Pacific Horticultural and Agricultural Market Access Program (PHAMA)

Technical Report 49: Disease Survey of Honey Bees in Fiji (FIJI15)

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Abbreviations

Abbreviation	Description
ACIAR	Australian Centre for International Agricultural Research
AFB	American foulbrood
AHPD	Animal Health and Production Division of MoA
AusAID	Australian Agency for International Development
CCD	Colony collapse Disorder
DWV	Deformed Wing Virus
EFB	European foulbrood
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FJD	Fiji dollar
GPS	Geographical positioning systems
HMD	Halfmoon disorder or syndrome
IAPV	Israeli Acute Paralysis Virus
IHS	Import Health Standard
MoA	Ministry of Agriculture
MPI	New Zealand Ministry for Primary Industries (formerly Ministry of Agriculture and Forestry)
Nucs	Nucleus hives, small hives usually comprising four frames of bees and brood, a queen bee, and food stores
OIE	International Animal Health Organization
OMAR	Overseas market access requirement
PCR	Polymerase chain reaction
PHAMA	Pacific Horticultural and Agricultural Market Access Program (AusAID)
PICs	Pacific Island Countries
PMS	Parasitic mite syndrome (usually associated with varroa mite)
PO Box	Post Office Box
RMP	Risk Management Program
SHB	Small hive beetle
SPC	Secretariat of the Pacific Community
URS	URS Australia Pty Ltd
USDA	United States Department of Agriculture

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Executive Summary

The Pacific Horticultural and Agricultural Market Access Program (PHAMA) is designed to address constraints to market access from primary production products, including honey and other bee products. PHAMA funded the current bee disease survey to assist Fiji in establishing and maintaining market access to Australia and New Zealand, with potential interest in exporting to China, Japan, Korea and the European Union.

This bee disease survey was carried out by Tony Roper and Marco Gonzalez of AsureQuality Limited, New Zealand, from 8–17 April 2013. Previous bee disease surveys were conducted by Simpson in 1983, by Anderson in 1986 and by Driscoll, Goodwin and McBrydie in December 2000 and January 2001. A further bee disease survey was undertaken by Yong Jung Kwon et al. from January–March 2001. The Fijian Ministry of Agriculture (MoA) undertakes bee disease surveys as well (Prasad, 2013 pers. comm).

Currently, honey and other bee products entering New Zealand from a number of Pacific island countries (PICs) must be accompanied by a zoosanitary certificate issued by the veterinary authority of the exporting country which certifies that:

- The honey originates from that country; and
- The country is free from European foulbrood (EFB) caused by *Melissococcus pluton.*[1]

(EFB is a bacterial disease that affects the developing brood and is controlled in many countries by feeding antibiotics to beehives. EFB-causing bacteria can be transmitted in bee products, especially honey and pollen. EFB has never been detected in Fiji or New Zealand, but regular surveys by competent personnel, and reporting to international authorities, are required to confirm this status. EFB is present in Australia.)

Fiji is not included on the list of PICs covered by this Import Health Standard (IHS), so access to New Zealand would need to be negotiated. The New Zealand Ministry for Primary Industries (MPI), formerly the Ministry of Agriculture and Forestry, revised the IHS for Specified Processed Bee Products in June 2009. However, this standard is on hold while issues with a similar IHS for bee products from Australia are resolved. It is likely that any application to import bee products into New Zealand would not be considered until the new IHS for bee products has been established, which won't be until 2014.

http://www.fedfarm.org.nz/Files/130527-Letter-from-MPI.pdf

The survey team inspected 523 beehives for bee diseases and pests – in particular, EFB, Chalkbrood and the Small Hive Beetle (SHB). 40 samples of bees were collected from these hives for testing in New Zealand for Deformed Wing Virus (DWV) and four known isolates of Israeli Acute Paralysis Virus (IAPV), the microsporidian *Nosema ceranae*, the internal or tracheal mite *Acarapis woodi* and the external mites *Varroa spp* and *Tropilaelaps spp*. A further 53 samples of bees were also collected for screening in Fiji. Each sample of bees contained around 150 bees per sample jar.

All these diseases, except DWV, *A. woodi* and the external mites, were raised as pathogens of concern by the beekeeping industry in New Zealand following the risk analysis done by MPI to allow heat-treated honey from Australia into New Zealand. DWV was found in New Zealand in 2007. *A. woodi* and the external mites *Varroa spp* and *Tropilaelaps spp* are not transmitted in honey. *Varroa destructor* is endemic in New Zealand. Since the IHS was reviewed, MPI has confirmed the presence

[1] Now renamed *Melissococcus plutonius.*

of *Paenibacillus alvei* and *Nosema ceranae* in New Zealand. A nationwide survey, plus ongoing annual sampling and testing, has not detected the presence of IAPV in New Zealand, and this remains a bee disease of issue with the New Zealand beekeepers (McFadden, AMJ, Tham, K, et al., 2012).

Bees were tested for DWV, *Nosema ceranae*, the tracheal mite, and *Varroa spp* and *Tropilaelaps spp* in case Fiji is in a position to export live bees, queen cells or drone semen in the future. Bees were also observed for the presence of the exotic Asian honey bee, *Apis cerana*. This was important because the presence of *Apis cerana*, with its associated pests and diseases, could limit the export potential of live bees.

MoA's Animal Health and Production Division found one case of American foulbrood (AFB) in 2006 (Tavua) and 14 cases in 2011 (Lautoka). Four cases of AFB were detected in the current survey. AFB is one of the most widespread and serious honey bee diseases in the world. This disease is endemic in New Zealand and is controlled by inspection and burning infected bees, combs and hive equipment. Some approved beekeepers can recover infected equipment by dipping in paraffin wax heated to 160°C for at least 10 minutes. AFB in New Zealand is subject to a Pest Management Plan. It is recommended that inspection for AFB be included in an annual surveillance program and that the current destruction policy for AFB-infected material continues.

The team inspected 532 colonies (6.5%) and sampled approximately 279 colonies from a population of approximately 8800 colonies. New Zealand has a target inspection rate of 1.4% of hives under its exotic honey bee disease surveillance program. However, all hives in New Zealand must be inspected for AFB each year by an approved beekeeper, which increases the possibility of beekeepers finding an exotic bee disease or pest.

The survey team inspected 31 apiaries and 2 feral colonies. There is no official apiary register, but based on Kamal Prasad's Fijian beekeeping statistics the team inspected around 3.1% of managed apiaries, compared to New Zealand's target surveillance rate of 2.6%.

The Asian honey bee, *Apis cerana*, was not detected on Viti Levu or Vanua Levu. Awareness raising measures such as posters at ports and pamphlets for commercial and recreational sailors could help to reduce the chance of the Asian honey bees arriving in the Fijian islands. A meeting was held with senior Fijian Biosecurity staff at Nadi International Airport to discuss ways of detecting *Apis cerana* at the ports. The Fijian Biosecurity staff have a critical role to play in detecting any incursions early and quickly passing this information on to MoA's Animal Health and Production Division for further investigation.

Laboratory analysis in New Zealand of the Fijian bee samples did not detect any case of DWV or IAPV, the tracheal mite *Acarapis woodi*, or the external mites *Varroa spp* and *Tropilaelaps spp*. The external mite *Acarapis externus* was detected on bees sampled from five apiaries. These mites are common in New Zealand and are not known to cause any harm to honey bees.

The microsporidian *Nosema ceranae* was detected by polymerase chain reaction (PCR) in 6 of the 20 apiaries tested (30%). Previous surveys did not test for the presence of *Nosema ceranae*, so it is not known how long it has been present in Fiji. *Nosema ceranae* was confirmed in New Zealand in 2010 using PCR technology. It is not known what pathological effect, if any, this species of nosema is having on honey bees either in New Zealand or in Fiji.

EFB has never been reported in Fiji and no evidence of this disease was found during this survey or during past surveys. Two suspect larval samples were tested in the New Zealand laboratory for EFB using PCR and both tested negative. No clinical signs of Chalkbrood were sighted during the survey.

No cases of tracheal mites or SHB were found. Also there was no evidence of the African honey bee (*Apis mellifera scutellata*) or the Cape honey bee (*Apis mellifera capensis*). These beekeeping pests and honey bee sub-species are not transmitted through honey.

Other minor diseases were reconfirmed as being present, such as the greater and lesser wax moths (which also exist in New Zealand). Cane toads are a major pest of honey bees in Fiji, but their effects can be moderated by raising hives off the ground on stands. Various species of ants, cockroaches, centipedes and lizards were also found living in or around the hives, but these are not transmitted live in honey.

The risk pathways into Fiji for an exotic honey bee disease or pest are considerable, with ongoing importation of honey from Australia, and regular shipping and air flights from a number of countries (plus visiting cruise ships and yachts) that could have honey on board. Tourists represent a biosecurity risk and tourist numbers more than doubled from 2000 to 2011 (www.statsfiji.gov.fi).

Importation of honey into Fiji is managed under the Biosecurity Promulgation 2008 Act. This document requires honey imports to be restricted. Only honey imports over 20 kg must be accompanied by an import permit (www.biosecurityfiji.com). The risk of importing EFB and Chalkbrood disease with personally accompanied supplies of honey (up to 20 kg) needs to be considered, even though such personal use consignments must be accompanied by receipts from a supermarket or evidence of processing in a government registered premise. Evidence of the origin of the bee products will not reduce the risk of importing an exotic bee disease.

In order to retain stability in the local market as honey production increases, it will be necessary to investigate export opportunities. At present, Fiji does not produce sufficient honey to satisfy local demand, but this could change over the next few years. Fiji exported two tonnes of honey to Australia and the United States in 2012.

Other recommendations are made concerning colony management, surveillance for bee diseases, training, and quarantine extension.

1 Introduction

The Pacific Horticultural and Agricultural Market Access Program (PHAMA) is designed to address constraints to market access for primary products by providing practical and targeted assistance via a multi-component, multiple phase program. To achieve the objectives, AusAID works collaboratively with regulatory and industry bodies to gain and maintain access to key markets for selected products.

Honey and other bee products entering many countries are subject to various restrictions. For example, to enter New Zealand the bee product must meet the current Import Health Standard (IHS). This standard only allows bee products from selected countries to enter New Zealand. Honey must be accompanied by a zoosanitary certificate issued by the veterinary/competent authority of the exporting country which certifies that:

- The honey originates from that country; and
- The country is free from European foulbrood (EFB) caused by *Melissococcus pluton.*[2]

EFB is a bacterial disease that affects the developing brood and is controlled in many countries by feeding antibiotics to beehives. EFB-causing bacteria can be transmitted in bee products, especially honey and pollen. This bee disease has never been detected in Fiji or New Zealand, but regular surveys by the competent authority and reporting to the International Animal Health Organization (OIE) are required to confirm this status. Subsequent New Zealand Ministry for Primary Industries (MPI) import risk analyses have identified other honey bee pathogens of concern and this proposal will attempt to address these potential risks.

Similarly, honey exported to the European Union (EU) must come from apiaries of known disease status, which usually means an annual bee disease survey is carried out and beekeepers are reporting on the presence of listed bee diseases. The EU also requires bee products to be processed under a Risk Management Program (RMP) and an annual Honey Residue Monitoring Program to be operated by the competent authority.

PHAMA requested that AsureQuality Ltd:

- Undertake a bee disease survey in Fiji to assist Fiji in establishing and maintaining market access to Australia and New Zealand, with potential interest in exporting to China, Japan, Korea and the EU. A surveillance survey was to be undertaken to determine the disease status of honey bees (*Apis mellifera sp*) in Fiji, particularly the presence or absence of any exotic honey bee diseases and pests. This was to be done by:
  - Determining the presence or absence by laboratory analysis of the following exotic pathogens: the mid-gut microsporidian *Nosema ceranae*, the viruses Israeli Acute Paralysis Virus (IAPV) and Deformed Wing Virus (DWV), the internal mite *Acarapis woodi*, and *Varroa sp.* in managed *Apis mellifera* colonies and/or feral colonies if possible.
  - Surveying for all OIE-listed bee diseases to reconfirm the presence or absence of exotic bee pests, diseases, or undesirable genetic strains of honey bees that have recognised clinical symptoms, e.g. EFB or Africanised bees.
  - Reconfirming the presence or absence of endemic bee diseases found during previous surveys based on clinical symptoms, e.g. American foulbrood (AFB).

[2] Now renamed *Melissococcus plutonius.*

The survey aims to examine at least 2% of European honey bee hives and 3% of apiaries for equivalence with New Zealand's exotic bee disease surveillance program. It is understood that there are approximately 978 beekeepers with 8828 hives. Statistics on the number of apiaries in Fiji have not been provided.

- Provide instruction and training to Fiji's Department of Agriculture and other nominated personnel on bee disease inspection, recognition and sampling in the field.

2 Background

Honey bee disease surveys were carried out by Simpson in 1983, by Anderson in October–November 1986, and by Driscoll, Goodwin and McBrydie in December 2000 and January 2001. Anderson found 34 cases of AFB in two locations, but no AFB was detected by Driscoll et al. Sacbrood virus was seen in the field and Anderson detected a number of other bee viruses in the laboratory. No other major bee diseases were identified. *Nosema apis* was found during laboratory testing, but no case of Chalkbrood was found. A further bee disease survey was undertaken by Yong Jung Kwon et al. from 31 January – 30 March 2001, but no cases of AFB, EFB or Chalkbrood were detected.

To the best of the authors' knowledge, no other surveys for exotic honey bee pests and diseases have been completed by international experts between the 2000/01 surveys and the current PHAMA-funded survey. The Fijian Ministry of Agriculture (MoA) conducts annual routine bee disease surveys (Prasad, 2013 pers. comm).

While little work has been done in the area of market access, it is likely that there would be an export demand for bee products produced in Fiji and possibly live bees. Potential markets include New Zealand, Australia, other South Pacific countries, some Asian countries and the EU. Most of these countries will require evidence of Fiji's bee health status before permitting importations of bee products. New Zealand's MPI reviewed its IHS for bee products in 2003 and again in 2005. A revised general standard was issued in November 2006:

http://www.biosecurity.govt.nz/imports/animals/standards/beeproic.all.htm

MPI had prepared a risk analysis for bee products entering New Zealand with a view to drafting an IHS for heat-treated honey from Australia. The risk analysis was published in December 2004:

http://www.biosecurity.govt.nz/files/regs/imports/risk/ira-bee-products.pdf

An IHS for honey from Australia was subsequently issued in August 2006:

http://www.biosecurity.govt.nz/imports/animals/standards/beeproic.aus.htm

This standard was successfully challenged in the courts by New Zealand's beekeeping industry, but this was subsequently overturned by the Court of Appeal. Legislation was then passed that reinstated the IHS, but required a suspension on imports until an independent review panel had reported to MPI and the latter had made a determination on whether any amendments to the rules were required. The report was received from the panel in June 2009 and pointed to some areas in which the scientific evidence has evolved since the original risk analysis for the standard was undertaken. In particular, the presence or absence and effects of some new pathogens were raised. These included *Paenibacillus alvei*, *Nosema ceranae* and IAPV. *P. alvei* is a bacterium associated with EFB, and may be used as the indicator for the presence of EFB, while *Nosema ceranae* is a microsporidian that has jumped species from the Asian honey bee, *Apis cerana*. *N. ceranae* is believed by some researchers to be the cause of significant bee losses and even the cause of Colony Collapse Disorder (CCD) (Higes et al. 2009). IAPV has only recently been isolated from bees and has also been associated with CCD.

The existing 2006 IHS was also reviewed in the meantime and some minor changes were proposed, e.g. replacing the word *honey* with *bee products* where appropriate in order to allow products like propolis to be treated the same as honey. This revised standard was put on hold until the import standard for Australian honey is finalised, which means the 13 November 2006 IHS for Processed Bee

Products remains the current operational standard in the meantime. However, it is likely that any application to import bee products into New Zealand would not be considered until the new IHS for bee products has been established, which won't be until 2014:

http://www.fedfarm.org.nz/Files/130527-Letter-from-MPI.pdf

Pitcairn Island has negotiated its own IHS for honey into New Zealand and is required to certify freedom from AFB and EFB:

http://www.biosecurity.govt.nz/imports/animals/standards/beehonic.pit.htm

Since the IHS for Australian honey imports was reviewed, MPI has asked Pitcairn authorities for new information regarding checks/tests on Pitcairn bees for *Paenibacillus alvei*, *Nosema ceranae* and IAPV. Pitcairn honey is tested for residues to meet EU Overseas Market Access Requirements (OMARs) (Driscoll, 2013 pers. comm).

New Zealand's MPI has confirmed the presence in New Zealand of *Paenibacillus alvei* from soil and one bumble bee (2010). *Nosema ceranae* was also confirmed in New Zealand in 2010, so these pathogens are no longer classed as exotic pests or diseases by MPI. DWV was detected in 2007. A survey in New Zealand in 2011, and ongoing surveillance, has not detected the presence of IAPV (McFadden et al. 2012).

http://www.fedfarm.org.nz/Files/130527-Letter-from-MPI.pdf

The total number of beehives in Fiji is estimated to be around 8800 managed colonies (Prasad, 2013 pers. comm). Hive numbers have doubled over the past 12 years, with the majority of beekeeping activity in the Western Division. The local prices for honey are quite high in Fiji (FJD15 per kg) and interest in beekeeping is increasing, with around 1000 bee farmers keeping beehives.

All honey produced in Fiji is consumed locally, with the annual crop estimated to be around 190 tonnes. Kamal Prasad estimates the potential local demand to be approximately 800 tonnes, or about four times the present annual Fijian crop. It was noted that some honey harvested during or after the sugar cane harvesting season does not meet the definition of honey according to the Codex Alimentarius. This is because the honey will test positive for honey adulteration with sugar. It is recommended that the Fijian government develops a National Honey Standard for the domestic market. This will help sustain growth of the honey industry by protecting consumers and the integrity of the product.

Demonstrating a high bee health status and maintaining this status is crucial if the commercial beekeeping industry is to continue to develop and expand and export bee products. Imported bee products and used beekeeping equipment could introduce exotic bee diseases which, if established, could threaten the wellbeing of the beekeeping industry in Fiji. Existing import protocols for honey don't provide a very high level of protection. This is discussed in more detail later in the report.

3 History of Beekeeping in Fiji

While the origins of beekeeping in Fiji are uncertain, it is likely that, as in many other Pacific island countries, honey bees *(Apis mellifera)* were introduced by missionaries in the 19th century. The bees would have been the North Western European dark bee *Apis mellifera mellifera,* which is a very good 'survivor' bee, but unfortunately has an undesirable bad temperament. Yellow Italian honey bees were introduced in 1924 and at intervals thereafter, mainly from New Zealand and Australia (Driscoll, 2000).

The beekeeping industry grew slowly until 1986, when there were 115 bee farmers with about 1000 hives. Since then, the beekeeping industry has increased to just under 1000 bee farmers with approximately 8800 hives.

Fiji has long been a net importer of honey, but this situation is changing. Currently, only a small amount of honey (500 kg) for the baking trade is imported. Because Fiji is blessed with a wide range of melliferous flora, there is considerable potential for local bee farmers to lift production to a point where Fiji would become a net exporter of honey.

4 Size of the Industry

Hive numbers increased from approximately 1000 in 1986 to 3800 in 2000 (Driscoll, 2000) and then to more than 8800 by December 2012. There are about 20 beekeepers with 100–300 hives each who produce more than half of Fiji's commercially available honey. There is also scope to increase hive numbers from current levels, particularly on Vanua Levu and also in some of the outlying islands, according to staff in MoA's Animal Health and Production Division (AHPD). However, while these islands could all carry more bees, it is essential to continue to improve the temperament of the current stock in order to attract locals into beekeeping.

The industry produces around 190 tonnes of honey per year, which equates to approximately 22 kg per hive. Experienced commercial operators have averaged 50 kg per hive (Driscoll, 2001). Two tonnes of honey were exported in 2012 to the United States and Australia.

5 Training of Ministry of Agriculture Staff

Training of MoA AHPD staff included both classroom and field-based practical sessions. This training was delivered before the bee health survey began.

The classroom sessions consisted of two presentations, including:

- Identification of honey bee pests and diseases, including both those pests and diseases that are thought to be exotic to Fiji and those that have previously been identified; and
- Inspection and sampling procedures for the bee heath survey and also procedures for delimiting surveys.

The group visited an apiary in Navua, where a demonstration was given of the process of inspecting a hive for pests and diseases, together with cleaning and disinfection procedures. The use of geographical positioning systems (GPS) to record accurate apiary locations was also demonstrated.

Prior awareness among AHPD staff on bee disease surveillance, recognition and differential diagnosis was limited, with only Kamal Prasad having real experience and knowledge in this area. The training provided to AHPD staff has increased awareness of the importance of a healthy bee population and knowledge of bee diseases to a level where a locally-managed active surveillance program could be put in place.

6 Bee Disease Status in Fiji

Bee disease surveys were carried out in Fiji by Simpson (1983), Anderson (1986), Driscoll et al. (2000–2001) and Yong Jung Kwon et al (2001). The surveys were funded by the New Zealand Aid Programme and the Food and Agriculture Organization of the United Nations (FAO). The authors of these surveys also trained beekeepers and AHPD staff, and assessed legislation relating to bees and bee products. Laboratory staff were also trained in differential diagnosis procedures, and a laboratory manual was developed by Goodwin and McBrydie.

Anderson reported that Fiji was free of all serious bee diseases except AFB when a major outbreak was identified. During the 2000–2001 surveys, a number of honey bee diseases with negligible economic importance were re-confirmed, but no cases of AFB were found. Four cases of AFB were identified during the current disease survey.

This current survey funded by PHAMA inspected 523 managed European bee colonies (6.5%) out of approximately 8800 hives. Bees from two feral colonies were also observed for the presence of Asian bees, but none were detected. No evidence was seen of Asian bees on either Viti Levu or Vanua Levu.

No evidence was seen of Chalkbrood and Fiji remains one of the few countries free of this fungal disease. Wax moths were again identified as a serious pest.

Table 6-1 Comparison of the status of honey bee pests and diseases in Fiji, New Zealand and Australia

Common name	Scientific name	Agent	Fiji	New Zealand	Australia
American foulbrood	*Paenibacillus larvae*	Bacteria	Present	Present	Present
European foulbrood	*Melissococcus plutonius*	Bacteria	Absent	Absent	Present
P. alvei	*Paenibacillus alvei*	Bacteria	Unknown	Present – found in soil and one bumble bee	Present
Chalkbrood	*Ascosphaera apis*	Fungus	Absent	Present	Present
Varroa mite	*Varroa destructor*	Mite	Absent	Present	Absent
Varroa mite	*Varroa jacobsoni*	Mite	Absent	Absent	Absent
Asian Bee mite	*Tropilaelaps clareae*	Mite	Absent	Absent	Absent
Tracheal mite	*Acarapis woodi*	Mite	Absent	Absent	Absent
Small Hive Beetle (SHB)	*Aethina tumida*	Insect	Absent	Absent	Present
Asian honey bee	*Apis cerana*	Undesirable species	Absent	Absent	Present – Queensland
Africanised honey bee	*Apis mellifera scutellata*	Undesirable subspecies	Absent	Absent	Absent
Cape honey bee	*Apis mellifera capensis*	Undesirable subspecies	Absent	Absent	Absent
Nosema	*Nosema apis*	Microsporidia	Present	Present	Present
Nosema	*Nosema ceranae*	Microsporidia	Present	Present	Present
Amoeba	*Malpighamoeba*	Microsporidia	Present	Present	Present

Common name	Scientific name	Agent	Fiji	New Zealand	Australia
Sacbrood		Virus	Present	Present	Present
Chronic bee paralysis		Virus	Present	Present	Present
Black queen cell virus		Virus	Present	Present	Present
Kashmir bee virus		Virus	Present	Present	Present
Bee virus X		Virus	Present	Present	Present
Bee virus Y		Virus	Present	Present	Present
Israeli Acute Paralysis Virus			Absent	Absent	Present
Colony Collapse Disorder		Unknown but varroa and viruses implicated	Absent	Absent	Absent

7 Survey Methods and Locations

7.1 Bee Health Survey

The current survey concentrated on visual inspections for brood diseases and sampling of adult bees for laboratory analysis of diseases that could have an impact on the export of bee products and or live bees to New Zealand, Australia, Korea, Japan, China and the EU. Many of the serious bee diseases and pests that affect adult bees are not of quarantine concern for extracted honey packed in honey drums or retail packs. Raw bee products like propolis, pollen or beeswax can harbour pests such as wax moths and SHB, but are usually treated by freezing or fumigation.

The term 'bee disease' is used in this report to refer collectively to all bee diseases and exotic pests of the honey bee, as well as undesirable genetic strains.

7.1.1 Location of Colonies

The selection of apiaries for inspection and sampling was based on an assessment of the risk of contracting an exotic bee disease or pest, and follows the method used in New Zealand. Apiaries deemed to be of high risk are those near ports, airports, garbage dumps, and tourist and population centres. Having said this, the inspection teams inspected as many apiaries as possible in the time available. It was calculated that somewhere in the order of 3% of the total apiaries in Fiji were visited and inspected.

Navua (southwest of Suva)

One apiary with eight hives in Navua was inspected and three hives were sampled. Two of the hives were light in stores but the other had sufficient stores. Some of the bees were quite dark and fairly aggressive. Team members were also trained in inspection procedures and the methods required to detect exotic bee pests and diseases. A landfill was also visited in this region to see if risk material, such as old honey containers, was being handled properly. Unfortunately, we were not allowed to inspect the dumping facilities, but the plant supervisor stated that material is buried frequently, so the risk was assessed as minimal.

Nausori to Rakiraki

The survey team visited five apiaries belonging to bee farmers in Nausori, Ra, and Rakiraki region and inspected 142 hives and sampled 15 hives. Both Sacbrood and Baldbrood were found in two apiaries. A sample was taken for suspected EFB, as the larvae were curling up on the cell wall. However, the larvae were pearly white and the curling could have been caused by a nutrition deficiency.

The rainy season had just finished and a strong cyclone affected this area in December 2012. Consequently, a number of hives were very hungry with no stored honey. The Fijian rainy season can be likened to the New Zealand winter period, which is a dearth period for honey and pollen.

The strain of the bees varied a lot from gentle to fairly aggressive. Some beehives showed capped brood where the cappings were left uncompleted. This is referred to as bald brood and may be associated with wax moth infestation or a genetic origin:

https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=201

Tavua, Ba, Lautoka, Nadi

The survey team visited 19 apiaries belonging to five beekeepers on this north-western side of Viti Levu, inspecting 327 hives and sampling 57 hives. Hives were generally healthy, but four hives were found with AFB. The team also visited two feral colonies in one location, both of which were confirmed as being European bees. Some of the MoA-bred queens were very gentle, with good brood patterns.

A meeting was held at Nadi International Airport with senior Quarantine Officials (Francis Lemeki Ratucicivi, Taitusi Naiduki and Surend Pratap) to discuss biosecurity issues at the airport and seaport. Recommendations for improving Fiji's biosecurity measures are discussed in Chapter 9.

Savusava, Labasa (Vanua Leva)

The survey team visited three apiaries on Vanua Levu and inspected 26 hives and sampled 9 hives. The bees on this island were far less aggressive than bees on other parts of Fiji, so they have potential to be used as breeders for producing queens.

Sigatoka

The survey team visited four apiaries and inspected 20 hives, with 9 hives being used to collect laboratory samples. One apiary was particularly aggressive, but the honey was harvested from these hives the day before, which could possibly explain some of the aggressive behaviour.

7.1.2 Collection of Specimens

At least 30 bees were collected as a composite sample from three hives per apiary. These were to be tested by polymerase chain reaction (PCR) for viruses and *Nosema ceranae*. These samples were also dissected for the presence of the tracheal mite and screened for external mites, i.e. *Varroa spp* and the Asian mite *Tropilaelaps spp*. These bees were placed on ice in insulated containers in the field and later frozen.

7.1.3 Field Observations

A selection of hives were also inspected but not sampled. These hives were opened and brood frames and bees were examined for clinical (visual) symptoms of:

- AFB (bacteria)
- EFB (bacteria)
- Half-moon Disorder or Syndrome (HMD) (nutritional/genetic disorder)
- CCD
- Parasitic Mite Syndrome (PMS)
- Chalkbrood (fungus)
- Sacbrood (virus)
- Chronic bee paralysis (virus)
- *Varroa spp* and *Tropilaelaps spp* (external mites)
- SHB (insect)
- Africanised honey bee, Cape honey bee and Asian honey bee (undesirable subspecies/species)
- Wax moths and other pests

Observations were also made on colony temperament, hygienic behaviour and genetic diversity of bee stocks.

8 Survey Results

8.1 Results

8.1.1 American Foulbrood (Bacterium)

Four cases of AFB were identified. Every hive inspected was checked for clinical signs of AFB, including those close to known outbreaks. AFB was found during the disease survey carried out by Anderson in 1986.

Considering the low incidence of AFB found, it is recommended that Fiji adopts an AFB National Management Plan equivalent to that of New Zealand to try to eradicate this disease. Fiji should establish a national apiary register in which both beekeeper competency and apiary location and inspection information could be recorded. From discussions with Kamal Prasad, a lot of the information, apart from geospatial information, has already been collected by MoA staff.

AFB is caused by a spore-forming bacterium that is very hardy and can survive on used equipment or in honey for 30+ years. It survives boiling in water. Temperatures of 160°C for at least 10 minutes are required to kill the spores. The disease can exist in a colony as an unapparent infection for 12–18 months. During this time, beekeepers can inadvertently spread the disease by transferring frames of brood and bees or honey or honey supers to healthy hives.

8.1.2 European Foulbrood (Bacterium)

A small number of colonies were found to have field symptoms that resembled EFB, HMD or PMS. Two samples were taken for further laboratory examination. The samples tested negative for EFB using PCR.

8.1.3 Half-moon Disorder or Syndrome

HMD is believed to be a nutritional effect caused when developing queen bees are undernourished (Anderson, 1988). HMD can be eliminated by re-queening a colony. This disorder is only of concern because it can be mistaken for EFB, which is a much more serious bee disease.

8.1.4 Colony Collapse Disorder

CCD is a phenomenon that was first described in the United States in late 2006. It describes a sudden population loss in a colony with few, if any, associated dead bees in front of or inside the hive. Brood combs contain brood of all ages and, in some cases, plenty of food. Similar observations have been made in several countries throughout Europe.

Theories for CCD have included pesticide poisoning, miticides, and mite infestation and associated viruses. Recently a team of researchers in the United States used whole genome microarrays to compare cells from the stomachs of bees, as this is the primary site of pesticide detoxification and immune defence (Johnson et al., 2009). However, genetic analysis of the bees' stomachs failed to reveal elevated levels of pesticide response genes. In addition, genes involved in immune response showed no clear expression pattern, despite the increased prevalence of viruses and other pathogens in CCD colonies. The guts of the CCD bees had an abundance of fragments from the ribosome that

makes cell proteins. This finding suggests that protein production is likely to be compromised in bees from CCD hives.

Previous research showed that picorna-like viruses such as DWV and IAPV attack the ribosome and instead of making honey bee protein, they make virus proteins. None of these viruses were detected in bees taken for testing. Other research has shown a link between an iridovirus, *Nosema ceranae* and CCD (Bromenshenk, 2010).

More recently, the neonicotinoid group of insecticides has been implicated as one of the causes of CCD, especially in maize crops in the United States and in several European countries. The insecticides are used to coat seeds that are sown using air or pneumatic drills. Talcum powder is commonly used to lubricate the seeds, but during the sowing process the powder plus the insecticide is blown into the air that bees fly through. Sub-lethal doses of neonicotinoids have been shown to affect bees' memory and ability to orientate and return to their hives. In addition, neonicotinoids can persist in soils for some years and translocate through any flowering plants that are present, in which they affect the nectar and pollen. Neonicotinoids have recently been shown to affects bees' ability to eat and recruit other foragers to a potential food source (Blacquière, et al., 2013).

No evidence of CCD was seen in Fiji.

8.1.5 Parasitic Mite Syndrome and Varroa Mites

PMS is caused by viruses associated with heavy infestations of varroa mites. Some symptoms that resemble PMS were found in a several hives, but no sign of varroa mite infestation was seen. PMS symptoms can be very similar to EFB and HMD symptoms. EFB was eliminated by subsequent laboratory diagnosis.

8.1.6 Chalkbrood (Fungus)

No sign of chalkbrood was found during this survey. To the best of the authors' knowledge, chalkbrood has not previously been identified in Fiji.

8.1.7 *Tropilaelaps* Mites

No *Tropilaelaps spp* mites were seen in the hives or detected following subsequent laboratory screening. *Tropilaelaps* has not been detected during previous surveys.

8.1.8 Internal mites

No evidence of tracheal mite, *Acarapis woodi,* was seen in the colonies during this survey or past surveys. Samples from 20 apiaries were dissected in the laboratory by MPI and no tracheal mites were detected.

8.1.9 Sacbrood Virus

Clinical signs of Sacbrood virus infection were found in a small number of hives during this survey. This disease can be managed by re-queening the colonies with strains of bees resistant to the virus. Sacbrood infection rates within a colony also decrease during major honey flows. This disease was confirmed during previous surveys.

8.1.10 Chronic Bee Paralysis (Virus)

No clinical sign of chronic bee paralysis virus was found during this survey. Chronic bee paralysis virus was detected in the laboratory by Anderson in 1986.

8.1.11 Nosema spp. (Microsporidian)

The nosema microsporidian is a fungus-related microbe that produces spores that bees consume when they clean out infected cells. The spores germinate in the bees' digestive tract and cause an infection that spreads to other tissues. Nosema is probably the most common honey bee disease in the world and can be found in just about every hive. *Nosema apis* was the leading cause of microsporidia infections among domestic bee colonies until recently, when *N. ceranae* jumped species from the Asian honey bee to the European honey bee.

N. ceranae appears to be more virulent than *N. apis* in European honey bees. Researchers in Spain have shown that it may be the cause of CCD in that country (Higes et al., 2009). Colonies were being wiped out or lost much of their strength within weeks of being infected.

No visual signs of either nosema species were seen, although confirmation is usually by PCR diagnosis. Anderson found *Nosema apis* in 45 samples collected from eight apiaries (47%), while the 2000 survey tested 17 samples for *Nosema apis,* 5 of which were positive with infection levels described as 'very light'.

Samples taken during the current survey were tested for *N. ceranae*, with 6 out of the 20 samples (30%) testing positive. As in the New Zealand situation, it is not known how long *Nosema ceranae* has been present, as this is the first survey to test for this disease. It is also not known what effect, if any, this species of nosema is having on Fijian honey bees.

Regular comb replacement, re-queening and good protein nutrition is generally recommended to help reduce the effects of nosema. These techniques were discussed during the training and out in the field with MoA staff. Feedback indicated that, while MoA staff understood and supported such management techniques, the non-availability of hive ware, queens and protein supplement would make it difficult to implement these techniques.

8.1.12 Africanised Honey Bee and Cape Honey Bee (Undesirable Subspecies)

Most hives examined were hybrids of the Italian strain (*Apis mellifera ligustica)* and the North-Western European dark strain of honey bee *(Apis mellifera mellifera).* There was no evidence of the African or Africanised honey bee (sometimes called the killer bee) or of the Cape honey bee.

8.1.13 Asian Honey Bee (*Apis cerana*)

See also Section 11.2.

No Asian honey bees were identified, although no baiting surveillance activities were carried out for this invasive honey bee species. It is suggested that MoA apiculture staff survey for the Asian honey bee on an annual basis around air and sea ports where the risk of an incursion is greatest. Surveillance activities should include baiting (as per the protocol used by Dr Dennis Anderson in Solomon Islands), inspection and sampling of known swarms, and observation of bees on flowers.

Asian honey bees have spread in Solomon Islands since first being reported in 2003. They have destroyed beekeeping there by out-competing the European honey bee and also introducing the *Varroa jacobsoni* mite. In Solomon Islands, the Asian honey bee is a prolific swarmer that frequently robs European honey bee colonies and is very difficult to manage in hives. It is also a very poor honey producer, only producing a small amount of honey in comparison to the European honey bee.

The Asian honey bee has been reported in Australia on a number of occasions, but became established in Cairns in 2007. Despite attempts to contain and eradicate the bee, it was found in May 2011 some 88 km south from Cairns in the Innisfail area. The Asian honey bee is established on Efate in Vanuatu and could be easily brought to Fiji on a yacht or ship.

8.1.14 Small Hive Beetle (Insect-beetle)

No SHBs or SHB larvae were seen. SHB larvae infest hives and consume pollen and honey stores. In the process, they infect honeycombs with a yeast that creates a noxious slime all over the frames and makes the honey inedible. SHB are present in Australia and are now reported to be causing a major nuisance and wiping out weak colonies or ones showing ill thrift (Sommerville, D, 2012 pers. comm).

8.1.15 Wax Moth

Many hives inspected showed some level of infestation with both species of wax moth. All of the dead hives examined had most of or their entire comb destroyed by wax moth. Both the greater wax moth (*Galleria mellonella*) and the lesser wax moth (*Achroia grisella*) are serious pests of honey bees in Fiji. Strong hives are able to keep wax moth under control, but it has a debilitating effect on weak colonies. Wax moth causes significant economic loss by rapidly destroying the combs in dead colonies so that the combs are no longer usable by bees and the wax cannot be salvaged for melting down for use in foundation.

It was observed that the more yellow the bees were, the more resilient they were against wax moth infestation. Hives in total shade were more affected by wax moth than hives located in full sun, although it is not apparent why this should be so.

The survey team also found evidence of ‘bald headed brood’. This describes a situation where apparently normal pupae are uncapped or partially capped. These pupae will often develop into healthy adults. The cause of bald brood is unknown, but it has been linked with faecal material of the lesser wax moth. Greater wax moth may also produce these symptoms (Morse & Flottum, 1997).

8.1.16 Other Pests

Several species of ants were found in beehives, as well as lizards, cockroaches and centipedes. The previous status with respect to these pests is unknown. Cane toads are also a beekeeping pest in Fiji and hives must be raised above the ground to prevent toads from eating bees at the entrances.

The external mites *Acarapis externus* were found on bees in 5 of the 20 samples sent to MPI laboratory. These mites are common in New Zealand and are not known to be economically significant.

8.1.17 Genetic Base

The honey bees in Fiji are a hybrid of the Italian bee *Apis mellifera ligustica* and the dark or north-western European bee (*Apis mellifera mellifera*). The dark bee is a very hardy strain, and capable of living without human assistance as feral colonies. Since dark bees predominate as the background population in Fiji, drones of this stock are more likely to mate with virgin queens flying from managed colonies. Without an active re-queening program, this results in increased hybridisation of the strain of bees in managed colonies, and the eventual reversion to darker bees.

Dark bees and their crosses are much more aggressive than the Italian strain, and run excessively on the comb, making finding queen bees very difficult. They are therefore not the preferred strain for commercial or village beekeeping.

The authors observed variation in bee stock depending on the location of the bees. Typically, bees on parts of Vanua Levu were gentler than those found elsewhere. It would be possible for a suitably trained beekeeper to select genetics from within the existing Fijian honey bee stock and produce queens of a sufficiently gentle nature to restock Fijian hives. This stock may eventually have to be supplemented by genetic material sourced offshore. However, care would have to be taken to ensure that new viruses are not inadvertently imported with the genetic material. As mentioned earlier, the more yellow Italian strains were more resistant to wax moths, so selection could be made on the basis of colour. A simple method for re-queening hives with better stock would be to use protected queen cells (Reid M, 1979).

Both industry stakeholders and MoA AHPD staff acknowledged that bee stock selection and queen bee production would be hugely beneficial to beekeeping on Fiji. In fact, the MoA AHPD has been proactive in this regard and has initiated a breeding program. AsureQuality and its predecessors have delivered genetic improvement / queen rearing programs in other Pacific island countries and could potentially customise a training program to suit the situation in Fiji.

8.2 Exotic Surveillance Program

Maintaining area freedom in regard to Asian bees on Fiji would be beneficial in order to protect the beekeeping industry. The Fijian MoA AHPD has the capability to carry out annual delimiting surveys around high risk areas such as sea and air ports. It is also recommended that awareness raising activities (such as posters at ports and airports) are used and that port and shipping staff be encouraged to watch for bees and report swarms to AHPD. It is envisaged that these awareness raising activities would be similar to those used for foot-and-mouth disease, rabies and Newcastle Disease:

http://www.biosecurityfiji.com/images/stories/pdf/publications/factsheets/unwanted-pest.pdf

Table 8-1 Location of managed apiaries surveyed in Fiji during April 2013

No.	Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number inspected	Number sampled	Comments
1	Raiwaqu Navua	Bhan Pratap	18° 11' 53''.0	178° 08' 26''.5	12	8	3	Some of the hives needed feeding.
2	Dobuilevu Research Station Nausori	MPI	17° 33' 47''.3 17° 33' 42''.2	178° 14' 57''.2 178° 15' 03''.7	12	12	3	Four dead hives in two sites, Sacbrood in one weak hive, more gentle strain, need feeding.
3	Barutu Rakiraki	Ra (Provincial Group)	17° 28' 38''.7	178° 14' 23''.3	29	29	3	All nucs; Sacbrood found, plus EFB suspected in one nuc (H28). Nucs hungry, some pupae had no cappings (bald brood).
4	Kings Highway Dganaleotu Ra	Ra Provincial	17° 26' 23''.6	178° 13' 48''.0	42	42	3	Hungry hives, bald brood. Some queenless hives. Some of the hives were strong and should do well once honey flows start. Some hives gentle but others aggressive.
5	Kings Road	Jaffar	17° 21' 22''.2	178° 10' 01''.6	21	21	3	Near rubbish dump. Hives strong but hungry with no stored honey. Some hives were aggressive. **AFB** sample taken.
6	Waivuku Rukivalu	Mr Tika Ram	17° 21' 22''.1	178° 10' 01''.4	38	38	3	Strong hives, with some of them very aggressive. Few of the hives were hungry.
7	Tavua Fiji Water Rd	Vaqara Pastral	17° 33' 20''.5	178° 15' 03''.7	9	9	3	Strong hives with stored honey. Not too aggressive. Two hives were dead.
8	Tavua	Vaqava Pastrol	17° 26' 44''.5	177° 59' 03''.9	4	4	3	Broken frames but hives quite strong.
9	Tabada Moto	Bimle	17° 36' 37''.3	177° 41' 22''.1	25	25	3	Good strong hives, good brood patterns, good strain.
10	Tabataba Ba	Bimla Naidu	17° 36' 55''.6	177° 40' 46''.5	23	23	3	Good hives, bit on the light side with stores but fresh nectar coming in.
11	Tabataba Rd	Bimla Naidu	17° 36' 53''.1	177° 41' 36''.4	7	7	3	Good hives with fresh nectar coming in. Hives a bit hungry. Some new queens.

No.	Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number inspected	Number sampled	Comments
12	Tabataba Moto Ba	Ni Khlesh	17° 37' 01''.0	177° 41' 09''.9	8	8	3	Strong hives with good brood patterns. Hungry but fresh nectar coming in.
13	Tabataba	Papaita	17° 36' 35''.0	177° 41' 12''.1	36	16	3	Good strain of bee. Hungry hives. Not strong enough for two boxes. Two hives queenless and one dead.
14	Waiwai	Mustat Ahmd	17° 35' 29''.6	177° 40' 23''.3	45	22	3	Hungry hives but good strain of bee. Not strong enough to be doubles. Also Sacbrood found. Two hives with **AFB** found.
15	Waiwai	Azil	17° 35' 40''.6	177° 40' 30''.8	22	22	3	Strong hives but some were hungry. Fresh nectar coming in. One hive queenless.
16	Nukuloa	Ram Suarath	17° 37' 54''.7	177° 44' 54''.2	13	13	3	Good strong colonies with fresh nectar. Not gentle.
17	Vitogo (Deshbundu) Lautoka	Salesh Mahara	17° 35' 44'.4	177° 31' 42''.0	55	26	3	Rotten boxes and frames that need replacing. Strong hives but aggressive. Hives had not been worked for some time. Some hungry but fresh nectar being collected. Bald brood present.
18	Johnson Rd	Dewandra Sharma	17° 36' 11'.6	177° 30' 45''.5	16	16	3	Strong hives, hungry but fresh nectar coming in. Toads were affecting bees as stands were too low.
19	Vatulaulau	Mr Imraz Al	17° 24' 26''.1	177° 32' 18''.9	21	21	3	14 hives and 7 nucs. Some were queenless. Some of the hives were strong. Gathering fresh nectar.
20	Vatalaulau	Amraz Al	17° 33' 35''.3	177° 40' 44''.2	32	32	3	Sacbrood found. Strong hives, very hungry. Fresh nectar and pollen in hives. One hive with **AFB** found.
21	Lomolomo Lautoka	Mohamad Safiq	17° 39' 46''.4	177° 24' 50''.7	25	13	3	Strong hives with stored honey, aggressive. Apiary was overgrown.
22	Lomolomo Lautoka	Mohamad Safiq	17° 39' 48''.7	177° 25' 38''.9	23	12	3	Strong hives with stored honey, overgrown with weeds. **AFB** sample taken.
23	Lenga Lenga Nadi	Jacks Farm	17° 45' 19''.4	177° 27' 43''.1	39	39	3	Close to airport. Good, strong hives with stored honey. Not that gentle. Overgrown with weeds.
24	Vatualevu Nadi	Dhireu Nath (Peter)	17° 46' 14''.5	177° 30' 37''.9	8	8	3	Old hives, very old frames. Weak colonies, hungry. One dead-out.

No.	Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number inspected	Number sampled	Comments
25	Togomasi Nadi	Bimal Kumar	17° 46' 14''.4	177° 30' 37''.9	11	11	3	Bit of wax moth damage. Good hives, some a bit hungry. Fresh nectar, not that gentle.
26	Savusavu Vanua Levu	Robin Myser	17° 27' 17''.4	178° 35' 07''.6	9	9	3	Strong hives with stored honey. Good strain, some wax moth. Some need extra box. Some hives had plastic frames which have not been accepted. Good brood patterns.
27	Batiri Bee Station Vanua Levu	MoA	16° 48' 23''.9	179° 20' 50''.2	9	9	3	Four dead-outs. Hungry hives but gentle strain. Some hives were weak.
28	Batiri Bee Station Vanua Levu	MoA	16° 35' 11''.4	179° 03' 26''.5	24	8	3	Two dead-outs. Good strain of bee. Medium strength, some hungry.
29	Nadnonai Nadroga	Figz Ali	No GPS available		5	5	3	Good hives with honey and pollen. No disease found, except for some bald brood. Good strain of bee.
30	Naevuevu Nadroga	Naevuevu Bee farmers	No GPS available		15	7	3	Honey had been harvested the day before. The hives were aggressive and sited in shade. Fresh nectar and pollen. Some of the hives were very strong, whereas others were weak. Bees were quite dark.
31	Nawamagi Nadroga	Nawamagi beekeepers (Naisake)	No GPS available		25	0	0	Looked for hives in bush and couldn't locate them.
32	Korotogo Nadroga	Aporosa Yada	No GPS available		8	8	3	One hive empty. Good hives on a sunny site. Some were hungry. No disease, apart from some bald brood.
				Totals	**671**	**523**	**93**	

Table 8-2 Location of European feral honey bee colonies surveyed in Fiji during April 2013

			Degrees south	Degrees east	Number of hives	Number inspected	Number sampled	Comments
	Feral #1 & #2		17°37' 01''.0	177° 41' 09''.0	2	2		Two recent swarms at bee farmer's house. European honey bees, not Asian bees.

9 Summary and Conclusions

In Fiji, 523 managed colonies out of a total of approximately 8800 available were inspected for bee diseases and pests, and in particular for EFB and AFB. This is a hive inspection rate of 6.5%, compared to the target surveillance rate of 1.4% in New Zealand.

Thirty one apiaries were visited, which is approximately 3.0% of the estimated total number of apiaries. This compares to New Zealand's apiary selection rate of 2.6%.

In New Zealand, MPI contracts AsureQuality Limited to inspect and sample 350 apiaries each year using AsureQuality staff or warranted beekeepers, and to collect samples from another 300 apiaries that supplied live bees for export. The latter are examined for internal and external mites only.

In addition to inspecting managed colonies in Fiji, bees from two feral colonies were also checked for presence of the Asian honey bee. Both of the feral colonies were found to be European honey bees.

No cases of EFB or HMD were confirmed, and no evidence of CCD, PMS, or Chalkbrood were seen. Samples were taken from two colonies exhibiting some of the symptoms of EFB and HMD for laboratory analysis. No causative pathogens are associated with HMD and the samples were negative for EFB.

Four cases of AFB were detected; however, this disease has been known to be in Fiji for some time now. Clinical signs of Sacbrood virus infection were also found in some hives.

No field evidence was found of SHB or the very aggressive African honey bee or the Cape honey bee.

Both the greater and lesser wax moths (*Galleria mellonella* and *Achroia grisella*) were seen in weak and dead hives, sometimes in very high numbers. The warm tropical climate in Fiji is ideal for the wax moths.

Cockroaches, lizards, snails and centipedes were also reasonably common, as were several species of ants. None of these appear to be causing a problem to the hives. All have been seen in previous surveys. Cane toads are also present in Fiji and can be a major problem to bee farmers, as they eat a lot of bees. Hives are raised above the ground on stands; the only places where cane toads appeared to be causing a problem was where the stands were too low.

10 Recommendations

The following recommendations fall into two broad categories: honey bee colony management and regulatory recommendations.

10.1 Honey Bee Colony Management Recommendations

While the majority of colonies observed during the survey were producing well, given the prevailing conditions, the authors considered that some additional colony management focused on queen bees would be advantageous:

- Re-queen all hives at least every two years with protected queen cells. This would allow for the controlled improvement of bee stock in the areas of honey production and temperament.
- Continue to select strains of bees on Fiji that are more gentle and resistant to wax moth to use as breeders.

The authors recommend that any stock improvement is done firstly by sourcing promising genetics from within Fiji, as the risk of importing honey bee diseases with stock from outside Fiji is too great. It is understood that Solomon Islands is establishing contacts and protocols for imports of new stock from disease-free queen bee breeding centres in Western Australia. This could prove useful as a potential contact for AHPD if it is decided to seek new stock for Fiji.

Alternatively, authorities could look to Niue to provide bee stock genetics, as the bee population there has been isolated for many years and is relatively disease free. A bee disease survey is proposed for Niue in July 2013 with funding from the Secretariat of the Pacific Community (SPC).

A lot of honey produced in Fiji is obtained by bees working the sap from cut sugar cane. This does not meet the definition of honey under the Codex Alimentarius. The authorities in Fiji need to set up a national Honey Standard and a mechanism to ensure honey containing unacceptable levels of sugar cane sugar is not being commercialised as “honey”.

It is recommended that dry sugar or sugar syrup be fed to colonies earlier to ensure that they are in peak condition and able to take full advantage of nectar flows once the wet season ends. It was noted that the Fijian rainy season is a time of dearth somewhat similar to the New Zealand winter period. A lot of colonies were in very poor condition coming out of the wet season. Lack of pollen supplies may be a limiting factor as well.

It may be better to keep beehives under partial shade to prevent the colony from overheating. Beeswax on top of the frames was melting in some hives that were kept in the full sun.

Bee boxes do not last long under the weather conditions in Fiji. It is recommended that the feasibility of using timber treated with copper-based compounds that are not harmful to bees be explored. Untreated hive ware suffers a similar fate in Samoa; the Samoan beekeepers solve the problem by building open-sided shelters using poles and recycled roofing iron or thatch for the roofs.

10.2 Regulatory Recommendations

The authors believe that there is considerable scope for increasing honey production in Fiji, with the potential to eventually become a net exporter of honey and other bee products. In order to support this potential growth, Fiji should consider developing a ‘competent authority’ for bees and bee products.

Consideration should also be given to a surveillance program to support any country freedom declarations required on official assurances. Lastly, efforts to protect the current level of disease freedom should be considered.

Specific recommendations include:

- Up-skilling of a 'competent authority' for bees and bee products. This would likely involve specific training in New Zealand of a veterinarian and would include:
  - Liaising with AsureQuality Official Assurance verifiers to gain an understanding of the bee products certification system, verification/auditing of secondary processing premises, and various market access requirements
  - Spending time with bee product processors to understand processing and quality systems
  - Spending time with beekeepers to gain experience in hive management, disease recognition and control, and compliance issues at the primary production level.
- Follow-up training for AHPD staff every few years in honey bee disease surveillance and recognition. This could occur in either Fiji or New Zealand, but it would be more cost effective for this to occur in Fiji. This would include:
  - Classroom-based refresher training on honey bee diseases of interest
  - Field inspection practice. This could be part of the annual surveillance program for the year
  - Update of survey techniques for exotic bee diseases and especially Asian honey bees.
- Reassess the risks of allowing non-heat-treated honey to enter Fiji and especially the concession for up to 20 kg of accompanied honey for personal use. From the data collected in this survey, we can conclude that Fiji has a higher health status than Australia and New Zealand, but this could easily be destroyed by a new exotic disease such as EFB or Chalkbrood being introduced.
- Consider implementing an annual honey bee disease surveillance program, which should be designed to:
  - Support country freedom declarations
  - Assess the success of honey bee disease and pest exclusion measures
  - Justify any bee product import restrictions that might be implemented
  - Find a pest or disease early enough that an eradication attempt could be considered.
  - Attempt to control and even eradicate AFB.

The New Zealand Apiculture exotic bee disease active surveillance program samples hives in several high risk zones throughout the country. High risk zones are near ports and airports, garbage dumps, tourist centres and so on. The number of apiaries surveyed in each area is determined using a hypergeometric distribution model. Areas are surveyed at different rates, depending on the perceived risk in that area. The highest risk areas are surveyed at a level which gives a 95% chance of detecting a 5% apiary infestation/infection rate. All hives in selected apiaries are sampled; however, as most of the selected apiaries are in urban areas, hive numbers are typically less than five hives per apiary.

Fiji may not need to determine high and low risk areas as in the New Zealand model, but should treat each of the two islands as distinct areas for surveillance. About 30 apiaries would need to be surveyed to achieve equivalence with New Zealand's 2.6% apiary sampling rate. Based on current estimated hive numbers, between 120 and 140 hives should be inspected and sampled in each survey. Feral colonies would not be included due to the difficulty in inspecting the combs.

Apiaries would need to be selected randomly and surveyed for pests and diseases of concern to exporting countries. These include:

- EFB
- AFB
- IAPV.

It is possible for Fiji to develop a live bee/germplasm export market, as Fiji has very few bee pests and diseases compared to other countries. However, the current genetic stock may not be very desirable to potential customers. Fiji may wish to undertake some surveillance for other bee pests to support country freedom declarations.

Fiji should consider establishing and maintaining an apiary register to support disease surveys and official assurance declarations. This could take the form of a spreadsheet that is updated via AHPD staff with local knowledge. Inspection and disease information could be added, as well as beekeeper training information. Existing animal health databases could probably be used as well.

11 Legislation and Quarantine Systems for Bees and Bee Products

The risk pathways into Fiji for an exotic honey bee disease or pest are considerable, with regular shipping and air flights from a number of countries (plus visiting cruise ships and yachts) that could have honey or bees on board. The number of tourists visiting Fiji has dropped slightly in recent years but has grown considerably since the last survey was completed. As an indication, visitors have doubled between 2000 and 2011 (www.statsfiji.govt.fi).

One of Fiji's neighbours, Vanuatu, has recently discovered *Apis cerana*, an undesirable bee species, which may have arrived there from Solomon Islands. *Apis cerana* also introduced the varroa bee mite, *Varroa jacobsoni*. This has confirmed the ease with which exotic honey bee pests and diseases can be spread. The Fijian beekeeping industry needs government protection by way of import controls and border quarantine and inspection, ongoing field surveillance, and an ability and willingness to respond to an outbreak of a serious honey bee disease or pest.

11.1 Acts and Regulations

The legislation relating to the importation of honey into Fiji is the Biosecurity Promulgation 2008 Act. This is accompanied by the import conditions on www.biosecurityfiji.com.

These documents require that honey imports over 20 kg are accompanied by an import permit.

Importing honey as commercial consignments under permit or personally accompanied increases the risk of introducing the exotic EFB and Chalkbrood disease. Commercial honey processors could heat-sterilise honey to order for the Fijian market for both diseases, but honey sourced from most producer beekeepers would not be heat-sterilised.

11.2 Quarantine Systems

Fiji operates a quarantine system under the Biosecurity Promulgation 2008 Act. It appears that there is sufficient scope within the legislation to effectively protect the beekeeping industry; however, bees and bee products may need to be specifically addressed within the regulations in a similar way to many other animal products entering Fiji.

11.3 Honey Bee Disease Survey and Response Systems

It has been more than 13 years since the last bee disease survey was carried out in Fiji by international experts. If Fiji is to develop export markets for locally produced bee products, more frequent disease surveys would likely be required. Any negotiation of an IHS with New Zealand may require equivalence with New Zealand standards, which could mean an annual bee disease survey. Such surveys in New Zealand are the responsibility of MPI as the competent authority. MPI contracts AsureQuality Ltd, who in turn sub-contracts beekeepers warranted by MPI as Authorised Persons Level 2 to carry out the field inspection and sampling work.

Currently, all the bee disease recognition expertise in Fiji resides with a few key AHPD staff. As a result of the training conducted during this visit, more AHPD staff should now be able to recognise an exotic bee disease if one should become established and know who they can consult for further diagnostic advice. Response activities could be carried out internally, with international expertise brought in to help if necessary.

An import permit for biological products of animal origin was obtained from MPI for the current bee disease survey, but the bees had to be frozen or stored in alcohol. Suspect larval material was also permitted, but this material had to be tested using PCR and could not be cultured. Material was to be released to an MPI containment facility and destroyed afterwards.

Fortunately, in the absence of *Varroa destructor*, which can lead to PMS and CCD, both AFB and EFB and Chalkbrood have reasonably conclusive visual or clinical symptoms. IAPV requires RCR laboratory analysis.

Information on bee diseases, including colour photographs, has been left with AHPD staff and beekeepers. Copies of the brochure *Honey Bee Exotic Diseases and Pests* (produced by AsureQuality Ltd and funded by MPI) were supplied to AHPD, along with illustrations of exotic bee diseases. This could be used as a starting point for the development of awareness-raising material as previously discussed. It is anticipated that MPI will not withhold any permissions to use information in the pamphlet. AsureQuality will most likely also grant permission to use illustrations held by it.

However, it is likely that some laboratory diagnostic capability will be needed to support the surveillance program, especially for IAPV. This support could be outsourced, but it may be more cost-effective to develop in-country capability. If there is a desire to include internal and external mites, SHB, and undesirable bee genotypes in the surveillance program, this capacity could be developed by training existing AHPD staff who are currently doing entomological diagnostic work.

Diagnostic backup should be established with MPI labs in New Zealand in the first instance, as they have higher level containment facilities available and also have specialised equipment for PCR testing of bee diseases.

11.4 Industry Prospects and Export Considerations

Current production is estimated to be around 190 tonnes per year with a potential Fijian market of around 800 tonnes annually (Prasad 2013, pers. comm). Currently, all of the bee farmers' honey is easily sold on the local market at very good prices (FJD15 per kg) and does not meet the local predicted demand, so there is no urgent need to export honey.

Honey collected during the sugar cane harvesting season may exceed the accepted level for sucrose under Codex Alimentarius and all export honey may need to be tested for this molecule, especially if exported to the EU.

Based on the current distribution of hives and the availability of nectar sources, the hive stocking rates on Fiji are very low and could be increased significantly, provided land ownership and hive security issues can be managed. This is particularly true on the island of Vanua Levu, where the keeping of managed bees is not widespread. Ultimately, Fiji could, with some effort, be a net exporter of honey while also increasing the demand for honey locally.

Export markets should be developed if there is a demand and better prices can be secured. Export of honey to New Zealand would need to be negotiated under a bilateral agreement and an IHS developed. This probably won't happen until the current IHS review is completed and this is not likely until 2014 (see http://www.fedfarm.org.nz/Files/130527-Letter-from-MPI.pdf).

As the conditions on any negotiated import permit are likely to demand demonstrated freedom from EFB and IAPV, this will probably require regular surveys of hives to be undertaken by the competent authority.

Qualifications of staff that should carry out the survey work will be subject to negotiation. Suitably trained local personnel, or accredited experts from overseas, could do this work, or New Zealand authorities may accept qualified beekeepers inspecting their hives and making declarations as to disease freedom. A competent authority will also be required to issue Official Assurances / Export Certificates; the level of competency required will be negotiated with New Zealand authorities.

If honey from Fiji is to be consumed within New Zealand, then it should have been processed in premises approved for the purpose by local health authorities and the operator should ideally have a documented Food Safety Program or an RMP. If the honey from Fiji is likely to be re-exported from New Zealand, then the operator must have an RMP and meet all OMARs. AsureQuality Ltd carries out the majority of the RMP audits for New Zealand honey processors. See http://www.foodsafety.govt.nz for more information.

The Australian export market has similar requirements to New Zealand, with the additional requirement that all honey is subject to routine chloramphenicol testing. Because of the high cost of this testing and the fact that no antibacterial compounds are registered for use in beehives in New Zealand, honey can be exported from New Zealand to Australia without testing, provided it is accompanied by an official assurance from MPI. Fiji is likely to be able to make similar assurances and thus avoid this additional cost.

The EU is one of the more difficult markets to supply. Besides the requirement to process bee products under an RMP, the honey industry will also need to take part in an ongoing national honey residue program managed by the competent authority. Other requirements are subject to negotiations between the EU and Fiji.

http://www.foodsafety.govt.nz/industry/sectors/honey-bee/

Currently, testing under the New Zealand National Honey Residue Program includes chloramphenicol, nitrofurans, antibiotics, carbamates, synthetic pyrethroids, organophosphates and organochlorines.

It could be assumed that Fiji would be subjected to similar requirements, as is Pitcairn Island, and thus it is recommended that the focus be on the development of Asian and the Australian and New Zealand export markets in the first instance.

Should a large commercial beekeeping industry develop in Fiji, a significant number of employment opportunities could be created. As well as employing local people as beekeepers and to process the bee products, overseas seasonal employment opportunities may exist for Fijian beekeepers in New Zealand and Australia. New Zealand experiences a seasonal shortage of skilled beekeepers, which is currently met with workers from the Philippines.

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

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