Field Visit Report

Ginger Production and Processing in Fiji

September 23-29 2007

Ginger Field Visit - Fiji
September 23-29, 2007.

Acknowledgement
Vinaka vaka levu to the Director of Quarantine and all staff for their time and effort in making this trip a success.

This visit was funded under the Ausaid Pacific Governance Support Program and was made possible by the kind contribution of time and transport by Fiji's Quarantine and Inspection Services and staff of the Ministry of Agriculture and Forestry.

This trip has facilitated the collection of additional information, establish contacts and promote good relations with the relevant staff of Fiji MAF, which are pertinent to the progression of the ginger import risk analysis.

Summary
Two officers from Biosecurity Australia visited Fiji to collect information and documentation and observe the production pathway for the assessment of the likelihood of entry for 27 quarantine pathogens and nematodes we have categorised. The main pests and diseases reported to associate with ginger in Fiji of concern to Australia include nematodes and arthropods, and a fungal pathogen.

Based on the observation of ginger production systems and in consideration of the pests and pathogens, it can be noted that a systems approach (incorporating the preparation of the seed material, to cropping systems, harvesting and pack house) can adequately mitigate the pest and pathogen risk associated with ginger. This systems approach includes a hot water treatment of the seed material to eliminate any nematode and bacterial concerns, as well as further quality control measures through selection of suitable planting material (withered material are discarded). Additionally, ginger is cropped in rotation with taro and cassava, with an additional 6 months period of fallow. The harvesting of immature ginger is done manually with digging forks after 5 months. At the pack house, the ginger rhizomes are weighed and inspected prior to washing individually with a high pressure hose. The rhizomes are then left to dry on mesh for 10 to 14 days before being subjected to further quality control inspection and conditioned for export (removal of roots and any remaining soil).

Farmers participating in the export program for fresh immature ginger will be registered under a similar scheme implemented for fresh pawpaw exports to Australia.

Discussions are ongoing with the relevant staff of Fiji MAF to investigate the presence of bacterial wilt, *Ralstonia solanacearum* Race 1 Biotype III and IV.

Background
Australia has considered Fiji's application for fresh baby ginger in its work program under the regulated IRA process. As a requirement of this process, a list consisting of

pests and diseases known to associate with ginger in Fiji was provided to Australia for consideration. The analysis of Fiji's pest list identified a number of pests including nematodes, and fungal and bacterial rots of interest to Australia (Table 1). A complete table on the pests listed in table 1 can be found in Appendix 1. Australia consulted with the relevant officials in Fiji for relevant additional information such as the cropping and production systems, as well as the post harvest treatments which may be considered in the risk analysis. Further discussions with Fiji identified the need for a visit (24-28 September) to observe and document the procedures and processes that may be considered as measures to address the identified pests and diseases of concern to Australia.

Pest	**Common name**
Elytroteinus subtruncatus Fairmaire	Fijiian ginger weevil
Aspidiella hartii (Cockerell 1895) [syn: *Aspidiotus hartii*]	Yam scale; Tumeric root scale
Pheidole sp. [*Pheidole fervens* Smith, F. 1858 is a likely species]	Ant
Piletocera xanthosoma Meyrick 1886	Pyralid moth
Opogona regressa Meyrick 1916	Tineid moth
Caloosia longicaudata (Loos 1948) Siddiqi & Goodey 1964	Nematode
Criconemella denoudeni (de Grisse 1967) Luc & Raski 1981 [syn: *Macroposthonia denoudeni* de Grisse 1967]	Ring nematode
Criconemella rotundicauda (Loof, 1964) Luc & Raski, 1981	Ring nematode
Helicotylenchus egyptiensis Tarjan, 1964	Spiral nematode
Helicotylenchus mucronatus Siddiqi 1964	Spiral nematode
Rhizostilbella hibisci (Pat.) Seifert 1985 [Teleomorph: *Nectria mauritiicola (Henn.)* Seifert & Samuels 1985]	Fungi – Rot

Table 1: Quarantine pests and diseases of ginger in Fiji

Ginger in Fiji

Fresh baby ginger has been rated a high priority commodity by the government of the Fiji Islands for access to Australian markets.

The main ginger production areas in Fiji are located in the south east towards the central division of the main island of Viti Levu (Figure 1). The program for the visit (Appendix 2) started in Suva (Monday 24 September) where we visited the production areas at the highlands of Naitasiri, followed by visits to the flat land ginger in the Navua provinces and later to the research station at Koronivia. We then travelled by road to Nadi via Sigatoka where we visited the production areas for fruit fly commodities such as pawpaw and eggplant and the High Temperature Forced Air treatment facility in Nadi. Figure 1 gives an outline of the geographical distribution of the Fiji Islands.

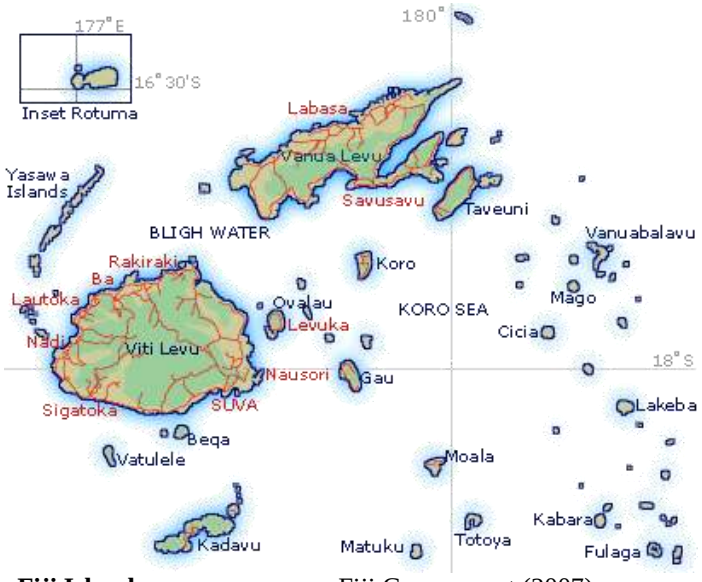

Figure 1: Map of the Fiji Islands source: Fiji Government (2007)

Export program

Fiji currently exports fresh mature (adult) ginger to a number of countries including New Zealand, Canada and occasionally Hawaii for direct retail in supermarkets. Fiji previously exported fresh mature ginger to the United States but the export program has since ceased due to a reduction in prices following China's access for ginger to the United States. This has further elevated the importance of the access for baby ginger to Australia for the Fiji Government.

Fresh mature ginger for further processing is currently permitted from Fiji to Australia subject to specific import requirements. The import requirements stipulate that the imported fresh mature ginger is to be processed commercially in an AQIS Approved Premises by any of the following methods:

- Drying, or
- Crystallisation, or
- Pickling, or
- Preservation of the ginger in brine.

Fiji also exports processed ginger (preserved in sugar, preserved in brine, and ginger powder etc) to Australia.

Monday 24 – Wednesday 26, September 2007

Extension officers from the Fiji Ministry of Agriculture and Forestry work closely with farmers to ensure that they are sustainable and profitable in their farming ventures. The extension officers visit farmers to discuss the procedures for the farming of ginger and other cash crops, as well as assisting in preventing the establishment and spread of pests and diseases. Each region is supported by a number of field staff stationed close-by.

Types of ginger farms

The two main types of ginger farms are the small subsistence holdings from the Waicoba region to the high lands of Naitasiri, and the commercial farms on the flat lands of Navua. In the highlands, the land relief and the size of the holdings for the subsistence farmers make it uneconomical for any mechanised assistance (farm machinery) in the production of ginger. However, the slopes have proven beneficial for the farmers in these areas by providing well drained soils, which is favourable for the ginger (Figure 2). The ginger from the highlands is harvested as mature ginger for export.

In contrast, even with mechanised assistance, the flat land commercial farmers face a difficult task in maintaining well drained soils. Discussions with field staff during the visits to the flat land ginger areas indicated that rotting appeared to be the major problem for ginger if kept in the field to mature. This meant that ginger was harvested early (as baby ginger) for processing into products such as ginger in brine. Investigations by the staff at the Koronivia research station are ongoing to determine whether this rotting is either due to pest and disease infestation or waterlogged soil conditions.

Figure 2: Ginger farms at the highlands of Naitasiri

Cropping systems

Ginger is currently planted in rotation with cassava and taro (Figure 3). In addition to the rotation, a fallow period of about 6 months is included in the program. The ginger planting material, particularly for the farmers in the high lands, are selected and sourced

on-farm from the previous crop. Sourcing planting material from previous crops lessens the risk of pests and diseases being introduced from infected areas to new areas.

As indicated in Fiji's submission for ginger to Australia, the ginger seed material is subjected to a number of treatments such as dipping in hot water (51°C) for 10 minutes to address any nematodes carried on the seed material. The healthy seeds for planting are selected from material that has been left to dry for a few days. Shrivelled seed materials are discarded. Unfortunately, we were not able to observe any seed and land preparation, but we managed to visit a planting operation on a small farm (Figure 4). Ideally, the planting program should take place between August and September before the onset of the rain season.

Figure 3: Ginger cropped in rotation with taro (top) and cassava (bottom)

Figure 4: Extension Officer demonstrating the planting operation

The seed material is packed in onions bags to facilitate heat penetration and effective treatment of all seed material (Figure 5). However, since the cessation of government assistance, which supplied gas for the hot water treatment, and the absence of any diseases affecting the planting material, some farmers have by-passed this process due to costs.

Figure 5: Seed material for planting

The results from farmers who follow the ginger production procedures (such as dipping in hot water) are mixed, and do not conclusively indicate that a single factor (pests and diseases or environmental conditions, or both) is responsible for the loss of the ginger for some farmers. This raises the question of whether factors other than nematodes are affecting the ginger during its growth.

For example, the ginger planted on the slopes where the soils are well drained has high yields (approx less than 3 percent loss of total crop) despite avoiding the dipping of the planting material in hot water. On the other hand, the farmers on relatively flat land who did not follow the hot water treatment suffered losses of around 70 percent due to rotting of the rhizomes. Officers from Fiji MAF are working with farmers to address this

problem and have set up an experiment on one of the affected farms to determine the cause of the rot.

When considering the two cases in this example and in relation to the pests and diseases reported to associate with ginger in Fiji, the following observations and synopsis could be made.

Ginger on the slopes

- Good crop husbandry (seed and land preparation) may have helped alleviate the pest and disease risks associated with ginger.
- The rotation with other crops has lessened the risk associated with soil pathogens.
- Pests such as nematodes are not likely to be prevalent in the highland areas, particularly on the slopes where ginger is planted.
- As the soils are well drained, the pests and diseases may be present but the soil conditions are unfavourable for pests such as nematodes to develop and be active.

Ginger on relatively flat land

- Poor crop husbandry may have allowed the pests and diseases reported to associate with ginger in Fiji to establish and become active on ginger.
- Irrespective of the above, the rot may not be due to pests and diseases but as a result of the waterlogged soils conditions.

Rotting is a common problem to the commercial ginger farmers on the flats of Navua (Figure 6). The ginger must be harvested early (baby ginger) as rotting often develops and spoils the crop if the ginger plant is allowed to reach maturity. Currently, this early harvest has served to meet the export demand for processed baby ginger in brine. Fiji MAF is working with the Queensland Department of Primary Industries to identify the causal organisms responsible for the rot. In addition, discussions with the agricultural officers from Fiji MAF indicate that the baby ginger is less fibrous and is apparently not affected by any significant pests and diseases at the time of harvest. Consequently, as the rhizomes are soft and not hardy, they are not likely to germinate. However, this may require further verification. Based on this observation, it appears that baby ginger may not have the same risks compared to the mature ginger.

Figure 6: Commercial ginger production in Navua.

Processed baby ginger – ginger in brine

The baby ginger from the commercial flat land farms is processed into ginger products such as ginger in brine etc. For this process, the ginger is washed with a high pressure hose to remove soil. The rhizomes are then stored in tanks of brine solution for a few weeks prior to being peeled, sliced or diced and weighed for the final product (Figure 7).

Storage tanks of baby ginger in brine solution

Peeling and cutting of ginger rhizomes for exports

Packing for export

Figure 7: Processing and packing of processed baby ginger for export

Pack house Procedures for mature ginger exports to New Zealand and Hawaii

Adult ginger is currently exported to New Zealand, Hawaii and other countries without additional treatments. Adult ginger for export is sourced primarily from the highlands and is transported from the field to the pack house in wooden crates. The ginger is weighed and quality assessed prior to being stacked on wire mesh for washing (Figure 8).

Figure 8: Adult ginger stacked for washing

The ginger rhizomes are washed individually using a high pressure hose to remove soil and external contaminants (Figure 9). The ginger rhizomes are then transferred on the wire mesh to another area where they are left for about 14 days to dry (Figure 10).

Figure 9: Ginger rhizomes being washed and inspected

When the rhizomes are dry, they are further graded and inspected to remove pieces unsuitable for export. Roots are also removed during the checking and grading process (Figure 11). The ginger is packed into boxes and stored in a shipping container at about 10° Celsius (Figure 12).

Figure 10: Washed ginger being left to dry prior to further inspection and preparation for export

Figure 11: Adult ginger rhizomes being conditioned for export

Figure 12: Adult ginger packed for export

Quarantine pests and diseases of ginger in Fiji

The preliminary pest categorisation process identified about 19 pests and diseases of quarantine concern to Australia. These include a few fungal pathogens such as *Cylindrocladium* sp. and *Nectria mauritiicola* (Anamorph: *Rhizostilbella hibisci*), but the majority are nematodes, including *Caloosia longicaudata* and *Criconemella denoudeni*.

Direction for the ginger IRA

Based on the observation of agricultural cropping procedures and pack house processes, it is highly likely that the quarantine risks associated with baby ginger (most or all of the pathogens and nematodes listed on Fiji's pest list) are reduced below Australia's acceptable level of protection.

While there is limited available information on the nematodes in Fiji's pest list, the hot water treatment of the seed material and the individual high pressure washing of rhizomes at the pack house will remove any soil and other materials of quarantine concern. This assessment is made on the assumption that all the nematodes considered further on Fiji's list are primarily external feeders or ecto-feeders. The above processes, particularly the washing with a high pressure hose followed by inspection for quality, will pick up fungal infected rhizomes.

Bacterial wilt, an important disease of ginger caused by *Ralstonia solanacearum* Race1 Biotype III and IV was not listed on Fiji's list. This is being investigated further.

When considering the two farming systems in relation to the pests and diseases reported to associate with ginger in Fiji, the following observations and synopsis could be made.

Ginger on the slopes

- Good crop husbandry (seed and land preparation) may have helped alleviate the pest and disease risks associated with ginger.
- The rotation of ginger with cassava and taro has reduced the risk of any soil pathogens to establish and affect the ginger.
- It is also likely that pests such as nematodes are not prevalent in the highland areas, particularly on the slopes where ginger is planted.

- As the soils are well drained, the pests and diseases may be present but the soil conditions are unfavourable for pests such as nematodes to develop and be active.
- The high yields from mature ginger grown in the highlands could mean that bacterial and fungal organisms responsible for rhizome rots are not present in these areas.

Ginger on relatively flat land

- Poor crop husbandry may have allowed the pests and diseases reported to associate with ginger in Fiji to establish and become active on ginger.
- Pests and diseases may not be responsible for the rot of rhizomes but more likely the waterlogged soil conditions late in the season.

Appendices

Appendix 1

Pest	Common name	Associated with ginger crop in Fiji	Presence on the importation pathway	Present within Australia
Elytroteinus subtruncatus Fairmaire	Fijiian ginger weevil	**Yes** (Stout 1982)	**Yes** – Weevil larvae bore in the stems and rhizomes of ginger (Stout 1982)	No records found
INSECTA: HEMIPTERA				
Diaspididae *Aspidiella hartii* (Cockerell 1895) [syn: *Aspidiotus hartii*]	Yam scale; Tumeric root scale	**Yes** (Stout 1982)	**Yes** – This scale may be found on ginger rhizomes (Anandaraj *et al.* 2001; Stout 1982)	No records found
INSECTA: HYMENOPTERA				
Pheidole sp. [*Pheidole fervens* Smith, F. 1858 is a likely species] Ant	**Ant**	**Yes** (NZ interceptio n data)	**Yes** – Potential hitchhiker. There have been 64 interceptions of *P. fervens* in NZ, 69% of which came from Fiji (Stanley *et al*. 2007a)	Only 2 species of Fijian *Pheidole* (*P. megacephala* & *P. oceanica*) are present in Australia. *P. fervens* is **NOT** present in Australia.
INSECTA: LEPIDOPTERA				
Piletocera xanthosoma Meyrick 1886	Pyralid moth	**Yes** (Stout 1982)	**Yes** – The larva of this species feeds on the outer rhizome tissue of ginger (Stout 1982)	No records found
Opogona regressa Meyrick 1916	Tineid moth	**Yes** (Stout 1982)	**Yes** – The larvae of several *Opogona* species attack stored tubers and occasionally feed on living plant material adjacent to decaying material (Robinson & Tuck 1997)	No records found
NEMATODA				
Caloosia longicaudata (Loos 1948) Siddiqi & Goodey 1964	Nematode	**Yes** (Fiji pest list)	**Yes** – *Caloosia* species are ecto-parasitic feeders on roots (Bridge *et al*. 1990)	No records found
Criconemella denoudeni (de Grisse 1967) Luc & Raski 1981 [syn: *Macroposthonia denoudeni* de Grisse 1967]	Ring nematode	**Yes** (Orton Williams 1980)	**Yes –** *Criconemella* species are migratory ectoparasites that feed on the outside of the host plant (Luc *et al.* 1990).	No records found
Criconemella rotundicauda (Loof, 1964) Luc & Raski, 1981	Ring nematode	**Yes** (Fiji pest list)	**Yes –** *Criconemella* species are migratory ectoparasites that feed on the outside of the host plant (Luc *et al.* 1990).	No records found
Hoplolaimidae *Helicotylenchus egyptiensis* Tarjan, 1964	Spiral nematode	**Yes** (Fiji pest list)	**Yes** – *Helicotylenchus* species may be found in the root cortex of host plants, but migration through the tissues has not been reported (Luc *et al.* 1990).	No records found
Helicotylenchus mucronatus Siddiqi 1964	Spiral nematode	**Yes** (Orton Williams 1980)	**Yes** – *Helicotylenchus* species may be found in the root cortex of host plants, but migration through the tissues has not been reported (Luc *et al.* 1990).	No records found

Pest	Common name	Associated with ginger crop in Fiji	Presence on the importation pathway	Present within Australia
FUNGI				
Rhizostilbella hibisci (Pat.) Seifert 1985 [Teleomorph: *Nectria mauritiicola (Henn.)* Seifert & Samuels 1985] Rot		**Yes** (Fiji pest list)	**Yes** – This species is mildly parasitic on the roots and bark of host plants, and has been isolated with soil (Rossman *et al.* 1999)	No records found