries are aware of, and have ownership of, the various project streams if and when change is required.

ANNEX 5: REGULATORY OVERVIEW: IMPORTATION OF DASHEEN (TARO) INTO THE UNITED STATES[80] *Prepared by Dr. John (Jack) Armstrong

NOMENCLATURE:

COMMON NAMES USED BY USDA-APHIS:

Dasheen, taro, kolokass,kilkass, edda, eddoe, cocoyam, dalo, kalo, gabi, ñame, inhame, malanga, elephant ear, yùtou, yùnĐi, wuh táu, ghandyali, chembu-kishangu, saru, pindalu, toran, aroei, ô-å, khôai mon, macabo, and numerous other common names specific to the country and area of cultivation and local language and dialect (Appendix 1).

SCIENTIFIC NAMES USED BY USDA-APHIS:

All species of regulatory importance are members of the family Araceae and are refered to by USDA-APHIS as "aroids." Genera and species approved for importation into the USA include *Colocasia* spp., primarily *esculenta* (L.) Schott (the most prominent species worldwide) which includes *C. esculenta* var. *esculenta* Schott and *C. esculenta* var. *antiquorum* Schott; *Alocasia* spp. (giant dasheen), *Amorphophallus campanulatus* (Roxb) (elephant yam); *Xanthosoma* spp., primarily *Xanthosoma sagittifolium* (L.) Schott.

SPECIES OF DASHEEN PERMITTED ENTRY INTO THE USA:

USDA-APHIS permits the importation of three genera of aroids under the name, dasheen, into the USA, including *Colocasia* spp., *Alocasia* spp., and *Xanthosoma* spp.

DASHEEN PLANT PARTS THAT CAN BE IMPORTED INTO THE USA:

All parts of the dasheen plant can be imported into the USA, including the corm (or tuber), stem, and leaf. Importation of dasheen stem and leaf material is primarily from the Caribbean region. Importation of corms is allowed from 70 countries (Appendix 2). The only prohibition of record presently is the prohibition against importation of dasheen materials from Republic of Korea, Timor-Leste, Indonesia, and taro production areas of the Commonwealth of Northern Marianas Islands, into Guam due to a research program at University of Guam with the goal of developing dasheen stocks free of taro blight (*Phytophthora colocasia*e Rac.). To support the development of blight-free stock, USDA prohibited dasheen from countries where taro blight is known to occur from entry into Guam. Whether this prohibition should remain in effect today is questionable if the research program has been completed or is no longer in operation.

USDA-APHIS REGULATIONS FOR THE IMPORTATION OF DASHEEN INTO THE USA:

All dasheen imported into the USA is subjected to inspection under standard inspection and release protocols. Inspection: Specifically, inspection of dasheen corms, stems or leaves is for:

- Soil – if found, the dasheen is rejected and returned or fumigated with methyl bromide.
- Insects (external or internal, dasheen pests or hitchhikers) – if found, insects are identified at the entry port and (1) if the insects are quarantine pests, the dasheen is fumigated with methyl bromide and released, or (2) if not quarantine pests, the dasheen is released.

[80] Dasheen" and "taro" can be used interchangeably in common usage. USDA-APHIS usually uses " dasheen," instead of "taro," but infrequently also uses "taro," probably reflecting different writers of import regulations over time. "Dasheen" is used uniformly throughout this document.

- Plant disease – if found, disease is identified. Most likely the dasheen will be released because the only disease of concern is dasheen mosaic virus and you'd only see this on stems and leaves. Additionally, dasheen mosaic virus seems to be prohibited only if found on ornamental Aroids, not on edible dasheen leaf or stem sold for food. If the issue is corm rots, APHIS will generally reject rotted product of any kind if the product appears unmarketable and because finding quarantine pests is too difficult.
- See Appendices 4 and 5 show pest interceptions found by APHIS-PPQ on dasheen entering the USA during the period 2000-2010. All listed interceptions were found by inspection. The shipment was held until the pest was identified to the taxonomic level required to satisfy APHIS that the pest was of no quarantine importance and then released to market channels.

TREATMENT:

The only quarantine treatment available is with methyl bromide under Schedule 2.3.1 - "Q Labels" and Section 18 Exemption Treatment Schedules, for a number of different crops, including dasheen. The methyl bromide fumigation schedule for corms is 64 g/m3 (4 lbs) MB per 93m3 (1,000ft3) for 4 hours at 4.44°C (40°F) or above. the methyl bromide fumigation schedule for stems and leaves is the same as for corms except the fumigation time is 2 hours (Appendix 3). It is doubtful that dasheen corms, stems, or leaves can undergo methyl bromide fumigation and maintain marketability.

Appendix 6 provides a list of USDA-APHIS regulated pests that, any one of which, if found in a shipment of dasheen, regardless of dasheen species or plant part, would require the shipment to be fumigated.

COMMENTS ON INSPECTOR DISCRETION:

All decisions for rejection/return, treatment and release, or release without action are made by the individual inspector(s) who use their own judgement based on a number of factors and issues. For example, if the inspector finds a major actionable quarantine pest in a shipment of one box of dasheen, the shipment can be released after the box is inspected and no more of that pest is found. But the same pest found in a shipment too large to inspect all of the dasheen can result in rejection/return or fumigation.

Some of the key issues inspectorsmay consider include (but are not limited to):

a. Is the interception an actionable pest? (i.e., rejection/return or fumigation is the only action that can be taken regardless of circumstances).
b. Is the interception a general agricultural pest, a taro pest, or an obvious hitchhiker? (e.g., a single actionable pest found in a shipment that obviously does not belong with dasheen and all the dasheen can be inspected)
c. How many of the pests were found in the shipment?
d. How big is the shipment? (Can the entire shipment be inspected?)
e. What is the past experience with the specific pest interception?
f. What is the risk of introduction?
g. Can the issue be ameliorated on site? (e.g., can a lump of dirt be removed and incinerated?)
h. What is the history of interceptions for that exporter?

Appendix 1. List of approved nomenclature used by used by USDA-APHIS for importation of dasheen into the United States.

Appendix 2. List of approved countries importing dasheen into the USA, nomenclature, and import information

Appendix 3. USDA-APHIS Quarantine Treatments Manual section 2.3.1: Methyl bromide treatments (includes dasheen treatment schedules).

Appendix 4. USDA-APHIS-PPQ List of Pest Interceptions on Taro (2000-2010)

Appendix 5. Footnotes to USDA-APHIS-PPQ List of Pest Interceptions on Taro (2000-2010).

Appendix 6. USDA-APHIS List of Regulated Pests (actionable quarantine pests).

Appendix 1: List of approved nomenclature used by used by USDA-APHIS for importation of dasheen into the United States.
Alocaz [SPANISH], *Colocasia esculenta*, **DASHEEN**[2]

Alocasia spp., **TARO**, Chinese ape, Chinese taro, elephant ear, giant *alocasia*,giant taro, see also **DASHEEN**[2]

Alocasia cucullata, **CHINESE TARO**, Chinese Ape

Alocasia macrorrhizos, **GIANT TARO**, ape, manschio-imo [JAPANESE],taro gigante [SPANISH]

Ape, *Alocasia macrorrhizos*, **GIANT TARO**

BLACK MALANGA, *Xanthosoma violaceum*, batata de taxola[PORTUGUESE], blue ape, blue taro, malanga noir [FRENCH], otoo[SPANISH], primrose malanga, tiquisque morado [SPANISH], yautia[SPANISH], Also see *Xanthosoma sagittifolium*

Blue ape, *Xanthosoma violaceum*, **BLACK MALANGA**

Blue taro, *Xanthosoma violaceum*, **BLACK MALANGA**

Chinese ape, *Alocasia cucullata*, **CHINESE TARO**

CHINESE TARO, *Alocasia cucullata*, Chinese ape

Colocasia [SPANISH], *Colocasia esculenta*, **DASHEEN**[2]
Colocasia esculenta, **DASHEEN**[2], alocaz [SPANISH], arum, cocoyam,*colocasia* [SPANISH], colocasie [FRENCH], eddo, elephant's ear, malanga[SPANISH], madumbe, taro, tayoba [SPANISH]

DASHEEN, *Colocasia esculenta* (for entry purposes, *Alocasia* spp. and *Xanthosoma* spp.), caladium, cocco (coco) [SPANISH], cocoyam, eddo,inhame [PORTUGUESE], kalo, otoe [SPANISH], talo, tannia, tanyatarua,

taro malangay [SPANISH], taro toran [KOREAN], yautia [SPANISH],*Xanthosoma* includes some species whose leaf is used as a vegetable. Seealso **CALALU**

Giant *alocasia*, *Alocasia* macrorrhiza, **TARO**, see also **DASHEEN**

Manschio-imo [JAPANESE], *Alocasia macrorrhizos*, **GIANT TARO**

TARO, *Colocasia esculenta*, **DASHEEN2**

Taro, giant, *Alocasia* macrorrhiza, **DASHEEN, TARO**

Taro gigante [SPANISH], *Alocasia macrorrhizos*, **GIANT TARO**

Taro malangay [SPANISH], *Colocasia esculenta*, D**ASHEEN**

Taro toran [KOREAN], *Colocasia esculenta*, **DASHEEN**

Xanthosoma violaceum, **BLACK MALANGA**, batata de taxola[PORTUGUESE], blue ape, blue taro, malanga noir [FRENCH], otoo[SPANISH], primrose malanga, tiquisque morado [SPANISH], yautia[SPANISH], Also see *Xanthosoma sagittifolium*

Corm—Underground stem, such as that of the taro, similar to a bulb butwithout scales.

TARO (Aroid family (Araceae) *Colocasia esculenta*)brown/tan banded—2 to 4 inches, a.k.a. C hong ya wu, M hong ya yu, caladium, cocco, eddo,inhame, kalo, môn,otoe, talo, tanyatarua,taro malangays, tannia, yautia

APPENDIX 2. LIST OF APPROVED COUNTRIES IMPORTING DASHEEN INTO THE USA, NOMENCLATURE, AND IMPORT INFORMATION

1. American Samoa[81]
2. Antigua and Barbuda
3. Austria
4. Bahamas
5. Barbados
6. Belize
7. Benin
8. Bosnia and Herzegovina
9. Brazil (whole plant)
10. Cayman Islands
11. China (from all provinces)
12. Colombia
13. Cook Island (tuber)
14. Costa Rica
15. Croatia
16. Cyprus
17. Dominica
18. Dominican Republic – imported under DARP[82]
19. Ecuador
20. El Salvador
21. France
22. French Polynesia
23. Germany
24. Ghana
25. Grenada
26. Guadeloupe
27. Guam and CNMI
28. Guatemala
29. Guyana
30. Haiti
31. Honduras
32. Hong Kong
33. Hungary
34. Indonesia (tuber)[83]
35. Italy
36. Jamaica[84]
37. Japan (from all areas other than Amami, Bonin, Ryukyu, Tokara, and Volcano Islands)
38. Korea (tuber)4
39. Macedonia (former Yugoslav Republic)
40. Malaysia (tuber)
41. Martinique (West Indies)
42. Mexico (corm, leaf, stem)
43. Micronesia (CNMI including Chuuk, Kosrae, Pohnpei, and Yap). Dasheen allowed from Kosrae, Pohnpei and Chuuk into Guam and CNMI, but dasheen from Yap is prohibited.
44. Montenegro
45. Montserrat (West Indies)
46. Morocco
47. Nicaragua (tuber)
48. Nigeria
49. Palau (prohibited from entry into Guam and CNMI
50. Panama
51. Papua New Guinea (tuber)
52. Philippines (tuber)
53. Portugal, including Azores and Madeira Islands
54. Saint Barthélemy (West Indies)
55. Saint Kitts and Nevis (West Indies)
56. Saint Lucia (West Indies)
57. Saint Vincent and the Grenadines (West Indies)
58. Samoa, Republic of
59. Serbia
60. Sierra Leone
61. Slovenia – Dasheen is listed as Not Approved?
62. Suriname
63. Taiwan
64. Thailand (corm, leaf, stem)
65. Timor-Leste (tuber)3
66. Togo
67. Tonga
68. Trinidad and Tobago (whole plant)
69. Vanuatu (root)
70. Venezuela

[81] Admissible fruits and vegetables from this country do not require a written permit
[82] National Agricultural Release Program
[83] Prohibited Entry into Guam. Cartons in which commodity is packed must be stamped, "Not for importation into or distribution within Guam."
[84] Consignments may or may not be precleared. if they are precleared, the consignment must be accompanied by a PPQ form 203 signed by the APHIS inspector on site in Jamaica to validate foreign site preclearance. If the consignment was not precleared, inspect and release.

APPENDIX 4. USDA-APHIS-PPQ LIST OF PEST INTERCEPTIONS ON TARO (2000-2010)

USDA-APHIS-PPQ, Taro Interception Data duroing the period 01/2000 through 08/2010 For information only and cannot be used for any purpose other than to provide a general review of pests intercepted on dasheen (taro) entering the USA.

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] [Number of Identical Interceptions[9]] (Action[10])
INSECT	Csp	P/C	Acrididae: *Schistocerca americana* (American grasshopper) [1] (NR)
INSECT	Ce	C	Acrolophidae: *Acrolophus sp.* (species of grass tube worms) [1]
INSECT	Ce	P/C	Acrolophidae: Family of tube moths [1]
INSECT	Csp, Xsp	L	Agromyzidae: Family of leaf miner flies [2]
INSECT	Asp, Ce, Csp, Xs	L, P/C	Aleyrodidae: *Aleurodicus dispersus* (spiraling whitefly) [7]
INSECT	Csp	L	Aleyrodidae: *Aleurodicus sp.* (species of spiralling whiteflies) [1]
INSECT	Ce, Csp	L, P/C	Aleyrodidae: *Aleuroglandulus malangae* (previously *subtilus)* (malanga whitefly) [2] (NR)
INSECT	Asp	L	Aleyrodidae: *Aleyrodes sp.* (species of whiteflies) [1]
INSECT	Csp	L	Aleyrodidae: *Bemisia argentifolii* (silverleaf whitefly, sweetpotato whitefly) [1] (NR)
INSECT	Asp, Ce, Csp, Xsp	L, P/C	Aleyrodidae: Family of whiteflies [78]
INSECT	Csp	L	Aleyrodidae: *Trialeurodes vaporariorum* (greenhouse whitefly) [2]
INSECT	Ce, Csp, Xsp	L, P/C	Aleyrodidae; *Bemisia tabaci* (cotton whitefly, sweetpotato whitefly) [6] (NR)
INSECT	Xsp	C	Anthicidae: Family of ant-like flower beetles [1] (NR)
INSECT	Csp, Xsp	C. P/C	Anthocoridae: Family of flower bugs, minute plant bugs [2]
INSECT	Ce, Csp	S, P/C	Anthribidae: *Araecerus fasciculatus* (coffee bean weevil) [2] (NR)
INSECT	Ce, Csp, Xsp	L, P/C	Aphididae: *Aphis gossypii* (cotton aphid, melon aphid) [27] (NR)
INSECT	Ce, Csp	L, P/C	Aphididae: *Aphis sp* . (species of bean aphids) [2]
INSECT	Asp, Ce, Csp, Xh, Xsp	L, P/C	Aphididae: Family of aphids [54] (NR)
INSECT	Asp, Csp	P/C	Aphididae: *Pentalonia nigronervosa* (banana aphid) [2] (NR)
INSECT	Csp	L	Aphididae: *Rhopalosiphum nymphaeae* (waterlily aphid) [1] (NR)
INSECT	Ce	P/C	Arctiidae: *Cosmosoma sp.* (species of tiger moths) [1]
INSECT	Csp	P/C	Arctiidae: Ctenuchinae (Subfamily of wasp moths) [1]
INSECT	Ce, Xv, Xsp	P/C	Arctiidae: Family of tiger moths and lichen moths [5]
INSECT	Xsp	C	Arctiidae; *Halysidota sp.* (species of tiger moths) [1]
INSECT	Asp	L	Asterolecaniidae: *Asterolecanium pustulans* (oleander pit scale) [1] (NR)
INSECT	Xs	P/C	Blatellidae: Family of common, German, household, and other cockroaches [1] (NR)
INSECT	Xsp	C	Blattidae: Family of American, oriental and other common cockroaches [1] (NR)
INSECT	Asp	S	Blissidae: *Ischnodemus sallei* (NCN; in group called seed bugs) [1] (NR)
INSECT	Xsp	C	Bostrichidae: *Dendrobiella sericans* (NCN; in group called horned powderpost beetles) [1] (NR)
INSECT	Asp	P/C	Bostrichidae: *dinoderus minutus* (powderpost beetle) [1] (NR)
INSECT	Xsp	C	Bostrichidae: Family of wood boring beetles [1]
INSECT	Xsp	C, P/C	Bostrichidae: *Heterobostrychus aequalis* (oriental wood borer) [2] (NR)
INSECT	Ce	C	Bostrichidae: *Xylobiops sp* . (species of horned powder post beetles) [1]
INSECT	Ce, Xsp	C, L	Braconidae: Family of braconid parasitic wasps [2] (NR)
INSECT	Ce	C, P/C	Brentidae: *Cylas sp* . (species of sweetpotato weevils) [2]
INSECT	Xsp	C	Cantharidae: Family of soldier beetles [1] (NR)
INSECT	Ce	C	Carabidae: Family of tiger beetles [6] (NR)
INSECT	Ce	C	Cecidomyiidae: *Camptomyia sp* . (species of gall midges) [3] (NR)
INSECT	Ce, Xsp	C, C/P	Cecidomyiidae: *Clinodiplosis sp.* (species of gall midges) [4] (NR)
INSECT	Xsp	P/C	Cecidomyiidae: *Contarinia sp* . (species of leaf-folding gall midges) [2]

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce	C	Cecidomyiidae: Family of gall midges or gall gnats [18]
INSECT	Xsp	P/C	Cecidomyiidae: *Lestodiplosis sp* . (NCN; species of predator cecidomyids) [1] (NR)
INSECT	Xsp	P/C	Cecidomyiidae: Lestremiinae (Subfamily of gall midges) [1] (NR)
INSECT	Ce	P/C	Cerambycidae: *Adetus sp* . (species of flat-faced long-horned beetles) [1] (NR)
INSECT	Xs	P/C	Cerambycidae: Cerambycinae (Subfamily of long-horned beetles) [2]
INSECT	Ce	P/C	Cerambycidae: *Chorida festiva* (NCM; a species of long-horned beetle) [1]
INSECT	Xsp	P/C	Cerambycidae: *Eupogonius sp* . (NCN; species of flat-faced long-horned beetles) [1] (NR)
INSECT	Ce	P/C	Cerambycidae: Family of long-horned beetles [1]
INSECT	Xsp	C	Cerambycidae: *Malondon dasystomus* (hardwood stump borer) [1] (NR)
INSECT	Ce	P/C	Cerambycidae: *Psapharochrus sp* . (NCN; species of long-horned beetles) [1]
INSECT	Asp	P/C	Cerambycidae: *Sybra alternans* (NCN; a species of long-horned beetle) [1]
INSECT	Xsp	C	Ceratopogonidae: Family of biting midges [2] (NR)
INSECT	Csp	L	Cercopidae: Family of froghoppers and spittle bugs [1]
INSECT	Am	P/C	Chalcididae: Family of Chalcid parasitic wasps [1] (NR)
INSECT	Asp	S	Chironomidae: Family of non-biting midges [2] (NR)
INSECT	Asp	P/C	Chrysomelidae: *Agroiconota sp.* (NCN; species of leaf beetles) [1]
INSECT	Ce, Xsp	C, P/C	Chrysomelidae: Alticinae (Subfamily of flea beetles) [4]
INSECT	Ce, Xsp	P/C	Chrysomelidae: *Brachypnoea sp.* (species of leaf beetles) [2]
INSECT	Ce	S, P/C	Chrysomelidae: *Colaspis sp.* (NCN; species of chrysomelids) [2]
INSECT	Ce, Xsp	S, P/C	Chrysomelidae: *Diabrotica sp.* (species of rootworms and wireworms) [2]
INSECT	Xs	C	Chrysomelidae: *Disonycha sp.* (species of flea beetles) [1]
INSECT	Ce, Xh, Xsp	C. L, P/C	Chrysomelidae: Family of leaf and flea beetles [3]
INSECT	Ce, Xsp	P/C	Chrysomelidae: Galerucinae (Subfamily of leaf and flea beetles) [4]
INSECT	Xsp	P/C	Chrysomelidae: Hispinae (Subfamily of leaf and flea beetles) [1]
INSECT	Ce	P/C	Chrysomelidae: *Microtheca sp.* (species of leaf beetles) [1]
INSECT	Csp	P/C	Chrysomelidae: *Rhabdopterus sp.* (species of oval leaf beetles) [1]
INSECT	Xs	P/C	Cicadellidae: *Chlorogonalia ultima* (NCN; a species of leafhopper) [1]
INSECT	Asp, Ce, Csp, Xh	L, P, P/C	Cicadellidae: Family of leafhoppers [38]
INSECT	Csp	P/C	Cicadellidae: *Hortensia similis* (NCN; a species of leafhopper) [1] (NR)
INSECT	Ce	C	Cicadellidae: Typhlocybinae (Subfamily of sharpshooters) [1]
INSECT	Ce	C	Cicadidae: Family of cicadas [1]
INSECT	Ce	L	Coccidae: *Coccus viridis* (coffee green scale, greeen scale) [1]
INSECT	Asp, Csp, Xsp	L, P/C	Coccidae: Family of soft scales [3]
INSECT	Csp	L	Coccidae: *Prococcus actuissimus* (mango shield scale) [1] (NR)
INSECT	Ce	L	Coccidae: *Vinsonia stellifera* (stellate scale) [1]
INSECT	Ce, Asp	P/C	Coleoptera: Order of beetles [6] (NR)
INSECT	Ce, Csp	C, L	Collembola: Order of springtails [2] (NR)
INSECT	Xsp	P/C	Coreidae: *Cebrenis centrolineata* (NCN; a species of leaf-footed bug) [1]
INSECT	Ce	C	Coreidae: Family of leaf-footed bugs [1]
INSECT	Ce	P/C	Corticariidae (now Latridiidae): Family of minute brown scavenger beetles [1] (NR)
INSECT	Ce	C	Cosmopterigidae: *Pyroderces sp.* (NCN; species of pyralid moths) [1] (NR)

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce	C	Crambidae: *Cacographis osteolalis* (NCN; a species of pyralid moth) [1]
INSECT	Ce, Csp, Sb, Xh, Xsp	L, P/C	Crambidae: *Diaphania nitidalis* (pickleworm) [6] (NR)
INSECT	Ce, Xs, Xsp	C, L	Crambidae: Family of grass moths [4]
INSECT	Xb, Xh, Xsp	L, P/C	Crambidae: *Herpetogramma bipunctalis* (two-spotted herptogramma moth) [6] (NR)
INSECT	Xh	L	Crambidae: *Pyrausta sp.* (species of snout moths) [1]
INSECT	Ce, Csp	L, P/C	Crambidae: Pyraustinae (Subfamily of crambid snout moths) [3]
INSECT	Xb	P/C	Crambidae: *Rhectocraspeda periusalis* (NCN; a species of pyralid moth) [1] (NR)
INSECT	Ce, Xb, Xh, Xsp	L, P/C	Crambidae: *Spoladea recurvalis* (beet webworm, Hawaiian beet webworm) [19] (NR)
INSECT	Xsp	C	Cryptophagidae: Family of silken fungus beetles [1] (NR)
INSECT	Asp, Ce	C	Cucujidae: Family of flat bark beetles [2] (NR)
INSECT	Ce, Xsp	C, P/C	Curculionidae: *Anchonus sp.* (NCN; species of cucurlionid weevils) [3]
INSECT	Csp	L	Curculionidae: Baridinae (Subfamily of curculionid weevils) [1]
INSECT	Xsp	C	Curculionidae: *Catolethrus sp.* (NCN; species of curculionid weevils) [1]
INSECT	Xs, Xsp	C, P/C	Curculionidae: *Conotrachelus sp.* (species of curculionid weevils) [2]
INSECT	Csp	L	Curculionidae: Cossoninae (Subfamily of snout and bark weevils [1]
INSECT	Ce	C	Curculionidae: Cyclominae (Subfamily of curculionid weevils) [1]
INSECT	Asp	C	Curculionidae: *Elytroteinus subtruncatus* (ginger weevil) [1]
INSECT	Xsp	P/C	Curculionidae: *Eubulus sp.* (NCN; species of curculionid weevils) [1]
INSECT	Ce	C, P/C	Curculionidae: Family of weevils [83]
INSECT	Ce	C	Curculionidae: *Faustinus sp.* (tomato weevil) [1]
INSECT	Ce	P/C	Curculionidae: *Heilipodus sp.* (species of root-boring weevils) [2]
INSECT	Ce	P/C	Curculionidae: *Listronotus sp.* (species of stem weevils) [1]
INSECT	Ce, Csp	C, P/C	Curculionidae: Molytinae (Subfamily of flightless weevils) [10]
INSECT	Ce, Csp	C, P/C	Cyclorrhapha: Suborder of flies considered advanced based on evolution [4] (NR)
INSECT	Ce	P/C	Cydnidae: *Amnestus sp.* (NCN; species of burrower bugs) [1]
INSECT	Ce	C	Cydnidae: *Dallasiellus alutaceus* (NCN; a species of burrowing bug) [1]
INSECT	Xsp	P/C	Cydnidae: *dallasiellus lugubris* (NCN; a species of burrowing bug) [1] (NR)
INSECT	Xs, Xsp	C, S, P/C	Cydnidae: Family of burrower (a.k.a. burrowing) bugs [9]
INSECT	Ce, Csp	P/C	Cydnidae: Pangaeus sp. (NCN; species of burrowing bugs) [2]
INSECT	Ce, Xsp	C, P/C	Cydnidae: *tominotus unisetosus* (NCN; a species of burrowing bug) [3] (NR)
INSECT	Ce. Csp	F, L, P/C	Delphacidae: Family of plant hoppers [12]
INSECT	Ce	P/C	Dermaptera: Order of earwigs [1] (NR)
INSECT	Csp	S	Dermestidae: *Dermestes sp.* (species of carpet beetles) [1] (NR)
INSECT	Ce	P/C	Diaspididae: *Aspidiella hartii* (rhizome scale) [1]
INSECT	Csp	P/C	Diaspididae: *Aspidiotus destructor* (coconut [brown] scale) [1] (NR)
INSECT	Asp	P/C	Diaspididae: *Aspidiotus excisus* (cyanotis scale) [1] (NR)
INSECT	Ac, Asp	F, P/C	Diaspididae: *Aspidiotus sp.* (species of armored plant scales) [2]
INSECT	Ce	P/C	Diaspididae: *Aulacaspis tubercularis* ([white] mango scale) [1]
INSECT	Xsp	L	Diaspididae: *Chrysomphalus aonidum* (black scale, Florida red scale) [1] (NR)
INSECT	Ce, Xsp	F. P/C	Diaspididae: Family of hard or armored scales [4]
INSECT	Asp, Ce, Csp, Xs	C, F, L, S, P/C	Diptera: Order of flies, mosquitos, and gnats [9] (NR)

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce	C	Dolichopodidae: Family of long-legged flies [1] (NR)
INSECT	Csp	C, S, P/C	Drosophilidae: Family of vinegar and pomace flies [3] (NR)
INSECT	Asp	P/C	Dryophthoridae: Family of palm and cane weevils [1]
INSECT	Ce	P/C	Dryophthoridae: *Metamasius dimidiatipennis* (a species of palm weevil) [1]
INSECT	Csp	P/C	Dryophthoridae: *Metamasius hemipterus* (silk cane weevil) [1]
INSECT	Ce, Xsp	C, P/C	Dryophthoridae: *Metamasius sp* . (species of palm and cane weevils) [4]
INSECT	Xsp	C	Dryophthoridae: *Rhynchophorus palmarum* (American palm weevil) [1]
INSECT	Ce, Xsp	C, P/C	Dryophthoridae: *Sitophilus sp* . (species of weevils including stored product weevils) [2] (NR)
INSECT	Csp, Xsp	C, P/C	Elateridae: *Aeolus sp.* (NCN; species of click beetles) [3]
INSECT	Xsp	C	Elateridae: *Conoderus exclamationis* (NCN; a species of click beetle) [1]
INSECT	Ce	P/C	Elateridae: *Conoderus falli* (southern potato wireworm, tobacco wireworm) [1]
INSECT	Ce, Csp	C, P/C	Elateridae: *Conoderus sp* . (species of click beetles and wireworms) [3]
INSECT	Ce, Xsp	C, P/C	Elateridae: *Dipropus sp.* (species of clickbeetles) [2]
INSECT	Ce, Xsp	C, P/C	Elateridae: Family of click beetles and wireworms [2]
INSECT	Ce	P/C	Elateridae: *Heteroderes amplicollis* (gulf wireworm) [1] (NR)
INSECT	Ce	C	Elateridae: *Neotrichophorus sp* . (NCN; species of click beetles) [1] (NR)
INSECT	Xs	P/C	Elateridae: *Pyrophorus texanus* (NCN; a species of click beetle) [1] (NR)
INSECT	Xsp	C	Elmidae: Family of riffle beetles [1] (NR)
INSECT	Xh	L	Eulophidae: *Diglyphus sp.* (species of parasitic wasps on leafminers) [1] (NR)
INSECT	Csp	S	Flatidae: Family of [flatid] planthoppers [1]
INSECT	Csp	C	Forficulidae: Family of earwigs associated with plants and plant detritus [1] (NR)
INSECT	Ce	P/C	Formicidae: *Atta sp* . (species of leaf cutter ants) [2]
INSECT	Ce	C	Formicidae: *Brachymyrmex sp* . (species of very minute ants) [1] (NR)
INSECT	Ce	P/C	Formicidae: Formicinae (Subfamily of ants) [1] (NR)
INSECT	Xsp	C	Formicidae: *Monomorium pharaonis* (pharoah ant) [1] (NR)
INSECT	Ce	P/C	Formicidae: Myrmicinae (Subfamily of ants) [1]
INSECT	Ce	P/C	Formicidae: *Odontomachus troglodytes* (trap-jaw ant) [2] (NR)
INSECT	Asp, Ce, Xsp	C, P/C	Formicidae: *Paratrechina longicornis* (crazy ant) [3] (NR)
INSECT	Ce, Xsp	C, P/C	Formicidae: *Pheidole sp.* (NCN; species of ants) [2]
INSECT	Csp	C	Formicidae: Ponerinae (Subfamily of ants) [1] (NR)
INSECT	Ce	C	Formicidae: *Solenopsis invicta* (red imported fire ant) [1] (NR)
INSECT	Xsp	C	Formicidae: Solenopsis sp. (species of fire ants) [1] (NR)
INSECT	Ce	C	Formicidae: *Tetramorium bicarinatum* (tramp ant) [1] (NR)
INSECT	Ce	P/C	Formicidae: *Wasmannia auropunctata* (little fire ant) [1] (NR)
INSECT	Ce, Xsp	C, S, P/C	Formicidae: *Camponotus sp.* (species of carpenter ant) [3] (NR)
INSECT	Ce	C	Formicidae: *Tapinoma melanocephalum* (ghost ant) [1] (NR)
INSECT	Ce	P/C	Fulgoridae: Family of lanternflies and [fulgorid] planthoppers [1]
INSECT	Ce	L	Gelechiidae: Family of twirler moths [1]
INSECT	Asp, Ce, Xsp	L, S, P/C	Geometridae: Family of geometer moths [3]
INSECT	Xsp	P/C	Geometridae: *Nemoria sp.* (species of emerald moths) [1]

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]]
INSECT	Csp	P/C	Gracillariidae: Family of leaf miner moths [1]
INSECT	Ce, Xv	P/C	Gryllidae: *Acheta domestica* (house cricket) [2] (NR)
INSECT	Ce, Csp	P/C	Gryllidae: *Allonemobius sp.* (species of ground crickets) [2]
INSECT	Ce	P/C	Gryllidae: *Allonemobius sp.* (species of striped cricket) [1]
INSECT	Ce	C	Gryllidae: *Amphiacusta caraibea* (NCN; a species of cricket) [1]
INSECT	Ce, Xsp	C	Gryllidae: *Anaxipha sp.* (species of trig crickets) [4]
INSECT	Ce	P/C	Gryllidae: *Anurogryllus sp.* (species of short-tailed crickets) [1]
INSECT	Csp	C	Gryllidae: *Argizala sp.* (NCN; species of crickets) [1]
INSECT	Xsp	P/C	Gryllidae: Family of crickets [6]
INSECT	Ce	P/C	Gryllidae: *Gryllodes sigillatus* (house cricket, tropical house cricket, banded cricket) [3] (NR)
INSECT	Xsp	P/C	Gryllidae: *Gryllus assimilis* (field cricket) [1] (NR)
INSECT	Xsp	P/C	Gryllidae: *Gryllus capitatus* (field cricket) [1]
INSECT	Asp, Ce, Csp, Xv, Xsp	C, P/C	Gryllidae: *Gryllus sp.* (field crickets) [57]
INSECT	Xsp	P/C	Gryllidae: *Miogryllus convulutus* (NCN; a species of cricket) [2]
INSECT	Ce, Csp, Xs, Xsp	C, P/C	Gryllidae: *Miogryllus sp* . (NCN; species of crickets) [9]
INSECT	Xs	P/C	Gryllidae: *Neonemobius sp.* (NCN; species of ground crickets) [1]
INSECT	Ce	C	Gryllidae: *Pteronemobius sp* . (species of field cricket) [1]
INSECT	Ce, Csp, Xsp	P/C	Gryllidae: *Pteronemobius sp* . (species of field crickets) [3]
INSECT	Ce	P/C	Gryllotalpidae: *Scapterisus sp.* (NCN; species of mole crickets)
INSECT	Ce, Cea, Csp	L, P/C	Hemiptera: Homoptera (Suborder of true bugs with piercing-sucking mouthparts, e.g., soft scales, mealybugs) [3]
INSECT	Asp, Ce, Csp	L, P/C	Hemiptera: Herteroptera (Suborder of true bugs with distinctive front wings, e.g., plant, seed and stink bugs [14]
INSECT	Ce	L	Hesperiidae: Family of skipper butterflies [1]
INSECT	Ce	C, P/C	Histeridae: Family of clown beetles or hister beetles [3] (NR)
INSECT	Xsp	C	Hydrophilidae: Family of water scavenger beetles [1] (NR)
INSECT	Ce	C	Hymenoptera: Order of bees, wasps, yellowjackets, hornets, bumblebees, ants [2]
INSECT	Asp, Xsp	C, L	Ichneumonidae: Ichneumonoidea (SubFamily of ichneumon parasitic wasps) [2] (NR)
INSECT	Ce	L	Isoptera: Order of termites [1]
INSECT	Ce	C, S, P/C	Lampyridae: Family of fireflies and lightning bugs [1] (NR)
INSECT	Ce	C, L, S, P/C	Lepidoptera: Order of butterflies, moths, and skippers [23]
INSECT	Ce, Csp	C. L, P/C	Lygaeidae: Family of lygaeid bugs, seed bugs, chinch bugs [3]
INSECT	Ce	S	Lygaeidae: *Nysius sp.* (species of seed bugs) [1]
INSECT	Ce	P/C	Lygaeidae: *Ochrostomus puchellus* (NCN; a species of seed bug) [1]
INSECT	Ce, Xs	C, P/C	Margarodidae: Family of cottony cushion scales [2]
INSECT	Ce	P/C	Megalopygidae: *Norape argnorrhoea* (NCN; a species of flannel moth) [1]
INSECT	Ce	C	Meloidae: *Epicauta sp.* (NCN; species of blister beetles) [1]
INSECT	Xs	C	Meloidae: *Pyrota sp.* (NCN; species of blister beetles) [1]
INSECT	Xsp	C	Micropezidae: Family of stilt-legged flies [1] (NR)
INSECT	Csp	L	Miridae: *Cyrtorhinus lividipennis* (NCN; a species of predaceous mirid plant bug) [1] (NR)
INSECT	Ce, Csp, Xs, Xsp	C, P/C	Miridae: *Eurychilella sp.* (species of plant bugs) [10]
INSECT	Asp, Ce, Csp, Xsp	F, L, P/C	Miridae: Family of plant bugs [11]
INSECT	Ce, Xsp	C	Miridae: *Fulvus sp.* (NCN; species of predaceous plant bugs) [2] (NR)

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce	L	Miridae: *Rhinacloa cardini* (NCN; a species of mirid plant bug) [1]
INSECT	Ce	P/C	Muscidae: Family of muscid flies (e.g., housefly) [1]
INSECT	Ce, Csp	S, P/C	Mycetophagidae: Family of hairy fungus beetles [2]
INSECT	Asp	C	Mycetophagidae: Mycetophagus sp. (NCN; species of mold-eating fungus beetles) [1]
INSECT	Asp, Ce, Csp	C, P/C	Mycetophagidae: *Typhaea stercorea* (hairy fungus beetle) [3] (NR)
INSECT	Csp	P	Neuroptera: Order of lacewings [1] (NR)
INSECT	Xb	L	Nitidulidae: *Carpophilus sp.* (species of sap and yucca beetles) [1] (NR)
INSECT	Ce, Csp, Xsp	C, P/C	Nitidulidae: Family of sap-feeding beetles, souring beetles [15] (NR)
INSECT	Ce	L	Noctuidae: *Argyrogramma verruca* (golden looper moth) [1] (NR)
INSECT	Csp	L	Noctuidae: *Chrysodeixis eriosoma* (green garden looper moth) [2]
INSECT	Ce	C	Noctuidae: *Copitarsia sp.* (species of cutworm moths) [1]
INSECT	Asp, Ce, Csp, Xs, Xsp	L, P/C	Noctuidae: Family of owlet moths [69]
INSECT	Csp	L	Noctuidae: *Heliocoverpa zea* (corn earworm) [1] (NR)
INSECT	Asp	P/C	Noctuidae: *Mamestra brassicae* (cabbage moth) [1]
INSECT	Ce	C, L	Noctuidae: *Plusiinae sp.* (species of semi-loopers and measuring [inch] worms) [2]
INSECT	Xsp	L	Noctuidae: *Pseudoplusia includens* (soybean looper) [1] (NR)
INSECT	Xh	L	Noctuidae: *Spodoptera androgea* (a species of tropical armyworm moth) [1]
INSECT	Xsp	L	Noctuidae: *Spodoptera eridania* (southern armyworm) [1] (NR)
INSECT	Asp, Ce, Xh	L, P/C	Noctuidae: *Spodoptera exigua* (beet armyworm) [4] (NR)
INSECT	Xb	P/C	Noctuidae: *Spodoptera frugiperda* (fall armyworm) [1] (NR)
INSECT	Ce, Xsp	L, P/C	Noctuidae: *Spodoptera latifascia* (garden armyworm) [3] (NR)
INSECT	Asp	P/C	Noctuidae: *Spodoptera litura* (oriental leafworm moth) [1]
INSECT	Asp, Ce, Csp	L, P/C	Noctuidae: *Spodoptera sp.* (species of armyworm moths) [5]
INSECT	Csp	L	Noctuidae: *Trichoplusia ni* (cabbage looper) [1] (NR)
INSECT	Ce	L	Noctuidae; *Heliocoerpa sp.* (species of corn earworm and bollworm moths) [1]
INSECT	Ce	P/C	Nocutidae: *Achaea janata* (croton caterpiller, caster oil semi-looper, caster oil moth) [1]
INSECT	Csp	P/C	Notodontidae: *Hapigia nodicornis* (NCN; a species of prominent moth) [1]
INSECT	Asp, Ce	C, F, P/C	Otitidae: Family of picture-winged flies [3] (NR)
INSECT	Ce	L	Ottidae: *Euxesta sp.* (NCN; species of picture-winged flies) [1] (NR)
INSECT	Csp	C	Pemphigidae: *Patchiella reamuri* (NCN; a species of gall-forming aphid) [1]
INSECT	Xsp	C	Pentatomidae: *Berecynthus hastator* (NCN; a species of shieldbug [stinkbug]) [1]
INSECT	Xsp	C	Pentatomidae: *Euschistus sp.* (NCN; species of common brown shieldbugs [stinkbugs]) [1]
INSECT	Ce, Csp, Xh, Xsp	L, P/C	Pentatomidae: Family of shieldbugs [stinkbugs] [13]
INSECT	Xsp	C	Pentatomidae: *Macropygium sp.* (NCN; species of shieldbugs [stinkbugs]) [1]
INSECT	Xh, Xsp	L	Pentatomidae: *Nezara viridula* (southern green stinkbug, green vegetable bug) [2] (NR)
INSECT	Ce	P/C	Pentatomidae: *Oebalus mexicana* (NCN; a species of shieldbug [stinkbug]) [1] (NR)
INSECT	Ce	C	Pentatomidae: *Euschistus sp.* (species of brown shieldbugs [brown stinkbugs]) [1]
INSECT	Ce	P/C	Phalacridae: Family of shining flower beetles [1] (NR)
INSECT	Asp	P/C	Phlaeothripidae: Family of very diverse Thysanoptera (thrips) [1]
INSECT	Ce	P/C	Phoridae: *Pulichiphora borinquenensis* (NCN; a species of scuttle fly) [1] (NR)
INSECT	Xs	P/C	Platypodidae: *Euplatypus parallelus* (ambrosia beetle) [1] (NR)

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce, Xs, Xb	C. L, P/C	Plutellidae: *Plutella xylostella* (diamondback moth) [3] (NR)
INSECT	Ce, Csp, Xsp	C, P/C	Pseudococcidae: *Dysmicoccus brevipes* (pineapple mealybug) [9] (NR)
INSECT	Xsp	C	Pseudococcidae: *Dysmicoccus hambletoni* (NCN; a species of mealybug found on palms) [1]
INSECT	Ce	P/C	Pseudococcidae: *Dysmicoccus mackenziei* (NCN; a species of mealybug found on pineapple) [1]
INSECT	Csp	P/C	Pseudococcidae: *Dysmicoccus neobrevipes* (grey pineapple mealybug) [1]
INSECT	Asp, Ce, Xsp	C, P/C	Pseudococcidae: Dysmicoccus sp. (species of mealybugs) [3]
INSECT	C, F, L, Ce	C. L, P/C	Pseudococcidae: Family of mealybugs [71]
INSECT	Asp, Ce, Xsp	C, P/C	Pseudococcidae: *Ferrisia virgata* (striped mealybug) [3] (NR)
INSECT	Ce, csp	C	Pseudococcidae: *Geococcus coffae* (coffee root mealybug) [2]
INSECT	Csp	L	Pseudococcidae: *Maconellicoccus hirsutus* (pink, grape, or hybiscus mealybug) [1]
INSECT	Csp	P/C	Pseudococcidae: *Mutabilicoccus sp.* (NCN; species of mealybugs) [1]
INSECT	Csp	L	Pseudococcidae: *Paracoccus sp.* (NCN; species of mealybugs) [1]
INSECT	Ce	S	Pseudococcidae: *Paraputo leveri* (NCN; a species of mealybug common to the Pacific Basin) [1]
INSECT	Ce	C	Pseudococcidae: *Paraputo sp.* (NCN; species of mealybugs) [3]
INSECT	Xb, Xsp	P/C	Pseudococcidae: *Planococcus citri* (citrus mealybug) [2] (NR)
INSECT	Asp	F, P/C	Pseudococcidae: *Planococcus minor* (passionvine mealybug) [2]
INSECT	Ce, Csp	C, P/C	Pseudococcidae: *Planococcus sp.* (species of mealybugs) [2]
INSECT	Asp	S	Pseudococcidae: *Pseudococcus longispinus* (longtailed mealybug) [1] (NR)
INSECT	Ce, Csp	C, L	Pseudococcidae: *Pseudococcus sp.* (species of mealybugs) [2]
INSECT	Ce	P/C	Pseudococcidae: *Rastrococcus spinosus* (white, mango, or Philippine mango mealybug) [1]
INSECT	Ce	C	Pseudococcidae: *Rhizoecus sp.* (NCN; species of mealybugs) [3]
INSECT	Asp	P/C	Psocoptera: Order of book lice and bark lice [1] (NR)
INSECT	Asp, Ce	F, L	Psychidae: Family of bagworm moths [2]
INSECT	Ce	C	Psychodidae: Family of moth flies, sand flies, and drain flies [1] (NR)
INSECT	Ce	C	Psyllidae: *Diaphorina citri* (Asian citrus psillid) [1]
INSECT	Ce	L	Psyllidae: Family of jumping plant lice [2]
INSECT	Xsp	L	Pterophoridae: Family of plume moths [1]
INSECT	Ce, Csp, Xb, Xsp	C, L, P/C	Pyralidae: Family of bee moths, snout moths, corn borers, flour moths, cactus moths, and others [10]
INSECT	Csp	C	Pyrrhocoridae: *Dysdercus andreae* (St. Andrew's cotton stainer) [1] (NR)
INSECT	Ce	P/C	Pyrrhocoridae: *Dysdercus mimus* (NCN; a pyrhocorid species) [2] (NR)
INSECT	Xs	P/C	Reduviidae: Family of assassin bugs [1] (NR)
INSECT	Ce	C	Rhinotermitidae: Family of subterranean termites [1]
INSECT	Ce	P/C	Rhopalidae: *Jadera coturnix* (NCN; a species of scentless plant bugs) [1]
INSECT	Ce	P/C	Rhyparochromidae: *Cistalia sp.* (species of dirt-colored seed bugs) [1]
INSECT	Asp	P/C	Rhyparochromidae: *Drymus sp.* (NCN; species of dirt-colored seed bugs) [1]
INSECT	Xsp	P/C	Rhyparochromidae: Family of dirt-colored seed bugs [1]
INSECT	Csp	P/C	Rhyparochromidae: *Froeschneria multispinus* (NCN; a species of dirt-colored seed bug) [1]
INSECT	Xsp	C	Rhyparochromidae: *Heraeus eximus* (NCN; a species of dirt-colored seed bug) [1] (NR)
INSECT	Ce, Csp	C, P/C	Rhyparochromidae: *Heraeus sp.* (species of dirt-colored seed bugs) [2]
INSECT	Ce, Xsp	C, P/C	Rhyparochromidae: *Myodocha sp.* (NCN; species of dirt-colored seed bugs) [2]
INSECT	Ce	P/C	Rhyparochromidae: *Neopamera albocincta* (NCN; a species of dirt-colored seed bug) [1] (NR)

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce	P/C	Rhyparochromidae: *Neopamera bilobata* (NCN; a species of dirt-colored seed bug) [1] (NR)
INSECT	Ce	P/C	Rhyparochromidae: *Neopamera neotropicalis* (NCN; a species of dirt-colored seed bug) [1] (NR)
INSECT	Ce, Xsp	P/C	Rhyparochromidae: *Ozophora sp.* (NCN; species of dirt-colored seed bugs) [2]
INSECT	Ce	P/C	Rhyparochromidae: *Paragonatas divergens* (NCN; a species of dirt-colored seed bug) [5] (NR)
INSECT	Ce, Xsp	C, P/C	Rhyparochromidae: *Prytanes oblonga* (NCN; a species of dirt-colored seed bug) [2] (NR)
INSECT	Csp, Xs	S, P/C	Rhyparochromidae: *Pseudopachybrachius sp.* (NCN; species of dirt-colored seed bugs) [2]
INSECT	Xs	C	Saturniidae: *Syssphinx colla* (giant silkworm moths, wild silkworm moths, royal moths) [1]
INSECT	Xs	C	Scarabaeidae: *Ataenius sp.* (NCN; species of scarab beetles) [1] (NR)
INSECT	Ce, Xs, Xsp	C, P/C	Scarabaeidae: *Cyclocephala sp.* (rhinoceros beetle) [21]
INSECT	Xs	C	Scarabaeidae: *Pelidnota sp.* (species of scarab beetles) [1]
INSECT	Asp, Ce, Csp	L, P/C	Scarabeidae: *Adoretus sinicus* (chinese rose beetle) [3]
INSECT	Ce, Xs, Xsp	P/C	Scarabeidae: *Anomala sp.* (NCN; species of scarab beetles) [4]
INSECT	Ce, Xsp	P/C	Scarabeidae: Aphodiinae (Subfamily of dung beetles) [7] (NR)
INSECT	Ce, Xsp	P/C	Scarabeidae: *Ceraspis sp.* ()NCN; species of scarab beetles) [2]
INSECT	Ce	C, P/C	Scarabeidae: Dynastinae (Subfamily of rhinoceros beetles) [3]
INSECT	Ce	P/C	Scarabeidae: *dyscinetus dubius* (NCN; a species of dung beetle) [1]
INSECT	Ce, Csp, Xsp	C, P/C	Scarabeidae: *Dyscinetus sp.* (species of dung or leaf chafer beetles) [8]
INSECT	Ce, Csp, Xs, Xsp	C, P/C	Scarabeidae: Family of scarab, dung, and leaf chafer beetles [9] (NR)
INSECT	Ce, Xsp	C, P/C	Scarabeidae: Melononthinae (Subfamily of scarab beetles [grass grubs]) [2]
INSECT	Xsp	C	Scarabeidae: *Onthophagus sp.* (species of dung beetles) [1] (NR)
INSECT	Ce	P/C	Scarabeidae: *Plectris sp.* (NCN; species of scarab beetles) [3]
INSECT	Ce	C	Scarabeidae: Rutelinae (Subfamily of leaf chafer beetles) [1]
INSECT	Ce	C, P/C	Scarabeidae: *Stenocrates sp.* (NCN; speceis of scarab beetles) [2]
INSECT	Ce	C	Scarabeidae: *Strategus sp.* (species of ox beetles) [1]
INSECT	Ce, Xs, Xsp	C, P/C	Scarabeidae: *Pyllophaga sp.* (species of June beetles [June bugs]) [7]
INSECT	Ce, Csp, Xsp	C, P/C	Scarabidae: *Tomarus sp.* (species of sugarcane and other root grubs) [6]
INSECT	Ce	C	Scatopsidae: Family of dung midges [2] (NR)
INSECT	Asp, Ce, Xsp	C, P/C	Sciaridae: Family of dark-winged fungus gnats, fungus gnats [8] (NR)
INSECT	Xsp	C	Scolytidae: *Coccotrypes sp.* (species of stem boring beetles) [1]
INSECT	Ce, Xsp	C, P/C	Scolytidae: *Xyleborus ferrugineus* (ambrosia beetle) [1] (NR)
INSECT	Am, Xsp	P/C	Silvanidae: *Ahasverus advena* (foreign grain beetle) [2] (NR)
INSECT	Ce	P	Sminthuridae: Family of collembola [springtails] [1]
INSECT	Ce	L	Sphaeroceridae: Family of lesser dung flies [1] (NR)
INSECT	Xsp	P/C	Sphingidae: *Erinnyis ello* (ello sphynx moth, ello sphynx caterpiller) [1] (NR)
INSECT	Ce	L	Sphingidae: *Manduca sp.* (species of hornworms [hornworm moths]) [1]
INSECT	Ce, Csp, Xs, Xsp	C, P/C	Staphylinidae: Family of rove beetles [12] (NR)
INSECT	Ce	P/C	Stratiomyidae: Family of soldier flies [1] (NR)
INSECT	Ce	C	Syrphidae: *Copestylum sp.* (species of flower flies) [1]
INSECT	Ce, Csp	F, L, P/C	Syrphidae: Family of hover flies and flower flies [11] (NR)
INSECT	Ce	C	Tenebrionidae: *Alegoria dilatata* (NCN; a species of darkling ground beetle) [1] (NR)
INSECT	Ce, Xs, Xsp	C, P/C	Tenebrionidae: *Alphitobius diaperinus* (lesser mealworn) [6] (NR)

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
INSECT	Ce, Xsp	P/C	Tenebrionidae: *Alphitobius laevigatus* (black fungus beetle) [4] (NR)
INSECT	Ce	P/C	Tenebrionidae: *Armalia sp.* (species of finely-punctated dark-red tenebrionid) [1] (NR)
INSECT	Asp, Ce	P/C	Tenebrionidae: Family of darkling ground beetles [5] (NR)
INSECT	Xsp	C	Tenebrionidae: *Lobometopon metallicum* (NCN; a species of darkling ground beetle) [1]
INSECT	Xsp	C	Tenebrionidae: *Opatrinus sp. (* species of darkling ground beetles) [1]
INSECT	Ce	C, P/C	Tenebrionidae: *Tenebrio sp.* (species of darkling ground beetles) [2] (NR)
INSECT	Ce	P/C	Tenebrionidae: *Blapstinus sp.* (species of darkling ground beetle) [21]
INSECT	Xs	C	Tephritidae: *Anastrepha sp.* (species of tephritid fruit flies) [1]
INSECT	Ce	P/C	Termitidae: *Nasutitermes ephrata* (NCN; a species of termite) [2]
INSECT	Xs	C	Tettigoniidae: *Conocephalus sp.* (species of lesser meadow katydids) [1]
INSECT	Ce	S	Tettigoniidae: *Neoconocephalus punctipes* (species of conehead katydid) [1]
INSECT	Xs	C	Tettigoniidae: *Neoconocephalus triops* (bright green katydid, broad-tipped conehead katydid) [1] (NR)
INSECT	Asp, Ce	F, L, P/C	Thripidae: Family of thrips [5]
INSECT	Csp, Xsp	P/C	Thripidae: *Frankliniella sp.* (species of flower thrips) [2]
INSECT	Ce	P/C	Thripidae: *Thrips fuscipennis* (rose thrips) [1] (NR)
INSECT	Xsp	L	Thripidae: *Thrips palmi* (melon thrips) [2]
INSECT	Csp	L, P/C	Thripidae: Thrips sp. (species of flower and leaf thrips) [2]
INSECT	Asp, Ce, Csp	L, P/C	Thysanoptera: Order of thrips [3]
INSECT	Asp, Ce, Csp, Xsp	P/C	Tineidae: Family of fungus moths [4]
INSECT	Ce	C, P/C	Tineidae: *Opogona sp.* (species of tineid moths) [4]
INSECT	Ce, Xsp	C	Tipulidae: Family of crane flies [3]
INSECT	Asp, Ce	P/C	Tipulidae: *Limonia sp.* (NCN; species of crane flies) [2] (NR)
INSECT	Asp, Ce, Csp	C, L, P/C	Tortricidae: Family of tortrix moths [7]
INSECT	Ce	P/C	Tortricidae: *Platynota sp.* (species of leafroller moths) [1] (NR)
INSECT	Ce	P/C	Trogossitidae: Family of bark-gnawing beetles [1] (NR)
INSECT	Ce, Csp	L, P/C	Tropiduchidae: Family of tropiduchid planthoppers [7]
INSECT	Csp	L	Tropiduchidae: *Kallitaxila granulata* (granary planthopper) [1]
INSECT	Ce	C	Zopheridae: Family of ironclad beetles [1] (NR)
INSECT	Ce	C	Zygaenidae: Family of smokey moths [1]
MITE	Ce	P/C	Astigmata: Suborder of Acari representing feather mites [1] (NR)
MITE	Ce	C	Laelapidae: Family of bee mites [1] (NR)
MITE	Xsp	C	Mesostigmata: Suborder of Acari representing free-living predatory mites [1] (NR)
MITE	Ce, Csp, Xsp	C, S, P/C	Oribatida (*syn* . Cryptostigmata): Suborder of Acari representing mites that live in soil [7] (NR)
MITE	Ce, Csp	C, P/C	Tarsonemidae: *Steneotarsonemus furcatus* (taro tarsonemid mite) [4] (NR)
MITE	Asp, Ce, Csp	C, L, P/C	Tetranychidae: *Tetranychus sp.* (spider mites) [18]
MITE	Asp, Xsp	C	Tydeidae: Family of yellow mites [2] (NR)
MITE	Ce	P/C	Uropididae: Family of parasitic mites [1] (NR)
ARTHROPOD	Ce, Csp, Xs, Xsp	L, P/C	Araneae: Subfamily of the arachnida (spiders) [4] (NR)
ARTHROPOD	Ce	P/C	Diplopoda: Order of millipedes [1] (NR)
ARTHROPOD	Ce, Csp	C, L	Isopoda: Order of pillbugs and sowbugs [2] (NR)
NEMATODE	Ce	C	Anguinidae: *Ditylenchus sp.* (species of stem and bulb nematodes) [1]

Pest	Host Plant Species[1]	Plant Part[2]	Pest Interception[3, 4, 5, 6, 7, 8] and [Number of Identical Interceptions[9]] (Action[10])
NEMATODE	Ce	P/C	Dorylaimidae: *Dorylaimus sp.* (species of swamp nematodes) [1] (NR)
NEMATODE	Ce	C, P/C	Rhabditidae: Family of free-living nematodes [3] (NR)
NEMATODE	Ce	C	Rhabditidae: *Caenorhabditis sp.* (species of nematodes that live in dead plant or animal matter) [1] (NR)
NEMATODE	Csp	P/C	Telotylenchidae: *Tylenchorhynchus sp.* (species of parasitic and stunt nematodes) [1]
ANNELIDA	Ce	P/C	Oligochaete: Subclass of earthworms and aquatic worms [2] (NR)
DISEASE	Asp, Ce, Csp, Xsp	C, L, P/C	Ceratocystidaceae: *Ceratocystis fimbriata* (black rot, moldy rot) [4] (NR)
DISEASE	Ce	L	Coelomycetes: *Camarosporium sp.* (NCN; species of endophytic fungi causing shoot and panicle blights) [1]
DISEASE	Asp, Csp	L, P/C	Coelomycetes: *Colletotrichum gloeosporioides* (anthracnose) [5] (NR)
DISEASE	Csp	L	Coelomycetes: *Phoma sp.* (species of endophytic fungi causing leaf spot, fruit spot, fruit rot) [1]
DISEASE	Asp	L	Coelomycetes: *Phyllosticta sp.* (species of endophytic fungi causing leaf spots) [1]
DISEASE	Ce	L	Hypomycetes: *Cercospora sp.* (species of endophytic fungi causing leaf spots and plant rots) [1]
DISEASE	Ce	P/C	Hypomycetes: *Fusarium sp.* (species of endophytic fungi causing blights) [2]
DISEASE	Csp	P/C	Mycosphaerellaceae: *Mycosphaerella sp.* (species of endophytic fungi causing leaf spot diseases) [1]
DISEASE	Ce	L	Pythiaceae: *Phytophthora colocasiae* (taro leaf blight) [1] (NR)
DISEASE	Ce	L	Ramalinaceae: Family of lichenized ascomycets (sac fungi) [1] (NR)
MOLLUSK	Asp, Ce, Csp	S, L, P/C	Achatinidae: *Achatina (Lissachatina) fulica* (giant African snail, east African snail) [24]
MOLLUSK	Asp, Ce, Csp, Xsp	C, L, S, P/C	Agriolimacidae: *Deroceras laeve* (marsh slug) [7] (NR)
MOLLUSK	Csp	P/C	Agriolimacidae: Family of common field and marsh slugs [1]
MOLLUSK	Ce	C, P/C	Ampullariidae: *Pomacea sp.* (species of apple snails) [2]
MOLLUSK	Asp	P/C	Ariophantidae: *Parmarion martensi* (yellow shelled slug) [1]
MOLLUSK	Asp, Csp, Xsp	L, S, P/C	Bradybaenidae: *Bradybaena similaris* (Asian tramp snail) [6] (NR)
MOLLUSK	Asp	P/C	Bulimulidae: *Bulimulus diaphanus* (NCN; a species of common snail) [1] (NR)
MOLLUSK	Asp	P/C	Bulimulidae: *Drymaeus sp.* (species of tree snails) [1] (NR)
MOLLUSK	Asp	P/C	Euconulidae: *guppya gundlachi* (glossy granule [snail]) [1] (NR)
MOLLUSK	Asp	S	Gastrodontidae: *Zonitoides arboreus* (quick gloss [snail], orchid or bush snail) [1] (NR)
MOLLUSK	Csp	S	Helicidae: *Cornu aspersum* (brown garden snail) [2]
MOLLUSK	Ce	P/C	Helminthoglyptidae: *Cepolis monodonta* (NCN; a terrestrial snail) [1] (NR)
MOLLUSK	Ce	L, P/C	Philomycidae: *Pallifera costaricensis* (mantleslug) [2]
MOLLUSK	Csp	L	Philomycidae: *Pallifera sp.* (species of browse slugs) [1]
MOLLUSK	Csp	L	Planorbidae: Family of ramshorn [ram's horn] snails [1] (NR)
MOLLUSK	Ce	L	Polygyridae: *Praticolella griseola* (vagrant shrubsnail, Vera Cruz shrubsnail) [1] (NR)
MOLLUSK	Xs	C	Sublinidae: Family of garden snails [1]
MOLLUSK	Ce	S	Succineidae: *Calcisuccinea sp.* (NCN; species of terrestrial snails) [1]
MOLLUSK	Asp	P/C	Succineidae: *Succinea costaricana* (amber snail) [4]
MOLLUSK	Asp, Ce, Csp, Xsp	L, S, P/C	Succineidae: *Succinea sp.* (species of amber snails) [18] (NR)
MOLLUSK	Asp	L	Veronicellidae: *Sarasinula plebeia* (bean slug) [1]
MOLLUSK	Asp	L	Veronicellidae: *Semperula wallacei* (NCN; a species of leatherleaf slug) [1]
MOLLUSK	Asp, Ce, Csp, Xs, Xsp	C, L, S, P/C	Veronicellidae: *Veronicella cubensis* (Cuban slug) [13]
WEED	Csp	C	Asteraceae: *Ageratum conyzoides* (billygoat-weed, chick weed, goatweed, whiteweed) [2] (NR)
WEED	Csp	P/C	Cyperaceae: *Cyperus sp.* (species of sedges) [1] (NR)
WEED	Ce	S	Poaceae: *Chloris sp.* (finger grass) [1] (NR)
WEED	Csp	C, S	Poaceae: *Digitaria sp.* (species of crab grasses) [2] (NR)
WEED	Ce, Csp	L, S	Poaceae: *Echinochloa sp.* (species of millets) [2] (NR)
WEED	Csp	S	Poaceae: *Eleusine sp.* (species of finger millets) [1] (NR)
WEED	Ce	P/C	Poaceae: *Paspalum sp.* (species of bead grasses) [1] (NR)
WEED	Ce	C, P/C	Poaceae: *Rottboellia cochinchinensis* (itchgrass, corngrass) [2]

-------END OF PEST INTERCEPTION LIST----------

APPENDIX 5. FOOTNOTES TO USDA-APHIS-PPQ LIST OF PEST INTERCEPTIONS ON TARO (2000-2010).

1 Dasheen species on which interceptions occurred:

CODE		DASHEEN SPECIES/VAR.
Ac	=	*Alocasia cucullata*
Am	=	*Alocasia macrorrhizos*
Asp	=	*Alocasia* species (the *Alocasia* was not identified to the specific or varietal levels)
Ce	=	*Colocasiaesculenta*
Cea	=	*Colocasia esculentum* var. *antiquorum*
Csp	=	*Colocasia* species (the *Colocasia* was not identified to specific or varietal levels)
Xb	=	*Xanthosoma brasiliense*
Xh	=	*Xanthosoma hastifolium*
Xs	=	*Xanthosoma sagittifolium*
Xv	=	*Xanthosoma violaceum*

2 Plant parts on which the interception was found:

CODE		PLANT PART
C	=	Corm
F	=	Flower
L	=	Leaf
S	=	Stem
P/C	=	Plant/Cargo – no plant part was identified indicating pest was found some where within the shipment but not necessarily feeding on the dasheen; also indicative of a hitchhiker that may or may not feed on dasheen.

3 All information on interceptions given herein is cited as: APHIS-PPQ, personal communication.

4 All interceptions listed as NR, "non-reportable," mean the pest was of no concern to the USA and, after the pest was identified, the dasheen was released into commercial marketing channels without further action (i.e., the dasheen was not fumigated or rejected and returned).

5 Names of insects identified only to the Order or Suborder levels are given as single names ending in –a; those insects identified to the Family level are single names ending in –idea. For Order, Suborder, Subfamily, and Family identifications, the general common name for members of that group is provided. For Genera or where Genus and species are provided, the species group or species-specific common name is given (e.g., the Order of Hymenoptera includes bees, wasps, hornets, yellow jackets, bumblebees, etc., whereas Braconidae is a Family of parasitic wasps within the Hymenoptera). Insect Subfamilies end in –inae.

6 No information was available about the insect life stage (e.g., egg, larva, nymph, pupa, or adult) that was intercepted in the dasheen shipment.

7 NCN = No Common Name

8 Although some of the Orders, Families, Subfamilies, and Genera intercepted and identified below include members that are actionable quarantine pests, no quarantine (actionable) pests were specifically identified as such. Cross-referencing to the APHIS quarantine pest list (Appendix 6) may provide an indication for some species, but action is dependent on the inspector's decision (see Footnote 10 below).

9 Number of times for this exact interception description. If the dasheen species/cultivar and plant part differed, all are shown their respective columns.

10 NR = Non-Reportable. All shipments with non-reportable interceptions were released into marketing channels without further action (see the Regulatory Overview of Dasheen Entering the USA, Comments on Inspector Discretion). All interceptions without NR should be considered actionable quarantine pests without additional information to the contrary.

NOTE: Non sequitur listings, such as "no identifiable insect found," "no identifiable disease," identification listed as "species of Insecta" or "dead organism," plant host given as "wood," "species of Mollusca," "secondary plant pathogen," "pathogen not found," where an intercepted weed was identified as "*Colocasia esculenta*" or simply as "Araceae," and other similar identifications that provided no viable information (i.e., rendered the reported interception meaningless) were deleted from the list. Additionally, synonymous taxa were combined into the most recent nomenclature. These changes reduced the original number of interceptions and spreadsheet lines from 1,567 to 1,509.

NOTE: Duplicate taxa for interceptions were condensed to simplify the list and the number of interceptions of duplicate taxa provided. This change reduced the number of original spreadsheet lines from 1,567 to 413.

ISPM No. 29

IPPC

INTERNATIONAL STANDARDS FOR PHYTOSANITARY MEASURES

ISPM No. 29

RECOGNITION OF PEST FREE AREAS AND AREAS OF LOW PEST PREVALENCE

(2007)

Produced by the Secretariat of the International Plant Protection Convention

F A O
FIAT PANIS