Pacific Horticultural and Agricultural Market Access Program (PHAMA)

Technical Report 34: Disease Survey of Honey Bees in Vanuatu (VAN10)

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Abbreviations

Abbreviation	Description
ACIAR	Australian Centre for International Agricultural Research
AFB	American foulbrood
AusAID	Australian Agency for International Development
CCD	Colony collapse Disorder
DLQS	Vanuatu Department of Livestock & Quarantine Services
DWV	Deformed Wing Virus
EFB	European foulbrood
EU	European Union
HMD	Half-moon disorder or syndrome
IAPV	Israeli Acute Paralysis Virus
IHS	Import Health Standard
MPI	Ministry for Primary Industries (New Zealand, formerly Ministry of Agriculture and Forestry)
OIE	World Organisation for Animal Health
PCR	Polymerase chain reaction
PHAMA	Pacific Horticultural and Agricultural Market Access Program (AusAID-funded)
PICs	Pacific Island Countries
PMS	Parasitic mite syndrome (usually associated with varroa mite)
RMP	Risk Management Plan
URS	URS Australia Pty Ltd

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Executive Summary

An AusAID initiative is to increase exports of high value primary products from Pacific Island Countries (PICs). The Pacific Horticultural and Agricultural Market Access Program (PHAMA) is designed to address constraints to market access for primary production products, including honey and other bee products. PHAMA funded the current bee disease survey to support the growth of the beekeeping industry in Vanuatu by establishing the disease status of the local honey bees and using this information as a basis for quarantine regulations and market access negotiations.

The bee disease survey was carried out by Byron Taylor and Tony Roper, AsureQuality Limited, New Zealand, from 17–27 October 2012. The last bee disease survey conducted in Vanuatu was done by Bettesworth and Grueber in 2000.

Gilbert Gibson has the largest hive holding in Vanuatu, currently managing approximately 250 colonies. A second beekeeper, Ian Shaw, operates around 70 colonies, and a number of individuals operate less than 6 hives. It is estimated that there are around 400 managed colonies in Vanuatu, with 90% or more on Efate. The annual honey crop is approximately 5 tonnes per year, all of which is consumed within Vanuatu. The estimated consumption is around 10 tonnes, with the shortfall being made up with imports of honey from Australia and France (Gilbert Gibson, pers. comm.). Gilbert Gibson has been beekeeping in Vanuatu for many years but has recently moved to full-time beekeeping. It is his hope to increase his current hive numbers to increase production for local consumption in the short term, with the potential to move into export markets in the long term.

In addition to European bees, the Asian Honey Bee (*Apis cerana*) has recently been discovered on Efate. It is unsure how long *Apis cerana* has been in Vanuatu but, judging by its distribution and comments from Gilbert Gibson, anywhere from 2 to 4 years is realistic. A component of the current survey was to assess the spread of *Apis cerana* and, in particular, whether it is present on the islands of Espiritu Santo, Malekula and Tanna.

Currently, honey and other bee products entering New Zealand from a number of 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]

Vanuatu is not included on the list of PICs covered by this import health standard (IHS), so access to New Zealand would need to be separately negotiated.

New Zealand's 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.

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 disease has never been detected in Vanuatu 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. In addition, honey exported to the European Union must come from apiaries of known disease history. This usually means an apiary database is being maintained,

[1] Now renamed *Melissococcus plutonius.*

annual bee disease surveys are being carried out, and beekeepers are reporting on the presence of listed bee diseases.

The survey team inspected 193 beehives for bee diseases and pests, in particular EFB and its associated secondary bacterium *Paenibacillus alvei*. Samples were also taken from 34 hives for testing for Deformed Wing Virus (DWV) and four known strains of Israeli Acute Paralysis Virus (IAPV), the microsporidian *Nosema ceranae*, the internal or tracheal mite *Acarapis woodi* and the external mites *Varroa* sp and *Tropilaelaps*. 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, and *A. woodi* and the external mites *Varroa* sp and *Tropilaelaps* are not transmitted in honey. *Varroa* destructor is endemic in New Zealand. Since the IHS was reviewed, MPI has confirmed the presence of *P. 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 it remains a bee disease of concern with New Zealand beekeepers (McFadden, Tham et al 2012).

Bees were tested for DWV, *Nosema ceranae*, the tracheal mite and *Varroa* spp and *Tropilaelaps*, in case Vanuatu is in a position to export live bees, queen cells or drone semen in the future. However, the presence of *Apis cerana* and *Varroa jacobsoni* could limit the export potential of this material.

No cases of EFB or American foulbrood (AFB) were detected, despite a case of AFB being discovered in the previous survey in 2000 and an additional case being discovered earlier this year by Mr Gilbert Gibson and Mr Nambo Moses. The recent find was in the same area as the original discovery in 2000. 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 total destruction of infected material. Some approved beekeepers can recover infected equipment by dipping in paraffin wax heated to 1600C for at least 10 minutes. AFB is subject to a Pest Management Strategy in New Zealand. It is recommended that for Vanuatu, AFB is included in an annual surveillance program and that any infected material found is destroyed.

Varroa jacobsoni was identified in European honey bee colonies during the survey. Samples of these mites were taken for morphological and molecular analysis, which confirmed the identification.

The survey in Vanuatu achieved a hive inspection rate of 48% and a hive sampling rate of 8.5%, from a population of approximately 400 hives. 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 disease each year by an approved beekeeper, which increases the possibility of beekeepers finding a notifiable exotic bee disease or pest.

The survey team inspected 46 apiaries and 21 feral colony locations. While there is no official apiary register, it is estimated that we inspected around 80% of managed apiaries, compared to New Zealand's target surveillance rate of 2.6%.

Apis cerana was confirmed on Efate and the two nearby islands of Pele and Emao, which lie north of Efate. Four samples were collected (three from Efate and one from Emao) and submitted to the laboratory for testing. These colonies were subjected to a brood inspection where possible. *Apis cerana* was not detected on Santo, Malekula or Tanna. Eradication of the Asian bees (*Apis cerana*) from Efate, Pele and Emao is not feasible; however, awareness raising measures such as posters at ports and pamphlets for commercial and recreational sailors could help to reduce the chance of the Asian bees spreading between islands.

Laboratory analysis of bee samples did not detect any cases of DWV and IAPV, the tracheal mite *Acarapis woodi*, or the external mites *Varroa* destructor and *Tropilaelaps*. The external mites *Acarapis externus* and *Acarapis dorsalis* were detected on many bees. These mites are common in New Zealand and are not known to cause any damage to honey bees.

The microsporidian *Nosema ceranae* was detected by polymerase chain reaction (PCR) in 13 of the 24 apiaries tested (54%). Previous surveys did not test for the presence of *Nosema ceranae*, so it is unclear how long it has been present in Vanuatu. *Nosema ceranae* has only recently been confirmed in New Zealand using PCR technology. It is not known what effect, if any, this species of nosema is having on honey bees either in New Zealand or in Vanuatu.

EFB disease has never been reported in Vanuatu and no evidence of this disease was found during this survey or during past surveys.

No cases of tracheal mites or the Small Hive Beetle were found. There was no evidence of the African honey bee (*Apis mellifera scutellata*) or the Cape honey bee (*Apis mellifera capensis*). These diseases or pests are not transmitted through honey.

Other minor diseases were reconfirmed as being present, such as both the greater and lesser wax moths (which exist in New Zealand). Various species of ants, cockroaches, centipedes and lizards living in or around hives were also found, but these are not transmitted live in honey.

The risk pathways into Vanuatu for an exotic honey bee disease or pest are considerable, with ongoing importation of honey from France and Australia, regular shipping and air flights from a number of countries, plus visiting cruise ships and yachts, which could have honey on board. The number of tourists representing a risk visiting Vanuatu has dropped slightly in recent years but has grown considerably since the last survey was completed. As an indication, the number of accommodation rooms available almost doubled from 800 to more than 1500 between 2005 and 2011 (http://www.tms.com.vu/statisitics1.html).

Importation of honey into Vanuatu is managed under the “Animal Importation and Quarantine Act, 1988” and the “Animal Importation and Quarantine Regulations, 1994”. These documents require that honey imports are accompanied by an import permit which states:

“Permission for import is granted under the following conditions:

- *Contain no substances harmful to human health;*
- *Have been processed, prepared, packaged, and transported according to the required public health legislation in the country of origin;*
- *Have been heat treated or pasteurised;*
- *No raw honey or combs are permitted entry.*”

In order to retain stability in the local market as honey production increases, it will be necessary to investigate export opportunities. Export to New Zealand is currently allowed from some PICs; however, Vanuatu is not included in this IHS. If Vanuatu were to negotiate its own conditions, New Zealand would likely require similar conditions to those currently imposed on other PICs. This includes attesting to the country of origin of the product and certifying that Vanuatu is free of EFB. A surveillance program to address this issue is recommended and discussed in more detail in the report. This surveillance program could also support the negotiation of export protocols to other export markets.

1 Introduction

An AusAID initiative is to increase exports of high value primary products from Pacific Island Countries (PICs). 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, PHAMA 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, certifying 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 Vanuatu or New Zealand, but regular surveys by the Competent Authority and reporting are required to confirm this status. Subsequent import risk analyses by New Zealand's Ministry for Primary Industries (MPI) have identified other honey bee pathogens of concern. This proposal will attempt to address these potential risks.

Similarly, honey exported to the European Union (EU) must come from apiaries of known disease history, which usually means an apiary database is maintained, annual bee disease surveys are carried out and beekeepers are reporting on the presence of listed bee diseases. The EU also stipulates conditions under which the honey must be processed and labelled.

PHAMA requested that AsureQuality Ltd undertake a bee disease survey in Vanuatu to assist Vanuatu in establishing and maintaining market access to Australia and New Zealand, with potential interest also in export to Singapore and the EU. A delimiting survey was undertaken to establish the disease status and areas colonised by the invasive Asian honey bee. The key objectives of the survey were to:

- Determine the disease status of European honey bees (*Apis mellifera sp*) and the recently established Asian honey bee (*Apis cerana*) in Vanuatu;
- Determine the disease status and distribution of the resident *Apis cerana* population;
- Provide instruction and training to Vanuatu Department of Quarantine and Livestock (DLQS) staff on bee disease inspection, recognition and sampling; and
- Recommend appropriate eradication or control measures for *Apis cerana* and any other pest or disease found.

[2] Now renamed *Melissococcus plutonius.*

2 Background

A honey bee disease survey was carried out in Vanuatu by Bettesworth and Grueber in 2000, which found one case of American Foulbrood (AFB) Disease but no other major bee diseases present. To the best of the authors' knowledge, no other surveys had been completed between the 2000 survey and the current PHAMA-funded survey.

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 Vanuatu. Potential markets include New Zealand, Australia, many Asian countries and the EU. Most of these countries will require evidence of Vanuatu'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 and can be found at http://www.biosecurity.govt.nz/imports/animals/standards/beeproic.all.htm

MPI has 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 and can be found at 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 and can be found at http://www.biosecurity.govt.nz/imports/animals/standards/beeproic.aus.htm

However, this standard was successfully challenged in the courts by New Zealand's beekeeping industry and was subsequently overturned by the Court of Appeal. Legislation was then passed which 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 Israeli Acute Paralysis Virus (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 is also associated with CCD.

In the meantime, the existing 2006 IHS was also reviewed and some minor changes were proposed – for example, replacing the word *honey* with *bee products* where appropriate to allow products like propolis to be treated the same as honey. However, this revised standard was put on hold until the import standard for Australian honey is finalised. This means the 13 November 2006 IHS for Processed Bee Products remains the current operational standard.

Pitcairn Island has negotiated its own IHS for honey into New Zealand and is required to certify freedom from AFB and EFB. Currently, Vanuatu cannot certify country freedom from AFB despite not finding a case of this disease during the current survey. AFB was found during the previous survey in 2000 and also during a DLQS-led inspection earlier this year. 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.

In recent years, 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. Deformed Wing Virus was detected in 2007. Surveys in New Zealand in 2011 did not detect the presence of IAPV (McFadden et al 2012).

The total number of beehives in Vanuatu (estimated to be around 400 managed colonies) has changed very little over the last 12 years, with the majority of beekeeping activity on Efate. However, in contrast to the situation in 2000, one beekeeper now operates more than half of the hives (approximately 250). A second beekeeper runs approximately 70 colonies, with the balance owned by hobbyist beekeepers.

In addition to the change in distribution of hives, Vanuatu has recently confirmed the presence of the Asian honey bee (*Apis cerana*). This is disturbing, as the particular strain found is the same as that present in the neighbouring Solomon Islands, where they have had a highly adverse effect on the local beekeeping industry. Limiting the spread of *Apis cerana* throughout Vanuatu should be a priority to protect the fledgling beekeeping operations on islands such as Santo, Malekula and Tanna.

All honey produced in Vanuatu is consumed locally, with the annual crop estimated to be around 5 tonnes. Local beekeepers estimate the demand to be approximately 10 tonnes annually, with the balance currently being imported from Australia and France (Gibson 2012, pers. comm.).

Demonstrating a high bee health status and maintaining this status is critical if an expanding commercial beekeeping industry is to develop and bee products are to be exported. Bee disease surveys not only help to facilitate the export of bee products from Vanuatu but also allow for additional steps to be taken to protect the health status of the local honey bee population. Imported bee products and used beekeeping equipment could introduce exotic bee diseases which, if established, could threaten the wellbeing of the beekeeping industry in Vanuatu. Existing import protocols in Vanuatu do provide a reasonable level of protection but are not able to protect the industry from AFB disease. This is discussed in more detail later in this report.

3 History of Beekeeping in Vanuatu

While the origins of beekeeping in Vanuatu are uncertain, it is likely that, as in many other PICs, 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 temperament. A study in 1985 by Burgett (TCP/VAN/4505) reported that while there was a substantial population of feral honey bees, there were only a few managed colonies being kept, mainly by expatriates.

In 1997, reports indicated approximately 20–25 beekeepers in Vanuatu keeping some 100 hives in total. The report also mentioned that most of the hives were kept by church schools. By 2000, the number of hives had climbed to approximately 400, where it has now plateaued. Currently, two commercial beekeepers operate 80% of the hives on Vanuatu.

Vanuatu has long been a net importer of honey and this situation has not changed. Currently, local beekeepers provide around half the local demand. There is considerable potential for local beekeepers to lift production to a point where Vanuatu could become a net exporter of honey.

4 Size of the Industry

During the bee disease survey in 2000, Bettesworth and Grueber reported that there were approximately 400 hives in Vanuatu. The current number of hives is similar to the 2000 reports, with the only difference being that the majority (approximately 250 hives) are now owned by one beekeeper.

The industry produces around 5 tonnes of honey per year, which equates to approximately 1.25 tonnes per 100 colonies or 12.5 kg per hive. From what the authors saw during the disease survey, there is significant scope to increase production, with average yields of double (or more) achievable. This means that it would be possible to satisfy current supply entirely from within existing hive stocks.

There is also scope to increase hive numbers significantly from current levels, particularly on Santo, Malekula and Tanna. However, while these islands could all carry more bees, it would be essential to improve the temperament of the current stock in order to attract people into beekeeping.

5 Training of Beekeepers and Vanuatu Department of Livestock & Quarantine Services Staff

Training of beekeepers and DLQS staff was conducted during the visit and included both classroom-based sessions and field-based practical sessions. This training was delivered before the bee health survey began.

The classroom sessions consisted of three presentations, including:

- An overview of basic beekeeping and beekeeping equipment.
- Identification of honey bee pests and diseases, including both pests and diseases that are thought to be exotic to Vanuatu and those that have previously been identified.
- Inspection and sampling procedures for the bee health survey and delimiting survey procedures. This was particularly targeted towards the DLQS staff and beekeepers taking part in the survey work. However, all beekeepers present were encouraged to inspect their own hives regularly for disease and report any unusual findings.

The practical sessions consisted of demonstrating the baiting procedure as per the model recommended by Dr Denis Anderson in his work in Solomon Islands (2007, Australian Centre for International Agricultural Research [ACIAR] project PC2004/030, Control of Asian Bees in Solomon Islands). While the bait station was left for approximately 2.5 hours, we were unfortunately unable to demonstrate any recruitment due to rain.

The group visited an apiary owned by Mr Gilbert Gibson, where the process of inspecting a hive for pests and diseases was demonstrated, as were cleaning and disinfection procedures.

General awareness among stakeholders on bee disease surveillance, recognition and differential diagnosis has previously been limited. The training provided to DLQS staff and local beekeepers has increased awareness of the importance of a healthy bee population and boosted both the quality of passive surveillance and the knowledge of bee diseases to a level where a locally managed active surveillance program could be put in place.

6 Bee Disease Status in Vanuatu

A bee disease survey was carried out in Vanuatu by Bettesworth and Grueber in 2000. This was funded by the New Zealand Aid Programme. In addition, the authors trained beekeepers and DLQS staff, and assessed legislation relating to bees and bee products. The report made several recommendations. It is not clear if all recommendations were implemented.

During the 2000 survey, a number of honey bee diseases with negligible economic importance were identified. The inspectors also found AFB in one colony, which was destroyed by DLQS staff. Earlier this year, a second case of AFB was confirmed in a hive in the same area as the find 12 years earlier. This hive was also destroyed. AFB was not identified during the current disease survey.

The current survey inspected 180 managed European bee colonies out of approximately 400 hives (45%). Seventeen feral colonies were also inspected, seven of which were Asian bees.

Recently, the Asian bee, *Apis cerana,* was confirmed as being present in Vanuatu on the island of Efate. This bee brought the varroa mite, *Varroa jacobsoni*, with it.

The disease survey confirmed the presence of Asian bees on both Efate and Pele and discovered a population on the island of Emao. The survey teams did not discover any evidence of Asian bees on Santo, Malekula or Tanna.

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

Common name	Scientific name	Agent	Vanuatu	New Zealand	Australia
AFB	*Paenibacillus larvae*	Bacteria	Present – one case found early in 2012, but not found during the 2012 survey	Present	Present
EFB	*Melissococcus plutonius*	Bacteria	Absent	Absent	Present (but not in Western Australia)
P. alvei	*Paenibacillus alvei*	Bacteria	Absent	Present – found in soil and one bumble bee	Present
Varroa mite	*Varroa destructor*	Mite	Absent	Present	Absent
Varroa mite	*Varroa jacobsoni*	Mite	Present	Absent	Absent
Asian bee mite	*Tropilaelaps clareae*	Mite	Absent	Absent	Absent
Tracheal mite	*Acarapis woodi*	Mite	Absent	Absent	Absent
Small hive beetle	*Aethina tumida*	Insect	Absent	Absent	Present
Asian honey bee	*Apis cerana*	Undesirable genotype	Present (islands of Efate, Pele, Emao)	Absent	Present – Queensland
Africanised honey bee	*Apis mellifera scutellata*	Undesirable genotype	Absent	Absent	Absent

Common name	Scientific name	Agent	Vanuatu	New Zealand	Australia
Cape honey bee	*Apis mellifera capensis*	Undesirable genotype	Absent	Absent	Absent
Nosema	*Nosema apis*	Protozoan; microsporidia	Present	Present	Present
Nosema	*Nosema ceranae*	Microsporidian	Present	Present	Present
Amoeba	*Malpighamoeba*	Amoeba	Unknown	Present	Present
Sacbrood		Virus	Present	Present	Present
Chronic bee paralysis		Virus	Unknown	Present	Present
Black queen cell virus		Virus	Unknown	Present	Present
Kashmir bee virus		Virus	Unknown	Present	Present
Bee virus X		Virus	Unknown	Present	Present
Bee virus Y		Virus	Unknown	Present	Present
IAPV			Absent	Absent	Present
CCD		Unknown but varroa and viruses implicated	Absent	Unknown	Absent

7 Survey Methods

7.1 Bee Health Survey

The survey concentrated on visual inspections for brood diseases likely to impede the entry of bee products into New Zealand and the EU. Many of the serious bee diseases and pests that affect adult bees are not a 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 Small Hive Beetles 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. Please see the AsureQuality and MPI pamphlet on exotic honey bee pests and diseases (2012).

7.1.1 Location of Colonies

The selection of apiaries for inspection and sampling was based on an assessment of the risk of contacting 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. That said, the inspection teams generally tried to inspect as many apiaries as possible in the time available and it was calculated that somewhere in the order of 80% of apiaries were visited and inspected.

Efate (including Pele and Emao)

The survey team visited 33 apiaries belonging to 26 beekeeper owners on Efate, inspected 190 hives and sampled 27 hives. One of the hives sampled was Asian bees and thus the sample was kept separate from the European bee samples. The team also visited 11 feral colonies. Of these, four colonies were European bees and seven were Asian bees. Samples were able to be retrieved from six of the Asian bee colonies, some of which were in the same area and therefore composited. Many of the feral colonies were not easily accessible for brood inspection, although one European and two Asian bee colonies were inspected.

Santo

The survey team visited five apiaries belonging to three beekeepers on Santo, inspected six hives and sampled two hives. The team also visited seven feral colonies, all of which were confirmed as being European bees. Samples were collected from two of these feral colonies.

Malekula

The survey team visited five apiaries belonging to five beekeepers on Malekula, inspected five hives and sampled three hives. The team also visited five feral colonies in three locations, all of which were confirmed as being European bees. Samples could not be collected from these feral colonies.

Tanna

The survey team visited two apiaries belonging to two beekeepers on Tanna, inspected two hives and sampled one hive. The team visited and sampled two feral colonies, both of which were confirmed as being European bees.

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 PCR for viruses and *Nosema ceranae*. These bees were placed on ice in insulated containers and later frozen. In addition, approximately 200 adult bees were collected as a composite sample from at least three hives and stored in 70% ethyl alcohol. Sub-samples of these bees were dissected for the presence of the tracheal mite. The samples were also washed in alcohol and screened for *Varroa* spp and the Asian mite *Tropilaelaps* spp.

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 Syndrome or Disorder (HMD) (nutritional / genetic disorder)
- CCD
- Parasitic Mite Syndrome (PMS)
- Chalkbrood (fungus)
- Sacbrood (virus)
- Chronic bee paralysis (virus)
- Varroa and Tropilaelaps (external mites)
- Small Hive Beetle (insect)
- Africanised honey bee, Cape honey bee and the Asian honey bee (undesirable genetic strains)
- Wax moths and other pests.

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

7.2 Delimiting Survey

In addition to the bee health survey, a delimiting survey was carried out to determine the extent of spread of the Asian bee (*Apis cerana*) in Vanuatu. Prior to our visit, Asian bees had been confirmed on both Efate and Pele (an offshore island approximately 2.5 km from Efate).

7.2.1 Delimiting Survey Methodology

The delimiting survey was carried out according to the methods developed by Dr Dennis Anderson to survey for Asian bees in Solomon Islands. Surveillance included one or more of the following:

- Erection of bait stations provisioned with sugar syrup to attract foraging Asian honey bees;
- Visual checks for foraging Asian bees on flowering plants; and
- Following up on reports from the public of bee swarms and wild bee colonies.

Anderson also advocated the use of empty ‘bait hives’ to attract newly arrived Asian Bee swarms. This was not done due to time and resource constraints.

It was observed that the bait station method of attracting bees did not work effectively during this survey. The authors believe that there are two key reasons for this. The most significant reason was that at the time of the survey the bees were on a significant nectar flow. This resulted in significant competition for the bait stations, essentially rendering them ineffective. This issue was also identified

by Anderson in Solomon Islands. He commented that *"The presence of flowering plants in the local environment and adverse weather had a notable effect on the numbers of foraging Asian honeybees visiting the bait-station. Usually the number of visitations fell in overcast conditions and usually totally ceased when it rained. Visitations also fell when nearby Malaysian apple (Syzygium malaccense) was in flower close to the feeding station"* (Anderson 2004).

The second reason for the lack of performance of the bait stations was that weather conditions during some baiting periods caused foraging to slow or, in a few cases, stop altogether. As a result of the issues identified above, the delimiting survey activities were limited to visual checks of flowering plants and inspection of bee swarms and wild bee colonies.

It is difficult to determine the relative sensitivity of the delimiting survey methods as, to the best of the authors' knowledge, there is no published material on this. Assessing area freedom for honey bees was addressed in the *Operational Plan to Eradicate* Varroa destructor *from the Nelson Region* (Goodwin et al 2006). The authors of that plan considered both baiting and flower searches but commented that weak colonies would need to be reintroduced into the area of interest post-baiting to assess the sensitivity of the respective methods. This work was not completed.

Ongoing surveys of the distribution of Asian bees should be carried out by DLQS staff. These surveys should be conducted annually using bait stations timed to coincide with periods of nectar dearth, and ideally when robbing activity by Asian bees is at its highest. The survey should follow an 'introduction pathways' approach, particularly focusing on areas near ports and airports. At the same time, DLQS officers should survey nearby flowers for Asian bees and inspect feral swarms and wild bee colonies or Asian bee colonies reported by locals and local beekeepers. Information on the latter should be solicited before the bait stations are set up.

8 Survey Results

8.1 Bee Health Survey Results

8.1.1 American Foulbrood (Bacterium)

No AFB was identified in hives inspected during this disease survey. Hives were checked for clinical signs of AFB in every hive inspected, including those close to the original and recent finds. AFB has previously been found in one colony during the disease survey carried out by Bettesworth and Grueber in 2000. This hive was destroyed in an effort to limit the spread of the disease.

Earlier this year, Mr Nambo Moses (DLQS) and Mr Gilbert Gibson (local commercial beekeeper) discovered another case of AFB in the same area as where the original infection was found in 2000. This colony was also destroyed by fire.

The results of the current survey are encouraging. However, due to the timeframe of the recent find, it is not possible to declare Vanuatu free of AFB at this stage. Further surveys will be required to meet World Organisation for Animal Health (OIE) requirements for 5 years of disease freedom, with ongoing annual surveillance. OIE survey requirements are outlined in the OIE Terrestrial Animal Health Code, Chapter 9.2, Articles 9.2.1–9.2.8, which can be found at:

http://www.oie.int/index.php?id=169&L=0&htmfile=chapitre_1.9.2.htm

It is recommended that, in the interest of meeting these trade guidelines, Vanuatu adopts an AFB surveillance program equivalent to that of New Zealand. This would require the inspection of every managed colony for AFB once per year by a person trained in the detection of this disease. This could be done by the Competent Authority (discussed later in the report) or, like the system in New Zealand, by competent beekeepers approved or authorised by the Competent Authority.

Vanuatu should establish an apiary register that could record both beekeeper competency and apiary inspection information. This would likely be in the form of a spreadsheet, the beginnings of which are contained in this report.

Hopefully AFB can be eradicated as the infected hive has been burnt and hives in the vicinity have been inspected. It is important to continue with a more regular inspection regime for adjacent colonies (say 3–4 inspections per year for the next 2–3 years) and to destroy or treat any other hive ware that may have been in contact with the infected hive. Discussions with DLQS staff and Gilbert Gibson indicated a willingness to do this with a view to eradication of AFB from Vanuatu.

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 and needs temperatures of 1600°C for at least 10 minutes to kill the spores. The disease can exist in a colony as an unapparent or ‘not obvious’ infection for 12–18 months. During this time, beekeepers can unwittingly spread the disease by transferring frames of brood and bees or honey or honey supers to healthy hives. As a result, if Vanuatu wishes to control AFB to the point of declaration of freedom, then implementation of an effective surveillance program and establishment of a good level of disease awareness amongst stakeholders is essential.

8.1.2 European Foulbrood (Bacterium)

No colonies with obvious field symptoms of EFB were found, nor were any suspects seen that required sampling and further laboratory examination. HMD and PMS can be confused with EFB, as clinical symptoms are similar. No hives exhibiting HMD symptoms were seen and PMS is usually associated with *Varroa destructor*. Despite seeing *Varroa jacobsoni* in managed European honey bee colonies, no evidence of PMS was seen.

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). While two cases of HMD were identified in the last disease survey (2000, AgriQuality New Zealand Ltd), no cases of HMD were seen during this survey.

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.

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). Previous theories for CCD have included pesticide poisoning, miticides and mite infestation.

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 Deformed Wing Virus 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 neonicitinoid 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 which bees fly through. Sub-lethal doses of neonicitinoids have been shown to affect bees' memory and ability to orientate and return to their hives. In addition, neonicitinoids can persist in soils for some years and translocate through any flowering plants that are present, where they affect the nectar and pollen. Neonicitinoids have recently been shown to affects bees ability to eat and recruit other foragers to a potential food source.

No evidence was seen of CCD in Vanuatu.

8.1.5 Parasitic Mite Syndrome

PMS is caused by viruses associated with heavy infestations of varroa mites. No evidence of this syndrome was seen.

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 Vanuatu.

8.1.7 *Tropilaelaps* Mites

No *Tropilaelaps* 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, either during hive inspections or following subsequent laboratory dissections of adult bees. Samples from 20 apiaries and 4 feral *Apis cerana* colonies were dissected by MPI lab and no tracheal mites were detected.

8.1.9 Sacbrood Virus

No sign of sacbrood virus was found during this survey, despite a small number of cases being identified in the previous survey. This disease can be managed by requeening the colonies with strains of bees resistant to the virus.

8.1.10 Chronic Bee Paralysis (Virus)

No sign of Chronic bee paralysis virus was found during this survey. To the best of the authors' knowledge, Chronic bee paralysis virus has not previously been identified in Vanuatu.

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 microscopic or PCR diagnosis.

In the survey in August 2000, 17 samples were tested for *Nosema apis,* 5 of which were positive, with infection levels being described as 'very light'. Regular comb replacement, requeening 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 stakeholders and DLQS staff. Feedback indicated that, while they understood and supported such management techniques, the non-availability of hive ware, queens and protein supplement would make it difficult to implement these techniques.

Samples taken during the survey were tested for *N. ceranae*, with 13 out of the 24 samples (54%) testing positive. As in the New Zealand situation, it is unclear how long *Nosema ceranae* has been present, as this is the first survey to test for the disease. It is also not known what effect, if any, this species of nosema is having on Vanuatu honey bees. It is possible that *Nosema ceranae* was introduced with its natural host, *Apis cerana*.

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

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*)[3]

Asian honey bees were confirmed as being present on Efate and the offshore island of Pele, which lies north of Efate. Additionally, Asian honey bees were confirmed on a second island, Emao, which lies approximately 6 km north-east of Efate and about the same distance from Pele.

Delimiting activities were carried out on the islands of Santo, Malekula and Tanna; however, no evidence of Asian bees was found. Delimiting activities included 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. The Asian honey bee has seriously affected beekeeping there by out-competing the European honey bee. In Solomon Islands, the Asian honey bee is a prolific swarmer, 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.

8.1.14 Small Hive Beetle (Insect-beetle)

No Small Hive Beetles or beetle larvae were seen. Small Hive Beetle larvae infest hives and consume pollen and honey stores. In the process, they infect honey combs with a yeast that creates a noxious slime all over the frames and makes the honey inedible. Small Hive Beetles are present in Australia and are now reported to be causing a major nuisance and wiping out hives and apiaries (Sommerville, D. 2012 pers. comm.).

[3] Refer also to Section 8.2.

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 Vanuatu. 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 different strains of bees are less affected by wax moth damage. The more yellow or Italian strains showed definite resistance to wax moths.

Additionally, the survey team 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 has been linked with fecal material of the lesser wax moth. Greater wax moth may also produce these symptoms (Morse & Flottum 1997).

8.1.16 Other Pests or Diseases

Several species of ants – as well as lizards, cockroaches and centipedes – were found in beehives. The previous status with respect to these pests is unknown.

The external mites *Acarapis externus* and *Acarapis dorsalis* were both found on a number of the samples. These mites are common in New Zealand and are not known to be economically significant. Additionally, *Pseudacarapis indoapis* was found on five of the 24 samples. This is the first time that *Pseudacarapis indoapis* has been identified in Vanuatu and the Pacific region. There are no known reports on the significance of this mite.

8.1.17 Genetic Base

The honey bees in Vanuatu are a hybrid of the Italian bee (*Apis mellifera ligustica*) and the black bee (*Apis mellifera mellifera*). The black bee is a very hardy strain, and capable of living without human assistance as feral colonies. Since black bees predominate as the background population in Vanuatu, 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 black bees.

Black bees 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 beekeeping.

During the survey, a number of hives were found to have patchy brood patterns. Patchy or irregular brood patterns can be a sign of inbreeding, but could also be caused by old queens, pollen deficiencies, nosema infections or sacbrood disease.

The authors observed variation in bee stock depending on the location of the bees. Bees on parts of Efate were typically more yellow than those found elsewhere. It would be possible for a suitably trained beekeeper to select genetics from within the existing Vanuatu honey bee stock and produce queens of a sufficiently gentle nature to encourage the wider uptake of beekeeping in Vanuatu. 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 strains were more resistant to wax moths, so selection could be made on the basis of colour. A simple method for requeening hives with better stock would be to use protected queen cells (Reid 1979).

Both industry stakeholders and DLQS staff acknowledged that bee stock selection and bee breeding would be hugely beneficial to beekeeping on Vanuatu. However, at this stage, the key industry stakeholder would require additional training (either in Vanuatu or offshore) to implement an effective genetic improvement program. This would ideally occur in an apprentice-based learning situation. AsureQuality and its predecessors have delivered genetic improvement / queen rearing courses in other pacific island countries and could potentially customise a program to suit the situation in Vanuatu.

8.2 Delimiting Survey Results

Asian bees were confirmed on Efate and the survey found that they were widely distributed on the island. Asian bees were also confirmed on Pele Island, which is approximately 2.5 km off the northern edge of Efate. This would be within flying distance for bees and it is therefore possible that the spread to this island happened without human assistance.

Asian bees were also confirmed as being present on Emao (an offshore island approximately 5.5 km from both Efate and Pele). While this island is further from Efate, it is conceivable that Asian bees could have arrived without human assistance given favourable weather conditions. Asian bees have a swarming range of up to 10 km (Hyatt 2012), although this figure is for land-based swarming rather than across water.

Asian honey bees were not found on the islands of Santo, Malekula and Tanna. This is encouraging, although without active controls, the chance of Asian bees spreading to these islands via shipping traffic is high.

Eradication of Asian bees from Efate is not considered feasible as they are very well established and the sensitivity of detection methods and efficacy of baiting methodologies have not been determined.

Maintaining area freedom in regard to Asian bees on Tanna, Malekula and Santo would be beneficial in order to protect beekeeping activities in these areas. It is recommended that awareness-raising activities are used, such as posters at ports and airports, and encouraging port and shipping staff to keep a watch for bees and report swarms to DLQS. It is envisaged that these awareness-raising activities would be similar to those used for Fire Ants in Vanuatu.

http://www.positiveearth.org/bungalows/TORBA/fire_ants.htm

Table 8-1 Location of managed apiaries surveyed in Vanuatu during October 2012

Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
Melek Tri	Gilbert Gibson	?	?	50	3		Training apiary.
Anne Pheu	Anne Pheu	17° 43.577'	168° 20.353'	3	3		One hive queenless (added brood). No disease seen.
Mont Marte	Charles Rogers	17° 44.431'	168° 21.548'	2	2	2	One hive requeening (queen cells seen). Wax moth observed.
Activ Centre	Sandrine Wallaz	17° 44.975'	168° 22.272'	9	9	3	One hive queenless (added brood). Evidence of wax moth.
Teoumaville	Dominic	17° 46.296'	168° 24.050'	1	1		Very aggressive.
Teoumaville	Josie	17° 46.272'	168° 23.839'	2	2	1	Varroa identified in hive #1. Hive #2 dead and infested with wax moth.
PZT Cattle Co	Gilbert Gibson	17° 48.293'	168° 28.204'	24	24		1 hive dead (wax moth). All other hives strong.
Teouma Bush	Toara Karie	17° 44.939'	168° 24.190'	2	2		One hive dead with significant wax moth. No disease seen in live hive.
Joe Ernst Rentapau	Gilbert Gibson	17° 46.989'	168° 27.152'	40	21	3	One hive dead. 1 hive weak. Others strong. Varroa observed in drone brood. Wax moth observed.
Gilbert Dihn #1	Gilbert Dihn	17° 44.607'	168° 29.617'	4	4	3	Small colonies. No disease observed. Hives from Gilbert Gibson.
Gilbert Dihn #2	Gilbert Dihn	17° 44.492'	168° 29.629'	12	12		3 hives queenless. Wax moth damage sighted. Some hives strong / aggressive.

Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
La Cresionairres corner	Gilbert Gibson	17° 41.555’	168° 33.722’	18	14		One hive dead. 1 hive weak. Others strong. Varroa observed in drone brood. Wax moth observed. Bald brood?
La Cresionairre	Gilbert Gibson	17° 42.727’	168° 33.862’	2	2		Small nucleus colonies. No evidence of disease.
“The Summit”	Presley	17° 40.878’	168° 14.159’	5	5		3 hives alive. 2 hives dead. No disease seen.
Julia Johnston	Ian Shaw	17° 41.325’	168° 14.561’	5	5		All strong colonies. No disease seen.
Ingrid	Ingrid	17° 41.277’	168° 14.767’	1	1		Good hive in single super. No disease seen. No sample taken.
Ian Shaw	Ian Shaw	17° 40.885’	168° 15.203’	22	9	3	Hives more yellow than others. No disease seen.
Melemaart	Payman	17° 40.878’	168° 15.663’	7	2		1 hive queenless. No samples taken.
Dan Dempsey	Dan Dempsey	17° 39.411’	168° 14.545’	1	1		Hive had recently swarmed. No brood in hive but likely a virgin queen. No sample taken.
BJ Johnston	BJ	17° 39.359’	168° 14.987’	4	4		Strong hives, no disease seen.
Nicole	Nicole	17° 45.438’	168° 23.678’	3	3	2	2 hives alive. 1 hive dead. Close to previous AFB find but no AFB seen.
Keith Amos	Keith Amos	17° 32.269’	168° 24.505’	1	1	1	No disease seen. Heavy honey stores.

Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
Sara Beach	Simeon Lesley	17° 33.529'	168° 27.667'	2	2		No disease seen. Heavy honey stores.
Presbyterian College	Mansez	17° 33.222'	168° 27.304'	4	4		3 hives strong. 1 hive from a swarm queenless with wax moth observed. Some boxes collapsing.
Havana Harbour	Nic Griffith	17° 34.534'	168° 14.930'	2	2	2	Strong hives, heavy stores. No disease seen.
Agriculture Department	John Tinambualia	17° 42.222'	168° 19.277'	1	1		Strong hives. Varroa in drone pupae. No sample taken.
Airport Area	Gwen	17° 42.167'	168° 19.168'	2	2		Strong hive. No disease. No sample taken.
Presbyterian Women's Missionary Union	Enikelen Netine	17° 43.010'	168° 18.763'	2	2		Strong hives. No disease seen.
Fresh Water 2	Wilue Kalo	17° 43.287'	168° 19.153'	2	2	2 (submitted as separate samples)	1 European hive. 1 Asian hive (destroyed and comb sample taken). No disease seen.
Fresh Water 1	George Saksak	17° 43.623'	168° 19.167'	1	1		Strong hives. No disease seen.
Unknown	Worearu Village	17° 29.112'	168° 23.523'	22	22	3	Good hives. No disease seen.
Lati School (Santo)	Mika	15° 31.405'	167° 09.377'	2	2	2	Samples taken, no disease seen.
Lanivet Daves (Santo)	Lanivet Daves	15° 30.357'	167° 10.405'	2	1		Managed colony inspected, feral in wall of shed. No samples taken, no disease seen.

Apiary	Beekeeper	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
Graham Hack (Santo)	Danny Barrett	15° 27.737'	167° 10.978'	1	1		Managed colony inspected. No samples taken, no disease seen.
Chapin Tadi (Santo)	Danny Barrett	15° 26.660'	167° 10.435'	1	1		Managed colony inspected. No samples taken, no disease seen.
Danny Barrett (Santo)	Danny Barrett	15° 27.095'	167° 12.900'	1	1		Hive dead. Significant wax moth. Likely failed queen.
Situ Kemuel (Tanna)	Situ Kemuel	19°.29.495'	169° 16.997'	1	1	1	Managed hive. Sample taken. No disease found.
Saiken Sikoma (Malekula)	Saiken Sikoma	16° 06.085'	167° 25.027'	1	1	1	Managed hive. Sample taken. No disease seen.
John Temar (Malekula)	John Temar	16° 06.155'	167° 25.113'	1	1	1	Managed hive. Sample taken. No disease seen.
Joel Kalnpel (Malekula)	Joel Kalnpel	16° 05.743'	167° 24.807'	1	1	1	Managed hive. Sample taken. Wax moth seen.
Department of Fisheries (Malekula)	Kevin Morris	16° 06.317'	167° 25.212'	1	1		Managed hive. No sample taken. Wax moth seen.
Department of Customs (Malekula)	Michael Huru	16° 06.278'	167° 25.560'	1	1		Dead hive. Wax moth seen.
Totals				**269**	**180**	**31**	

Table 8-2 Location of European feral honey bee colonies surveyed in Vanuatu during October 2012

Designation	Location description	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
Feral #2		17° 45.747'	168° 23.439'	1	1		Brood removed and inspected. Close to previous AFB find but no disease seen.
Feral #8	Marow Village (Emao)	17° 29.135'	168° 28.740'	1	1		European honey bees. No disease seen.
Feral #9	Marad Village (Emao)	17° 29.027'	168° 28.733'	1	1		European honey bees. No disease seen.

Designation	Location description	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
Feral #11	Piliura Village (Pele)	17° 29.918'	168° 24.080'	1	1		European honey bees. No disease seen.
Bait Station #2 – feral (Santo)		15° 30.833'	167° 11.257'	2	1 swarm	1	Feral colony in bank and swarm in tree. European bees. Sample taken.
Feral Colony #1 (Santo)		15° 35.230'	167° 02.805'	1	1		European bees. Sample taken.
Feral Colony #2 (Santo)	(Mika)	15° 31.930'	167° 08.967'	1	1		Recently put in box. No disease seen. No samples taken.
Feral Colony #3 (Santo)	Tiroas Shop	15° 30.880'	167° 12.433'	1	0		European bees. Strong in wall of shop. No sample taken.
Feral Colony #4 (Santo)	George Toa	15° 30.332'	167° 10.367'	1	0		European bees roof of house. No samples.
Feral Colony #5 (Santo)	Research Station (Santo)	15° 26.752'	167° 11.105'	1	0		European bees up tree (6 m). No samples.
Feral #6 (Santo)		15° 30.682'	167° 10.417'	1	1	1	European bees. Aggressive, in wall of building. Unable to inspect but sample taken.
Iawau Kamisak (Tanna)	Iawau Kamisak	19° 31.505'	169° 15.423'	1	1	1	Feral hive, sample taken. Unable to inspect.
Brightley Iamak (Tanna)	Brightley Iamak	19° 30.724'	169° 15.204'	1	1	1	Feral hive, sample taken. Unable to inspect.
Feral#1 (Malekula)	Elken Sink	16° 12.927'	167° 34.292'	1	0		In shop roof. No sample taken.
Feral #2 (Malekula)		16° 11.047'	167° 31.788'	1	0		In tree trunk. No sample taken.
Feral #3 (Malekula)		16° 11.348'	167° 32.145'	1	0		In tree trunk. No sample taken.
Feral #4 (Malekula)	Thompson Noel	16° 09.612'	167° 29.535'	1	0		In tree. No sample taken
Totals				**18**	**10**	**4**	

Table 8-3 Location of Asian feral honey bee colonies surveyed in Vanuatu during October 2012

Designation	Location description	Degrees south	Degrees east	Number of hives	Number of hives inspected	Number of hives sampled	Comments
Feral #1 (Asian)		17° 44.607’	168° 23.161’	1	1	1	Asian Bees in stump of tree. Comb sample and bee sample taken.
Feral # 3		17° 42.295’	168° 19.138’	1	1	1	Asian colony. Sample taken. No brood disease seen in combs inspected.
Feral #4	Wiana Village (Emao)	17° 29.728’	168° 28.943’	1	1		Asian honey bees in building. No disease seen. Strong.
Feral #5	Wiana Village (Emao)	17° 29.703’	168° 28.958’	1	1		Asian honey bees in tree. No disease seen. Moderate strength.
Feral #6	Wiana Village (Emao)	17° 29.728’	168° 29.028’	1	1		Asian honey bees in tree No disease seen. Strong
Feral #7	Wiana Village (Emao)	17° 29.777’	168° 29.128’	1	1	1	Asian honey bees in coconut palm. No disease seen.
Feral #10	Marad Village (Emao)	17° 28.893’	168° 28.510’	1	1		Asian bees in a tree. No disease seen.
Totals				**7**	**7**	**3**	

Table 8-4 Apiaries geo-located but not inspected

Apiary	Beekeeper	Degrees south	Degrees east	Number of hives
Two Tree	Gilbert Gibson	17° 44.702’	168° 29.436’	?
Whitewood	Gilbert Gibson	17° 43.958’	168° 30.335’	?
Switched on Electric	Robert Berkely	17° 45.020’	168° 19.160’	?
	Jara Bani	17° 43.565’	168° 19.277’	?
Tanoliu Village	Ulei Secondary School	17° 24.078’	168° 15.955’	20 nucleus colonies
Malapoa	Lyn Spor	17° 43.588’	168° 17.680’	1

9 Summary and Conclusions

In Vanuatu, 180 managed colonies out of a total of approximately 400 available were inspected for bee diseases and pests, in particular EFB and AFB. This is a hive inspection rate of 45%, compared to the target surveillance rate of around 1.4% in New Zealand. MPI contracts AsureQuality Limited in New Zealand 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 Vanuatu, a number of feral colonies were also inspected. The reason for visiting feral colonies was twofold:

- To identify the type of bees in the colony as part of the delimiting survey for Asian bees; and
- To inspect and take samples, particularly of Asian bees, to determine the health status of this population.

Eighteen of the feral colonies on 17 sites were found to be European honey bees. Samples from four of these colonies were taken for analysis. Two of the colonies sampled were from Tanna Island, one was found at the port on Santo Island and the last was a second feral colony found on Santo.

Seven of the feral colonies were found to be Asian bees, and samples were able to be retrieved from three of these colonies. Asian bees were confirmed on Efate, Pele and Emao but were not found on Santo, Malekula or Tanna.

No cases of EFB, CCD, PMS, HMD or *Paenibacillus alvei* were found. Additionally, no cases of the serious bee disease AFB were detected, despite the disease being found in a previous survey and another case earlier in the year. The inspection team focused additional attention on the area where both of these previous cases were discovered.

No field evidence was found of the Small Hive Beetle or the very aggressive African strain of honey bee or the Cape 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.

Cockroaches, lizards and centipedes were also reasonably common, as were several species of ants. None of these appear to be causing a problem to the hives.

10 Recommendations

Over the course of the visit, the authors observed some areas where it is felt that improvements could be considered. These have been presented as recommendations and fall into two broad categories: honey bee colony management and regulatory.

10.1 Honey Bee Colony Management

While the majority of colonies observed during the survey were producing well, the authors considered that some additional colony management, particularly focused on queen bees, would be advantageous. These recommendations include:

- Requeening 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; and
- Continuing to select strains of bees on Vanuatu that are more gentle and resistant to wax moth to use as breeders. As wax moth seems to be a significant issue in Vanuatu, it is recommended that this be a focus of any stock improvement program.

The authors recommend that any stock improvement is done firstly by sourcing promising genetics from within Vanuatu, as the risk of importing honey bee diseases with stock from outside Vanuatu is too great. It is understood that Solomon Islands are establishing contacts and protocols for imports of new stock from disease-free queen bee breeding centres in West Australia. This could prove useful as a potential contact for DLQS if the decision to seek new stock for Vanuatu is made. 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 in 2013 with funding from the Secretariat of the Pacific Community, World Vision and the Niue Honey Co. which will give updated information on Niue's status.

Both industry stakeholders and DLQS staff acknowledged that bee stock selection and bee breeding would be hugely beneficial to beekeeping on Vanuatu. However, at this stage, the key industry stakeholder would require additional training (either in Vanuatu or offshore) to implement an effective genetic improvement program. This would ideally occur in an apprentice-based learning situation. AsureQuality and its predecessors have delivered genetic improvement / queen rearing courses in other PICs and could potentially customise a program to suit the situation in Vanuatu.

10.2 Regulatory

As mentioned elsewhere in this report, it is the opinion of the authors that there is considerable scope for increasing honey production in Vanuatu, with the potential to eventually become a net exporter of honey (and perhaps other bee products). However, in order to support this growth, Vanuatu 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 or senior animal health extension practitioner and would include:
  - Liaising with AsureQuality Official Assurance verifiers to gain an understanding of the bee products certification system and various market access requirements;
  - Spending time with bee product processors, gaining an understanding of the processing system; and
  - Spending time with beekeepers, gaining an understanding of hive management, disease control and compliance issues at the primary production level.
- Follow-up training for DLQS staff every two years in honey bee disease surveillance and recognition. This could occur in either Vanuatu or New Zealand, although it may be more cost-effective for this to occur in Vanuatu. 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 Asian honey bees; and
  - Updates on any emerging disease or market access issues.
- Strengthen import controls on honey and honey products. This could take the form of a ban on importation based on disease risk concerns, or involve restricting importation to appropriately heated treated materials and sourcing from countries/zones that are of known status for diseases of concern such as AFB and EFB. This will require consultation between DLQS and stakeholders to determine whether local production can meet current demand, the level of risk Vanuatu is willing to accept from imports, and what disease mitigation measures (surveillance, testing and country/zonal freedom assurances) could be agreed for sources of imports.
- Consider implementing a honey bee surveillance program which should be designed to:
  - Support country freedom declarations based on OIE standards;
  - 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 at a point where an eradication attempt could be considered.

As an example system, the New Zealand Apiculture 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. This is in accordance with OIE standards for AFB surveillance. All hives in selected apiaries are sampled, but as most of the selected apiaries are in urban areas, hive numbers tend to be typically less than five hives per apiary.

It is impractical for Vanuatu to determine high and low risk areas; rather, each of the four islands surveyed should be treated as distinct areas (Emao and Pele would form part of Efate in this case). Based on the number of known managed apiaries from the survey, all apiaries on Tanna (one), Malekula (five) and Santo (five) would need to be surveyed to achieve the required sensitivity. On Efate, Emao and Pele, a total of 31 managed apiaries were visited. Twenty-four of these apiaries would need to be sampled annually to claim equivalence with New Zealand's system. Based on the

current information, this would mean that between 81 and 261 hives would be inspected and sampled in each survey. Feral colonies would not be included due to the difficulty in inspecting the combs.

In conducting the survey, apiaries would need to be selected randomly and surveyed for pests and diseases of concern to exporting countries. These include EFB and AFB.

With Asian honey bees endemic in Efate (the location of the majority of beekeeping activity), it will be difficult for Vanuatu to establish a live bee / germplasm export market. For this reason, surveillance for other beekeeping pests may not be economically worthwhile. Having said that, Vanuatu may wish to undertake some surveillance for other bee pests in order to support country freedom declarations as may be required.

To enable establishment of a surveillance program and support official assurance declarations, an apiary register should be put in place and maintained. This could take the form of a spreadsheet including apiary location and hive information that is updated via DLQS by beekeepers and DLQS staff with local knowledge. The hive ownership and location information gathered during this current survey can provide a start for developing the register. Detail of inspection and disease information could be added, as well as beekeeper training information. Any existing general animal health databases that DLQS may have that record farm or livestock enterprises could considered for holding this information.

11 Legislation & Quarantine Systems for Bees & Bee Products

The risk pathways into Vanuatu 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, all of which could have honey or bees on board.

Vanuatu has recently discovered *Apis cerana*, an undesirable bee species, which may have arrived from Solomon Islands. *Apis cerana* also introduced the varroa bee mite, *Varroa jacobsoni*. This has confirmed the ease by which exotic honey bee pests and diseases can be spread. The beekeeping industry needs government protection by way of improved 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.

11.1 Acts and Regulations

The legislation relating to the importation of honey into Vanuatu is the “Animal Importation and Quarantine Act, 1988”. This is accompanied by the “Animal Importation and Quarantine Regulations, 1994”. These documents require that honey imports are accompanied by an import permit that states the following as conditions of import:

Permission for import is granted under the following conditions:

- *Contain no substances harmful to human health;*
- *Have been processed, prepared, packaged, and transported according to the required public health legislation in the country of origin;*
- *Have been heat treated or pasteurised;*
- *No raw honey or combs are permitted entry.*

While these requirements would likely protect Vanuatu from most honey bee diseases, some thought should be given to a review of the requirements to protect the industry from AFB and EFB.

Until such time as Vanuatu (or zones within it such as Efate) can claim freedom from AFB, which will require ongoing internal surveys, control of any potential spread of AFB within Vanuatu may be achieved via internal quarantine procedures limiting movement of bees, hives and beekeeping equipment. It is desirable to protect the beekeepers on other islands from bacterial diseases such as AFB, and the more immediate threat of Asian bees and V.jacobsoni expanding their range in Vanuatu.

Also, while there remains a need to import honey to meet any shortfall in local production, such imports will represent a potential disease risk for AFB and EFB. AFB is a spore-forming bacteria that is heat stable and, as such, is virtually impossible to treat in honey using a non-destructive process. DLQS will need to consider the options for controls on imports in consultation with stakeholders. Prohibiting imports could be considered if local production can adequately meet local demand. Otherwise, there are options to mitigate the risk associated with honey imports. These should be considered by DLQS. One option may be to require that honey tests negative for AFB and EFB pre-border. This would be achievable for countries or zones with freedom from EFB and effective AFB control programs, an example being Western Australia. As an indication, New Zealand periodically tests retail packed honey for AFB spores to give an indication of how well the control program is working. In the most recent test, 97% of the samples were free of AFB spores. Additionally, 100% of samples in the previous survey tested negative.

11.2 Quarantine Systems

Vanuatu DLQS operates a quarantine system under the Animal Importation and Quarantine Act, 1988, supported by the Animal Importation and Quarantine Regulations, 1994. 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 Vanuatu.

Some effort should also be made to reduce or eliminate the chance of pests and diseases travelling within the archipelago. Protecting islands such as Santo, Malekula and Tanna from both Asian bees and AFB disease is a good example of an internal quarantine policy that would be beneficial to the beekeeping industry. As previously discussed for Asian bees, this could be done via awareness-raising campaigns on the risks involved in movement of honey, bees, hives and hive equipment. For AFB, this might include providing information to sailors encouraging them not to bring honey ashore. Under current legislation, DLQS also has the ability to limit the movement of animals and materials based on disease and pest concerns. Consideration should be given to practical means of implementing such control measures to prevent/limit the spread of identified pests and disease to elsewhere in Vanuatu's archipelago.

11.3 Honey Bee Disease Survey and Response Systems

It has been over 10 years since the last bee disease survey was carried out in Vanuatu. If Vanuatu is to develop export markets for bee products, more frequent disease surveys would likely be required. Also, any negotiation of an IHS with potential importing countries such as New Zealand may require Vanuatu to demonstrate equivalence with that importing country's standards, which will likely include the need for an annual bee disease survey.

Currently, all the beekeeping and disease expertise in Vanuatu resides with one or two beekeepers and DLQS staff. As a result of the training conducted during this visit, these beekeepers and DLQS 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. Any future response activities could be carried out internally, with international expertise brought in to help if necessary.

Information on bee diseases, including colour photographs, has been left with DLQS staff and beekeepers. Copies of the brochure *Honey Bee Exotic Diseases and Pests* (produced by AsureQuality Ltd and funded by MPI, revised in May 2012) were supplied to DLQS, along with illustrations of AFB disease. This could be used as a starting point for the development of awareness raising material. 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, despite reasonably clear clinical symptoms, that some diagnostic support will be needed to support the surveillance program. This support should be outsourced to an accredited service provider, given the low numbers of samples likely to require testing. Diagnostic backup could be established with MPI labs in New Zealand in the first instance, as they have higher level containment facilities available.

It is worth noting that if internal and external mites, Small Hive Beetle and undesirable bee genetics were to be included in the surveillance program, these specific diagnostic capabilities could potentially be developed in Vanuatu by additional training of those DLQS staff currently doing entomological

diagnostic work under the New Zealand Aid Programme-funded Quarantine Pest Diagnostic Training Project being implemented in the Pacific by MPI.

11.4 Industry Prospects and Export Considerations

Gilbert Gibson is the sole commercial beekeeper on Vanuatu. He operates some 250 hives, which is approximately 60% of the total number of hives in Vanuatu. A second beekeeper owns approximately 70 hives, with the balance operated by hobbyist beekeepers. Gibson has plans to expand his operation in order to meet a greater percentage of the local honey demand. Current production is estimated to be around 5 tonnes, with an annual consumption of 10 tonnes, leaving room to replace imported honey with locally produced product. Currently, all of Gibson's honey is purchased by a third party and packaged for retail sale.

Judging by the current distribution of hives and the availability of nectar sources, the hive stocking rates on Vanuatu are very low and could be increased significantly. This is particularly true on the islands of Santo, Malekula and Tanna, where the keeping of managed bees is not widespread. Gibson is supporting the development of beekeeping in some of these areas. Ultimately, Vanuatu could, with some effort, be a net exporter of honey, while also increasing the demand for honey locally.

In order to retain stability in the local market, it will be necessary to investigate export opportunities. Export to New Zealand is currently allowed from some PICs; however, Vanuatu is not included on this IHS. If Vanuatu were to negotiate their own conditions, New Zealand would likely require similar conditions to those imposed on other PICs. This includes attesting to the country of origin of the product and certifying that Vanuatu is free of EFB.

As the conditions on any negotiated import permit are likely to demand demonstrated freedom from EFB, this will probably mean regular surveys of hives by a 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 Export Certificates; the level of competency required will be negotiated with New Zealand authorities.

If honey from Vanuatu is to be consumed within New Zealand, then it should be processed in premises approved for the purpose by local health authorities and the operator should ideally have a documented Food Safety Program or a Risk Management Program (RMP). If the honey from Vanuatu is likely to be re-exported from New Zealand, then the operator must have an RMP and meet all Overseas Market Access Requirements. AsureQuality Ltd carries out the majority of the RMP audits for New Zealand honey processors. See the website below for more information:

http://www.foodsafety.govt.nz

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, New Zealand has negotiated around this requirement, based on the lack of use of antibiotics in beekeeping. Vanuatu 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. Exporting countries must apply for Third Country Approval Status, and submit information on standards. Currently, bee product processors in New

Zealand exporting to the EU are required to operate their factories under an RMP which can be viewed at:

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

They are also required to be audited against additional requirements specific to the EU market. These specific labelling requirements and product separation procedures are maintained by the Competent Authority in New Zealand, as is the publishing of approved premises. Operators must also participate in a national residue testing program if selected by MPI. Currently, testing is undertaken for chloramphenicol, nitrofurans, antibiotics, carbamates, synthetic pyrethroids, organophosphates and organochlorines. These requirements impose significant compliance costs for export to the EU and it is recommended that Vanuatu consider development of market access to Australia and New Zealand in the first instance.

If a beekeeping industry could be developed in Vanuatu, a significant number of employment opportunities could be created for the local people. As well as employing people in Vanuatu as beekeepers and to process the bee products, overseas employment opportunities could possibly exist for Vanuatu beekeepers in New Zealand and Australia, where there is a seasonal shortage of skilled beekeepers.

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