Non-Chemical and Minimum Chemical Use Options for Managing Varoa

Two related workshops 19–20 August 2010

RIRDC Publication No. 10/201

The Pollination Program
Non-Chemical and Minimum Chemical Use Options for Managing Varoa

Two related workshops 19–20 August 2010

October 2010
Foreword

*Varroa destructor* (Varroa) is a serious pest of honeybees. Untreated Varroa will cause the death of affected honeybee colonies and a loss of production from plant industries dependent on honeybee pollination. Almost alone on the world stage Australia remains free of Varroa mite infestation. It is expected that Varroa will likely infest Australian honeybee hives sometime in the future.

Therefore a window of opportunity exists for the honeybee and pollination dependent industries to learn from overseas experience and research best practice non-chemical and minimum chemical use options for management of Varroa under Australian conditions.

This report summarises outcomes from two related workshops facilitated by Michael Williams from Michael Williams & Associates Pty Ltd and convened by RIRDC and its pollination research partner Horticulture Australia Limited (HAL). The purpose of the workshops was to review control options, identify research projects and to raise Varroa management awareness.

While chemical use may be a necessary short term response to Varroa infestation, viable longer term non-chemical R&D requirements are scoped in this report. Non-Chemical R&D needs include measures to address industry profitability, prevention strategies and pre-incursion option evaluation. Communication messages developed during the workshops focus on the need to educate both beekeepers and pollination dependent plant industries.

This project is part of the Pollination Program – a jointly funded partnership with the Rural Industries Research and Development Corporation (RIRDC), Horticulture Australia Limited (HAL) and the Australian Government Department of Agriculture, Fisheries and Forestry. The Pollination Program is managed by RIRDC and aims to secure the pollination of Australia's horticultural and agricultural crops into the future on a sustainable and profitable basis. Research and development in this program is conducted to raise awareness that will help protect pollination in Australia.

RIRDC funds for the program are provided by the Honeybee Research and Development Program, with industry levies matched by funds provided by the Australian Government. Funding from HAL for the program is from the apple and pear, almond, avocado, cherry, vegetable and summerfruit levies and voluntary contributions from the dried prune and melon industries, with matched funds from the Australian Government.

This report is an addition to RIRDC's diverse range of over 2000 research publications which can be viewed and freely downloaded from our website [www.rirdc.gov.au](http://www.rirdc.gov.au). Information on the Pollination Program is available online at [www.rirdc.gov.au](http://www.rirdc.gov.au)

Most of RIRDC's publications are available for viewing, free downloading or purchasing online at [www.rirdc.gov.au](http://www.rirdc.gov.au). Purchases can also be made by phoning 1300 634 313.

**Craig Burns**
Acting Managing Director
Rural Industries Research and Development Corporation
Abbreviations and Acronyms

AHBIC  Australian Honeybee Industry Council
APVMA  Australian Pesticides and Veterinary Medicines Authority
CCE    Colony Collapse Events
CRC    Cooperative Research Centre
HAL    Horticulture Australia Limited
IPM    Integrated Pest Management
NSHP   National Sentinel Hive Program
NZ     New Zealand
R&D    Research and Development
RDC    Research and Development Corporations
RIRDC  Rural Industries Research and Development Corporation
RNA    Ribonucleic Acid
Contents

Foreword .............................................................................................................................................. iii

Abbreviations and Acronyms ............................................................................................................... iv

Background to the Workshop ................................................................................................................ vi
   Introduction and purpose .................................................................................................................... vi
   Workshop welcome ............................................................................................................................ vi

Varroa and Its Implications ...................................................................................................................... 1
   Denis Anderson, CSIRO – honeybees ............................................................................................... 1
   Saul Cunningham, CSIRO – pollination dependent industries ........................................................ 2

Chemical Options to Manage Varroa ........................................................................................................ 4
   Mark Goodwin, Plant and Food Research NZ – the NZ Experience ................................................... 4
   Karl Adamson, APVMA – Australian Government Regulatory Requirements .................................... 6
   Kevin Bodnaruk, Consultant Researcher – HAL Project to Meet APVMA Needs .................................. 6

Non Chemical Options to Manage Varroa .............................................................................................. 8
   Des Cannon, Chair RIRDC Honeybee Advisory Committee – Overview ........................................... 8
   Ben Hooper, Nuffield Scholar – Temperature Control to Manage Varroa ........................................... 9
   Mark Goodwin, Plant and Food Research NZ – NZ Non Chemical Experience ................................. 9
   Medhat Nasr, Alberta Canada – Practical IPM for Varroa Management ............................................. 10
   Chris Buller, Pestat Pty Ltd – Bid for Honeybee and Pollination CRC ............................................. 12

Non Chemical Research Needs .............................................................................................................. 13
   Summary of Non Chemical R&D Needs ............................................................................................ 13

Communication Messages ..................................................................................................................... 14
   Summary of Workshop ‘Plenary’ Communication Messages ............................................................. 14
   Summary of Table by Table Communication Messages .................................................................... 15

Appendices .............................................................................................................................................. 16
   Appendix 1: Workshop Agenda ........................................................................................................ 16
   Appendix 2: List of Participants ......................................................................................................... 18
   Appendix 3: Presentations ................................................................................................................... 19
   1. Denis Anderson – Varroa and its Implications ................................................................................. 20
   2. Denis Anderson – Varroa and its Implications (2nd Session) ......................................................... 31
   3. Saul Cunningham – Pollination Dependent Industries ................................................................. 37
   4. Mark Goodwin – Chemical Options to Manage Varroa ................................................................. 48
   5. Karl Adamson – Chemical Regulatory Requirements ...................................................................... 62
   6. Kevin Bodnaruk – HAL Project to Assist Chemical Registration .................................................. 67
   7. Des Cannon – Non Chemical Options ............................................................................................ 71
   8. Ben Hooper – Temperature Control to Manage Varroa ................................................................. 77
   9. Mark Goodwin – Non Chemical Options to Manage Varroa ......................................................... 87
   10. Medhat Nasr – Practical IPM for Varroa Management ................................................................. 100
Introduction and purpose
As part of the ongoing research and development (R&D) program for the pollination industry and its collaboration with the honeybee industry, Rural Industries Research and Development Corporation (RIRDC), in partnership with Horticulture Australia Limited (HAL) convened two one-day workshops on 20 and 21 August 2010 in Canberra. The workshops were expertly facilitated by Michael Williams from Michael Williams & Associates Pty Ltd. The purpose of the workshops was to:

- Review existing non-chemical and chemical options for management of Varroa;
- Identify research projects needed to enhance non-chemical management of Varroa in Australia;
- To raise awareness among honeybee industry participants of non-chemical and minimum chemical use options for management of Varroa; and
- Develop communications messages relevant to the pollination industry’s response to and management of the threat posed by Varroa.

This key outcomes report is a distillation and synthesis of participants’ views and dialogue as expressed at the workshop. Outcomes from the two one-day workshops have been combined into a single workshop report.

Workshop welcome
The workshop was opened by Gerald Martin, Chair of the RIRDC Pollination Advisory Committee. Gerald explained that the purpose of the workshop was to provide a ‘heads up’ on Varroa, a major forthcoming problem for the honey and pollination industries, so that these industries are as well prepared as possible if the mite becomes established in Australia. Gerald explained that Australian industries were in a ‘unique and privileged position’ having received prior warning of the Varroa threat and being afforded an opportunity to learn from the rest of the world’s experience with Varroa. Gerald explained that the workshop was to cover how to manage Varroa using the best possible chemical and non-chemical tools. The workshop was also to identify short and long term R&D opportunities and communication messages. Gerald introduced the workshop to the RIRDC and HAL joint Pollination Program and made the room aware of a current bid for a honey and pollination industry Cooperative Research Centre (CRC).
Dr Denis Anderson, CSIRO addressed ‘What is Varroa – where did it come from and why is it a serious pest of honeybees?’ The presentation covered:

- A brief overview of the host/parasite relationships and genetics of Varroa mites.
- Varroa pathology – mites are just part of it!
- What to consider for R&D activities into mite control.

Denis explained to the workshop that mites ‘specialise’ in particular bee species and that host/parasite relationships have co-evolved. He noted that *Varroa destructor* Korea (very pathogenic) and *Varroa destructor* Japan (less pathogenic) had crossed the species barrier from *Apis cerana* (Asian honeybee) to *Apis mellifera* (European honeybees) in the last 60 years and as a consequence European honeybees, on which the Australian pollination and honeybee industries rely, do not possess a protection strategy for the Varroa mite.

Denis explained that while Varroa will seriously retard affected honeybee hive health, it is the impact of viruses hosted by the mite, some of which are not currently in Australia, which will cause the colony’s collapse and rapid death.

Death of a honeybee colony results from a combination of effects, such as:

- Varroa mite feeding damage.
- Mite transmitted and/or activated virus infections.
- Lack of bee defences (e.g. hygienic behaviour).
- Mite induced suppression of the bee immune system.
- Environmental conditions (nutrition and climate).
- Bee and mite genetics.
- Beekeeping practices etc.

Denis proposed the following R&D activities:

- Prevent the mites from entering Australia (e.g. improve the port surveillance system).
- Develop new chemicals (synthetic or organic).
- Develop improved hive management methods.
- Develop microbial pathogens that kill Varroa mites.
- Breed for bee traits that may help the rapid development of “tolerant” or “resistant” bees once Varroa arrives (hygienic behaviour, virus resistance, bees with improved immune responses, etc).
- Develop novel approaches to mite control (for example, what chemical signals trigger Varroa reproduction? - use this information together with information from the bee and mite genome to produce a resistant bee).
- Improve beekeeper management skills.

Questions and clarifications for Denis, provided...
information that included:

• Genetic resistance can be in two forms – hygienic behaviours in bees and virus resistance in bees.
• Resistance to Varroa is highly localised.
• Shortening honeybee brood time from say 24 to 20 days has been suggested as a way to prevent Varroa from reproducing, but the hypothesis is controversial.
• Smaller cell size that does not allow Varroa to cohabit with brood has also been suggested, success with this control technique in NZ has been limited.
• Introduction of Varroa jacobsoni, a less virulent form, to displace Varroa destructor was suggested by the workshop in a somewhat ‘tongue in cheek’ fashion. A proposal such as this would not secure quarantine clearance.

Saul Cunningham, CSIRO – pollination dependent industries

Dr Saul Cunningham, CSIRO pollination specialist detailed the benefits or otherwise of pollination for plant industries, the pollination spectrum, the honeybee as preferred pollinator, the impact of Varroa and possible economic impacts.

The benefits of pollination include additional crop yield, additional seed production, number of fruit, size and shape of fruit, a shortening of the time between flowering and harvest and key quality attributes such as the storage potential of apples. These benefits need to be communicated to plant industries.

Across plant industries there exists a pollination spectrum from crops that do not require pollination (eg cereals), to those that receive some benefit from pollination (eg citrus and pome fruit) to those that would not produce any yield without pollination (eg kiwifruit). Most growers do not know their crops pollination requirements. When CSIRO tested pollination requirements honeybees are found to be more significant than was thought.

The European honeybee as a pollinator

• Effective, domesticated pollinator across a wide range of crops.
• Social and strongly recruiting – means it can be used to pollinate big crop areas.
• Successful Australian feral animal – based on nectar rich eucalypts and mild winters.
• A huge free service is provided by feral honeybees to Australia’s plant industries.
• However, we have not got comprehensive data to support our contention that feral honeybees provide a valuable plant industry service.

Impact of Varroa

• Varroa will ‘knock back’ the Australian feral honeybee population.
• Varroa will add significant new costs to commercial beekeeping.
• Farmers will demand additional pollination services from beekeepers at a time when honeybee numbers are diminishing.
• The cost of pollination services will rise.
• CSIRO estimate an average annual additional cost of $30 million with a peak one year cost of $120 million.
• The Pollination Program’s new publication ‘Pollination Aware’ has just been released and shows that post Varroa, plant industries will require 480,000 hives in the peak month of September and Australia currently has 572,000 hives not all of which will be made available or are suitable for pollination services.

Impact of Varroa on the bottom line – bad

• Short term chaos.
• Increased costs for growers.
• Impacts dependant on the crop and the environment in which it is grown.
• In some cases yield will suffer.

Impact of Varroa on the bottom line – good

• With time, could expect development of a larger, more professional pollination industry – based on NZ experience.
• With good management, potential for increased yields in long term (compared with current practice).

Questions and clarifications for Saul, provided information that included:

• Has the benefit cost analysis been done for pollination – yes at the national level, but not for individual industries. Trevor Monson, pollination broker, indicated that individual industries or at least individual enterprises are doing the numbers on best available information on a routine basis. Danny Le Feuvre, Australian Bee Services, indicated that industries and individuals are missing the key pollination/yield relationship data that would permit informed benefit-cost estimations.
• Vicki Simlesa, NT Department of Resources, Apiary Officer commented that feral bees are already disappearing from northern Australia.
• Ben Hooper, SA beekeeper stated that we shouldn't talk down industry opportunities for pollination services before Varroa arrives. For almonds we need to know what works for Australia, we are currently relying on California data and it could be that we can get away with less hives in Australia.

• David Dall, Peststat Pty Ltd noted that we need to get information (communication messages) from this workshop through HAL to individual industries. We need to be ‘alert but not alarmed’. The new publication ‘Pollination Aware’ is a good vehicle for raising awareness.

• Tiffane Bates, WA Queen Bee Breeder commented that the message needs to be communicated to horticulture that there could be short term ‘chaos’ and that individual growers should set up relationships with pollination beekeepers now to avoid this ‘chaos’.

• Denis Anderson said: keep Varroa out, prepare for Varroa, attempt novel solutions now while we have time and the luxury of experimentation.

• Saul Cunningham: there are economic benefits from implementing managed pollination services now, before Varroa arrives.

Communication messages arising from Saul’s presentation

• We need to communicate the benefits of pollination to those plant industries that receive a benefit.

• Most growers do not know their crops pollination requirements – it is time they found out.

• When CSIRO test pollination requirements they are more significant than was thought.

• A huge free service is provided by feral honeybees to Australia’s plant industries.

• We have not got comprehensive data to support our contention that feral honeybees provide a valuable plant industry service.

• Feral bees are fundamentally threatened by Varroa.

• Costs incurred by pollinator dependent plant industries will increase dramatically post Varroa.

• We currently do not have the hives to meet plant industry demands post Varroa.

• The new publication ‘Pollination Aware’ is a good vehicle for awareness creation.

• Message to horticulture should be that there will be short term ‘chaos’ and that individual growers should set up relationships with beekeepers now.

• There are economic benefits from implementing managed pollination services now, before Varroa arrives.
Chemical Options to Manage Varroa

Mark Goodwin, Plant and Food Research NZ – the NZ Experience

Dr Mark Goodwin, Plant and Food Research NZ provided a ‘Review of chemical options for management of Varroa internationally’. Mark made the following points:

- A beekeeper in NZ where Varroa is well established would lose 95% of their hives within 12 months in the absence of chemical control options for Varroa.
- There are a huge number of chemical controls for Varroa. Most of these chemicals have now been used and Varroa has a degree of resistance to each one.

Mark proposed the following process for selecting a chemical suitable for Varroa control in Australia, should the need arise:

1. Check to which chemicals the Varroa present in Australia is resistant.
2. Decide what chemical use approach is to be used – for example agricultural chemicals designed for other purposes cost around $NZ100 per 1,000 hives per annum to control Varroa and are likely to create rapid resistance problems for this and other industries along with honey/beeswax contamination problems. Whereas Varroa control chemicals will cost $NZ32,000 to perform the same job. It is important to eliminate the ‘homebrew’ eg cardboard dipped in agricultural chemical solution early, if long-term Varroa management is to be achieved.
3. Register all suitable Varroa control chemicals. NZ has a wide ranging arsenal of appropriate chemicals. Three options have been refused registration in NZ due to their propensity to create beeswax residue problems. They are CheckMite, Folbex VA and Apitol.
4. Things to consider when selecting a Varroa control chemical include:
   - Synthetic versus organic chemicals
   - Cost – including both chemical cost and labour
   - Effectiveness
   - Residues
   - Resistance

Generally speaking beekeepers will only be interested in cost and effectiveness.

5. NZ beekeepers really wanted to use organic compounds (such as Formic Acid, Oxalic Acid and Thymil [derived from thyme]) rather than ‘hard synthetic chemical’ solutions. The trouble with organic chemicals is that they are highly variable in their effectiveness and unless you can kill 80% of all mites every time, the honeybee colony will die. Nevertheless, organics can be used, as long as mite numbers are sampled and monitored and colonies retreated. The trouble with this approach...
is that it requires significant high cost labour and consequently is cost prohibitive. Use of organic chemicals without follow up sampling has resulted in the loss of 20,000 NZ hives.

6. Give up on organic chemicals – unless you have an extremely high value product (eg Manuka honey, lucrative kiwifruit pollination contracts) – organic chemicals are just too expensive.

7. Move to specialist synthetic chemicals. Three useful ones used in NZ are Apistan, Bayvarol and Apivar (see table below). It is very important to alternate between synthetic chemicals to minimise resistance and maximise each chemical’s useful Varroa control life.

8. Synthetic chemicals come ready to use in strips which are inserted into the hive. Cutting each strip in half and using half the recommended amount will still produce effective Varroa control. This cost mitigation option will increase resistance rates over use of recommended rates but is still a worthwhile action.

9. Timing of treatment – treat in autumn and spring in NZ which avoids that country’s defined November to February honey flow. An Australia specific treatment timing regime will need to be developed given Australia’s year-round honey flow. There is no honey withholding period following chemical treatment for Varroa in NZ.

10. Resistance management – through proper use of chemical strips and alternating chemicals eg spring use Apivar and in autumn use Bayvarol or Apistan.

<table>
<thead>
<tr>
<th>Strips (not cut)</th>
<th>Residues</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apistan</td>
<td>4 Wax - High</td>
<td>High</td>
</tr>
<tr>
<td>Bayvarol</td>
<td>8 Wax - Low</td>
<td>High</td>
</tr>
<tr>
<td>Apivar</td>
<td>4 Wax and honey</td>
<td>Not tested</td>
</tr>
</tbody>
</table>

In summary

Varroa resistance may remove chemical treatment choices

1. Avoid agricultural chemicals especially ‘homebrew’
2. Registration removed some options (residue problems)
3. Effectiveness removes most chemical treatment options
4. Maintain effectiveness by smart use of chemicals (rotation)

5. Manage residues (biggest issue is wax)

Questions and clarifications for Mark, provided information that included:

- NZ hives were only kept alive through synthetic chemicals, in reality Integrated Pest Management (IPM) “went out of the window”.
- Organic chemicals such as Formic Acid, Oxalic Acid and Thymol were tried in NZ and found not to be successful because follow up labour-intensive monitoring was too expensive.
- With our time again we would not provide a wide range of Varroa management options, including organic chemical options, we would have said ‘go synthetic chemicals’. Possibly, if enterprise can afford it, try IPM and monitor results rigourously.
- Mark: Should eradication be attempted – yes.
- Medhat Nasr of Alberta Canada: Don’t waste time and money on attempting to eradicate Varroa.
- Is the NZ industry profitable? Mark: yes Manuka honey plus pollination fees are high. Varroa is an ‘economic disease’ – it can be controlled but the cost is high.
- NZ lost 20% of its hives when Varroa arrived. There are now more hives in NZ than pre Varroa and they are operated more profitably by larger beekeepers. There are no feral bees.
- If it were decided that you did not want to chemically treat Varroa at all and let honeybees self select for resistance – then minimum of 2-3 years with no honey production or pollination services. This would not be economically acceptable in Australia, nor was it seen to be acceptable in NZ or Canada but this is what South Africa decided to do.

R&D suggestions arising from Mark Goodwin’s presentation

- There is a need to do R&D on how chemicals work on the mite (Saul Cunningham, CSIRO).
- There is a need to do R&D on interfering RNA to stop Varroa linked virus RNA replicating (Ben Oldroyd, Sydney University).
- Establish economic damage thresholds for Varroa in honeybee colonies – in NZ it is 80% ie if 80% of the Varroa mites in a hive are not removed the colony will die. It could be different in the Australian situation. It is different in Canada. This information could be used in IPM strategies that address when to treat with chemicals. It was noted that this research would be difficult to complete for Australia until the mite is present in Australia and the Australian situation is understood.
Saul Cunningham noted that potentially there are two R&D streams:

- Short term: R&D associated with keeping Varroa out of Australia and how to keep chemical solutions working effectively when Varroa arrives.
- Long term: understanding how host/parasite relationships have evolved and producing genetic responses. This research would be part of the global R&D effort and might produce a long-term genetic response.

Ben Oldroyd commented that we should be preparing the ground for long term research right now and addressing issues such as the controlled importation of Varroa resistant honeybee genetics.

Karl Adamson, APVMA – Australian Government Regulatory Requirements

Karl Adamson, Australian Pesticides and Veterinary Medicines Authority (APVMA) also presented on chemical options for Varroa control. Karl presented on the Australian regulatory approval process for Varroa control chemicals.

Key points made by Karl included:

- If you add anything to honeybee hives other than traps, it is classed as a chemical and requires APVMA regulatory approval. For example food grade acids and oils must be approved.
- To successfully gain a registration or permit approval the ‘chemical’ must meet the following criteria:
  - Not pose unacceptable risks to people, the environment, and target crop or animal,
  - Be effective, and
  - Not adversely affect international trade.
- The ‘chemical’ must be at least 95% effective or resistance will quickly develop. If the chemical is not effective it is unlikely to be registered for use in Australia.
- Bayvarol, Apistan and Apiguard (Thymol) are all approved by APVMA for use in maintaining/monitoring Australia’s quarantine barrier (emergency response). Quarantine destruction of colonies is permitted using either Permethrin or unleaded petrol.
- APVMA is aware of enough data to permit wider use of Bayvarol, Apistan and Apiguard and will not require local efficacy data. These three chemicals still require permit approval. Chemical registration is usually driven by the company that owns the rights to the chemical. Chemical companies usually provide extensive data packages assembled at their own expense to facilitate registration. For this reason it may be difficult to secure Australian registration of generic organic compounds, such as food acids and oils, for use against Varroa.
- A process known as ‘shelf registration’ is possible, whereby chemicals are registered or permitted (temporary measure) for use and ‘placed on the shelf’ for their later application in Australia against Varroa.
- It is also possible to apply for an emergency use permit or minor use permit. But even these ‘quick response’ measures take time for APVMA to deliver and support data is needed. For example formic acids with their low pH have OH&S implications. APVMA has seen no data on the use of oils to control Varroa. Thymol (an extract from the herb thyme) will be an issue for Australia’s food laws, including honey tainting and approval may require provisions for diluting honey that come from Thymol treated hives.
- Data to support chemical registrations will need to be sourced from existing overseas registrations. Trial data from NZ would be very useful.
- Chemicals are currently permitted by APVMA for Varroa eradication. The industry must register control chemicals for when Varroa moves to the management phase ie after it has become established.
- Issues to consider include permits for Varroa management chemicals needed (noting that eradication chemicals are already permitted), OH&S issues, residue issues, market access issues, IPM and resistance management, integration with State laws and training (eg Chem Cert and fumigation certificates) and strategies on whether it is better to apply for minor use or full chemical registration.

R&D Suggestions:

- Industry R&D projects that provide/collate data sets to support chemical registration.

Kevin Bodnaruk, Consultant Researcher – HAL Project to Meet APVMA Needs

Dr Kevin Bodnaruk, Consultant Researcher has a project within the Pollination Program, contracted through HAL, to facilitate APVMA approval of Varroa control chemicals. The project has within its scope eight possible ‘chemical’ options from which only efficacious chemicals will be pursued based on consultation with the industry:
**Synthetic chemicals**
- Apistan (tau-fluvalinate), Bayvarol (flumethrin) and Apivar (amitraz).

**Oils**
- Api-Life-var, Apiguard (thymol) and thymol crystal.

**Organic acids**
- Formic acid, oxalic acid.

The project will need to consider; use patterns required (chronic or acute), data sets (to support efficacy, residues, OH&S, trade), country specific differences in relation to overseas data sets, coordination and industry long term objectives (eg resistance planning, registration rather than perpetual permits, management of product supply, integration with existing systems, etc). Kevin noted the difficulty of securing data for widely available generic treatments.

Questions and clarifications for Karl and Kevin, provided information that included:
- There is an industry committee to manage the HAL project, specify scope and assist with data collection. Lindsay Bourke, Pollination Advisory Committee/ Honeybee biosecurity specialist advised that AHBIC could also provide direction to this project via an expert committee.
- Mark Goodwin noted that it is difficult to define requirements, use patterns or even the chemicals needed until Varroa is present in Australia and its resistance status is known (eg do we have resistant strains of Varroa from NZ or untreated Varroa from PNG). Kevin thought it might therefore be appropriate to seek 'off label' use until Varroa arrives.
- Medhat: Plenty of hard chemicals registered in Canada, organics are ‘rubbish’ but can assist with IPM if monitoring is undertaken and retreatment is done rigourously. Effective Varroa management requires lots of beekeeper education.
- Des Cannon, Chair RIRDC Honeybee Advisory Committee commented that organic chemicals might be of low efficacy but they are needed, there is no IPM without them.
- Karl commented that IPM will not be a cost effective control option for Varroa and that Small Hive Beetle has taught Australian beekeepers to use and manage ‘hard’ chemical controls. Karl suggested that we have synthetic chemicals registered first and then pursue organic options.
- Chris Buller Pestat/CRC bid, suggested that we need to get going quickly, with a strategy based around off label use permits. Even an emergency approval from APVMA takes 12 months; full registration can take up to 10 years!
- Bruce White, beekeeper NSW noted that we must have a suite of chemical options for the management of Varroa available to us at the earliest possible time.
- Mark Goodwin noted that chemical companies are reluctant to release chemicals for a minor industry like beekeeping, with high risks and a small market. Chemical companies have been blamed for Colony Collapse Events (CCE) in the US.
- The workshop agreed that with three chemicals approved by APVMA for emergency response, risk management would dictate that we need a fourth option as soon as possible.

**Summary points from the workshop’s first two sessions**
- Don’t use resources to eradicate Varroa once it is present in Australia. This was immediately contradicted from the floor – the Australian Government provides substantial assistance to support incursion eradication and if nothing else this funding provides invaluable mapping of the extent of spread. Denis Anderson pointed out that Varroa had been successfully eradicated from an island in Irian Jaya using synthetic chemicals.
- A framework for tackling Varroa might include:
  - Invest in keeping it out.
  - If it gets in, attack it early and with all available resources.
  - Manage Varroa once it is established through:
    - Cutting the nexus between mite and honeybee (long term R&D required)
    - R&D to tackle the viruses associated with Varroa and do this through RNA modification (long term R&D required)
    - R&D to help honeybees manage the mite through genetic selection for hygienic behaviour (long term R&D required).
- R&D is needed in the short term to provide data to inform Kevin Bodnaruk's chemical registration work.
Des Cannon, Chair RIRDC Honeybee Advisory Committee – Overview

Des provided the following introductory points in relation to non chemical options to manage Varroa:

1. Use of synthetic chemicals is just propping up a Varroa affected colony. It is not increasing honeybee resistance to Varroa. Every country with Varroa has developed synthetic chemical resistance problems. NZ, which was only been Varroa affected recently and has managed its chemicals relatively well, has started to see the emergence of chemical resistance.

2. Use of synthetic chemicals also has issues in relation to contamination of beeswax with residues and the ongoing viability of both queens and drones.

3. In Australia if we adopt a synthetic chemicals only approach we will have issues with contamination and residues in our products.

4. In Germany Varroa is being controlled cost effectively using only drone brood culling and formic acid, an organic chemical.

5. This is not to say that breeding for resistance will be easily achieved by importing resistant stock. It is noted that resistant stock bred in Avignon France and transported to northern Germany performed poorly. However these same stock when returned to Avignon France were still resistant to local Varroa populations.

6. If we are to be effective in breeding Varroa resistance in our honeybees we must look to our own honeybee genetic pool that is already adapted to our climate.

7. Breeding Varroa resistance will be expensive and long term. In the EU they have invested approx. $A320,000 per annum for many years.

8. Long term it may be more appropriate to travel the South Africa path and allow honeybees to self select for resistance but in the interim we would lose our industry.

Des provided a listing of non chemical Varroa control options:

- Varroa sensitive hygienic behaviour
- Breeding for resistance to Varroa
- Drone brood control
- Screen bottom boards
- Temperature control
- Organic acids
- Biological control
- Pathogen control and integrated pest management (IPM)

Des noted the big potential of IPM and that to make IPM work you need to be able to measure the level of Varroa activity in a hive pre and post treatment. He noted that the Canadians in Alberta were doing this very well.
**R&D Suggestions**

R&D needs and actions summarised by Des included:

1. Test Varroa for resistance to known chemicals.
2. Instigate widespread educational DIRECTED program/workshops for beekeepers to ensure they do the right thing meaning they treat effectively, rotate chemicals and do not mix ‘home brews’.

The workshop also suggested:

- A high priority R&D project to look for single gene Varroa resistance that can be used regardless of the environment that the bee is in.

David Dall, Pestat/CRC bid also noted that this would be an excellent project for the proposed CRC.

**Ben Hooper, Nuffield Scholar – Temperature Control to Manage Varroa**

Ben provided an overview of the Nuffield program followed by an explanation of his proposal to build a large cool room for hive storage. The cool room by providing a constant 4°C for four months every year is hoped to:

1. Address the issue of insufficient overwintering sites for his hives.
2. Overcome the issue of inconsistent winter conditions in terms of both weather and flora suitable for bees.
3. Assist with queen longevity – less disturbance and hive movement that affects the queen.

The cool room proposal will be managed in conjunction with a supplementary feeding program. In terms of Varroa management it is hoped that the cool room will:

- Create a significant break in the brood cycle – brood is required for Varroa mites to reproduce.

The cool room will be expensive to construct, around $75,000 in total but is anticipated to have relatively modest operating costs, approximately $600 over the four colder months. Ben noted in passing that the US reliance on only chemicals to treat Varroa is approaching the point where extreme levels of resistance are rendering all current chemical options ineffective.

**Mark Goodwin, Plant and Food Research NZ – NZ Non Chemical Experience**

Mark Goodwin also spoke on NZ experience with non chemical options to manage Varroa. Mark noted that there is any number of ‘internet solutions’ for non chemical treatment of Varroa. Mark cautioned against reliance on these ‘solutions’. To be effective non chemical solutions must compete with the cost of chemical management which is currently anywhere from $NZ8-$32/hive per annum. Non chemical solutions cost considerably more than this and much of the cost is for monitoring labour. Non chemical solutions considered by Mark in NZ include:

1. Small cell size – no room for Varroa to reproduce in brood cells
2. Mesh bottom hive boards – Varroa drop off honeybees and fall out of the hive
3. Drone trapping – Varroa prefer to reproduce on drones
4. Organic chemicals – kill Varroa
5. Breeding – for resistance
6. Biological controls – to provide a long term solution.

When using non chemical solutions Mark stressed that hive monitoring is all important – know what is and isn’t working and when to treat.

**Small cell size**

- A single NZ study and two overseas studies conclude that small cell sizes are not an effective way of controlling Varroa.

**Mesh bottom hive boards**

- Widely used in NZ.
- Overseas studies say no Varroa control benefit ie mesh bottom boards are not decreasing chemical use requirements so therefore not effective. There is no doubt that some Varroa fall through the floor of hives but not an economically significant number.

**Drone trapping**

- Works very well for amateur beekeepers, but takes lots of time and is therefore very expensive for large scale professionals.

**Oxalic acid**

- Useful organic chemical.
- Kills mites on honeybees, but not on brood.
- Kills 60% of mites, combine its use with re-queening.
- Low cost Varroa control option.
**Formic acid**
- Use of this organic chemical has significant OH&S issues, lots of danger in its use and formic acid is very corrosive.
- Tried and abandoned in NZ.

**Thymol**
- In NZ there are lots of proprietary products and the NZ authorities have registered it as a generic to lower its cost to beekeepers.
- Costs about $NZ1 per hive to treat Varroa.
- NZ industry has low satisfaction with the product and currently only 5% of NZ beekeepers use it. Its results are highly variable.

**Overall comment on organic chemicals**
- Organic chemicals are not sufficiently reliable unless lots of labour intensive monitoring is undertaken. This makes organic chemicals a very expensive Varroa control option.
- Organic chemicals also risk tainting honey.

**Breeding for resistance**
- Mark is not convinced that this is a worthwhile activity.
- NZ research has isolated hives where honeybee genetics are such that Varroa cannot breed. However, reproduction and dissemination of these honeybees would see this genetic resistance quickly dissipate as non resistant bees mate and dilute the resistant honeybee gene pool.
- Before Australia embarks on a Varroa genetic resistance breeding program it should develop the 'full picture' ie how will resistant honeybees be maintained in a real world commercial environment and not diluted with non resistant stock.
- Mark estimates no more than a three year life for resistance before it is bred out of honeybees in a commercial setting.
- Also if we select breeding stock on the basis of a single gene (Varroa resistance) there is every chance that resultant bees will be poor at everything else eg flying and foraging!

**Biological control**
- NZ have been working with Metarhizium a fungus that has been used against other pest insects such as plague locusts.
- Metarhizium works fine in the laboratory but not in hives on a consistent basis.
- Mark's NZ colleagues are currently attempting to commercialise Metarhizium as a biological control agent for Varroa. Their most recent attempts show promise. Application (strips or pour on?) is yet to be worked out. Its potential as an addition to IPM with additional R&D could be significant.

**A workable Varroa control strategy used in NZ**
1. Start with a standard chemical control program
2. Use only single, not double, brood boxes
3. Remove honey from hives early
4. Use mesh floor boards in hives
5. Practice drone trapping
6. Resistance management through chemical rotation
7. Use only low resistance treatments
8. Sampling to monitor Varroa levels
9. Understand and practice threshold treatments
10. Plan for organics

**In summary**
- It is not possible to go straight to the use of organics; you need an IPM development process first and start with proven chemicals!

**R&D Opportunity**
- Use Varroa controls in combination – Metarhizium and Thymol together.

**Medhat Nasr, Alberta Canada – Practical IPM for Varroa Management**
Medhat spoke on Alberta Canada’s experience with non chemical options to manage Varroa. Alberta has a well organised and professional beekeeping industry. The industry was firmly wedded to the idea of chemical control and took some time to convince of the potential of resistance breeding.

Medhat made the following points:
1. Quarantine is the key – keep Varroa out with every means possible. Eradication once an incursion has occurred is difficult but don't give up.
2. *Apis mellifera* does not have hygienic behaviour for Varroa – infestation is too recent. Breeding for genetic resistance does work and Canada is breeding for hygienic behaviour. In one to two generations hygienic behaviour can be infused into local domestic stock. The Canadians have done this using Russian genetics.
3. Drone removal – only remove some of the drone brood, if all of the drone brood is removed the drop in hive production will be too great. Ensure you have a suitable and favourable overwintering arrangement.
4. Mesh bottom hives – work in some parts of Canada.

5. Small cells – has lots of set up costs.

6. Synthetic chemicals – when using these it is important to monitor for resistance but in Canada no one ever does! Monitor and use chemical strips only when they are needed. It is important to register a large number of synthetic chemical options so that effective rotation of chemicals can be practiced.

7. Organic chemicals – produce variable results and are highly season dependent. Essential oils (eg Thymol) – only work when it is warm (ie >17°C) which is fine for the US (and probably Australia) but not for Canada. Essential oils work best in combination with synthetic chemicals so it is important that their use label is flexible. Exomite has 90% of the Varroa control market in the UK but does not work in Canada. Test formic acid for your local conditions – it has been successful in Canada. Organic chemicals can be very localised in their effectiveness. Oxalic acid – is useful and it works. Temperature control is important for oxalic acid. Oxalic acid currently has manageable levels of resistance in Canada whereas a number of the major synthetic chemicals and formic acid have resistance levels up to 83%.

8. Beekeepers in Canada are using illegal and dangerous Varroa control options and this is a threat to exports. Residues are on the rise in Canada. As a consequence Canada are no longer extracting honey from the brood chamber, only the honey chamber.

9. Resistance to Coumaphos took only four years in Canada, Apistan took 14 years. The chemical control system can collapse quite quickly.

10. IPM is an intelligent way to use controls. The big problem with IPM is monitoring costs – monitoring can cost three times the cost of organic chemicals. Medhat’s hand shaker (two peanut butter jars screwed together, filter in between and filled with 300 bees and water) is a low cost monitoring tool. Monitor 20% of hives before and after treatment.

11. The IPM toolbox includes regulatory measures to stop home brews, genetic breeding, cultural and physical control methods (eg drone brood removal), chemicals (use only when needed), essential oils (do have a role but variable results, 95% of Alberta beekeepers use formic acid).

12. In summary – organic chemicals can be effective, they are not simple to apply and they are environment dependent. Use organics to give synthetic chemicals a longer resistance free life. There is life after Varroa. Learn from overseas experience and develop your own Varroa response system.

Discussion points arising from Medhat’s presentation

- Medhat: with genetically resistant Russian cross honeybees it is still necessary to use some chemical treatments.
- Medhat: can formic acid be used during honey flows – I don’t know.
- Mark Goodwin: it should be noted that organic chemicals are also toxic to honeybees.
- Gerald Martin: is it possible to use remote sensing, for sentinel hives and for monitoring Varroa levels in commercial hives? Mark Goodwin and Saul Cunningham thought this would be difficult to achieve.
- Max Whitten, Wheen Foundation: In the short term we are OK with Varroa management solutions but in the long term we are going to need to embrace resistance breeding. When we establish a breeding program perhaps it should embrace other attributes such as superior pollination capacity.
- Dr Dave Alden, RIRDC: RIRDC is not in a position to invest in chemical research but everything else; including genetics is consistent with the Pollination Program’s research objectives.
- Denis Anderson: There is too much emphasis on chemical solutions. R&D should tackle surveillance – the mite is not here yet, therefore we cannot do chemical effectiveness research. Clearly defined research opportunities are missing for Australia.

Summary points provided by Des Cannon from workshop session three

1. In the NZ situation; organics haven’t worked. In the Canadian situation they have worked. Therefore Australian R&D needed to cover temperature and local conditions necessary for effective organics. This work needs to be done at the regional level. Solutions suitable for Queensland will not be appropriate for Victoria.

2. The Canadian machine developed to deliver Oxalic acid looks great and should be researched for the Australian situation.

3. Non chemical methods in an IPM framework are labour intensive and expensive – this needs research and especially development for the Australian situation. The current offering may work well for hobbyists and getting them to control Varroa will be important.

4. Des Cannon disagreed with Mark Goodwin about the limited worth of a breeding program. However Des Cannon did agree that it needs to be developed with an ‘end plan’ in mind.
Chris Buller, Pestat Pty Ltd – Bid for Honeybee and Pollination CRC

Dr Chris Buller from Pestat Pty Ltd presented research themes for the Honeybee and Pollination CRC:

1. Bee breeding
2. Pest and pathogen mitigation
3. Pest and pathogen new controls
4. Enhanced pollination
5. Biodiversity and resource security
6. Sustainable industry through enhanced pollination

The CRC will not be about border control, industry development or value adding honey.
Research workshop participants were self selected into four table based groups. The groups were asked to consider the material presented during day one of the workshop and provide an assessment of ‘What research is needed to enhance non-chemical options for management of Varroa in Australia or is novel research needed?’

The workshop agreed that chemical research was not the domain of an Australian research program.

Table based groups presented back to the workshop (see Appendix 4 below) and a summary was prepared by Gerald Martin.

**Summary of Non Chemical R&D Needs**

**Industry profitability**
- R&D to improve the efficiency and profitability of pollination.
- Extension to increase beekeeper productivity, profitability and capacity to control Varroa. Technical advice and support for beekeepers to enhance their profitability.
- Labour saving monitoring of treatments and hive health.
- Chemical application tools for non synthetic (organic) chemicals.
- Extension to stop the misuse of chemicals which results in resistance and product residues.

**Prevention**
- Invest in research to strengthen the sentinel hive program.
- Test sensitivity and effectiveness of the methods used on sentinel hives.
- Improve *Apis cerana* capture techniques.
- Increase the number and effectiveness of bait hives (*Apis mellifera*).
- R&D to support remote surveillance of sentinel hives.

**Pre Incursion Option Evaluation**
- Testing of organic and synthetic chemicals.
- Testing under Australian conditions.
- Ensuring data available for APVMA to provide use permits for Varroa control options.
- Research to support bee safety.
- Test options across a range of climatic conditions so that we have a range of treatments relevant to both northern and southern Australia.
- Test options to ensure their suitability for Australian long honey flows.
- Ensure non target species (native and introduced) are safe.
- Understand the impacts of viruses spread by Varroa.

**Genetics**
- Identify the bee ‘signal’ that permits Varroa reproduction.
- Understand bee genotype and host path interactions.
- Genetic selection and the breeding of Australian types with international resistant stock (eg Russians, Africans).
- Inserting RNA into bees to interfere with Varroa virus RNA.

The above summary was presented to the day two workshop.
Summary of Workshop ‘Plenary’ Communication Messages

On day two of the workshop participants were asked to identify key communication messages resulting from what they had heard. The following ‘open plenary’ messages were recorded by Dave Alden, day two morning session:

1. We don’t know all the impacts of Varroa or a comprehensive understanding of the contribution made by pollination to agricultural productivity in Australia.
2. Some crops will suffer yield and economic losses once Varroa arrives. There are highly vulnerable plant industries.
3. Beekeepers need to manage their bees to ensure there are enough bees.
4. Learn from information provided on overseas experience.
5. When feral bee numbers collapse we will need more managed bees for pollination.
6. Biosecurity awareness within the honeybee industry is a significant issue.
7. Additional investment is required in the National Sentinel Hive Program (NSHP) to keep the mite out of Australia. CSIRO have found that there is an economic return of $30 million per year from keeping Varroa out.
8. We need to make pollinating bees more efficient at pollination.
9. We need to extend key Varroa messages to all horticultural and agricultural sectors – be alert not alarmed.
10. Need to prepare – get relationships in place, get hygienic behaviour improved.
11. Try new things now to get ready for Varroa.
12. Benefits from pollination for growers now, before Varroa arrives.
13. Demonstrate the benefit cost for horticulture of keeping Varroa out.

Additional communication messages recorded during the day two afternoon session included:

1. Over the last two to three years the Varroa impact issue has been really only a ‘filler or colour’ story (not hard edged news) for the media, we now need a clear media strategy to take advantage of the audience we have already alerted to the issue (Saul Cunningham).
2. This awareness will garner support for a CRC bid (Gerald Martin).
3. I would like to see large agricultural producers appearing in the media saying pollination is vitally
important (Saul Cunningham).

4. We need education on where and when to use chemicals once Varroa arrives.

5. Awareness-raising is critical.

6. We need a range of tools available, and use this suite in rotation.

7. Lots of little improvements in beekeeping possible, there are combinations of solutions for the Varroa problem.

8. We need to target peer leaders/industry champions to deliver our messages to ensure adoption of recommended practices.

9. We must stress the economic importance of the issue.

10. Use the rest of the world as a case study: ‘your economic future is at stake’.

11. A workshop participant recounted US expert Randy Oliver's action points for Australia as: (i) make sure chemicals are registered – both synthetic and organic (ii) clear messages on chemical safety for beekeepers are important (iii) lobby for a government backed bee stock improvement program – it needs to be large scale (iv) big agriculture must be in the game.

12. Politicians do understand our issue. IPM is the smart use of chemicals, integration of genetic research is important (Max Whitten)

13. ‘Pollination Aware’ has garnered big agriculture’s support – it has 35 important case studies. We need agriculture and school kids to read this (Trevor Monson)

14. We need (1) a ‘big idea’ to attract funding eg genetic research to identify bee/Varroa ‘signal’ (2) educate growers on pollination (Mark Goodwin).

15. Varroa is an economic disease, we need R&D to improve the economics, we need to educate and we need breeding including genetic markers (Peter McDonald, beekeeper WA).

16. There is a lack of knowledge of this issue in NT (Vicki Simlesa, (NT Apiary Officer).

17. The public have the message wrong, they think we already have Varroa in Australia (John Davies, Better Bees).

18. We need to increase the economic base of both beekeeping and agriculture and build public support to take the industry through the forthcoming crisis.

19. We need integrated research eg genetic markers for hygienic behaviour (David Dall).

20. The following analysis framework was also suggested by David Dall:

<table>
<thead>
<tr>
<th>Varroa status</th>
<th>Focus</th>
<th>R&amp;D Needs and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>Exclusion</td>
<td>Preparedness Products (prospective) Permits Processes</td>
</tr>
<tr>
<td>Hope for the best, prepare for the worst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During</td>
<td>Crisis management</td>
<td>Eradication Local area freedom Business continuity</td>
</tr>
<tr>
<td>After</td>
<td>Sustainable management</td>
<td>Methods and procedures Deliverable technologies Aspirational technologies</td>
</tr>
</tbody>
</table>

**Summary of Table by Table Communication Messages**

Table based groups were also asked to formulate communication messages and present back to the workshop (see Appendix 5 below) and the following summary was prepared:

1. We are concerned that the current Varroa surveillance program is insufficient.

2. We need an integrated strategy for crisis management.

3. Talk to beekeepers about strategic plans for Varroa management, keep them informed during the crisis and tell them our successes after the immediate crisis has passed.

4. Continue to communicate the importance of pollination and the possible gains for growers now before Varroa is in Australia.

5. Improving beekeeper profitability is the foundation stone of effective Varroa control.

6. The message to plant industries is: you will be affected and each sector needs to understand its pollination requirements now.

7. The big idea: further understand and research honeybee/Varroa signal disrupters.

The above summary should be considered in partnership with communication messages developed through the plenary sessions and after Saul Cunningham's presentation.
Appendices

Appendix 1: Workshop Agenda

*Non-Chemical and Minimum Chemical Use Options for Management of Varroa*

*University House, ANU, Canberra*

*Two Workshops (19-20 Aug 2010)*

**Facilitator:** Mike Williams – Michael Williams & Associates Pty Ltd, Sydney  
**Scribe:** Michael Clarke – AgEconPlus Pty Ltd, Sydney

### Research workshop (19 August 2010)

**Desired outcomes**

1. Review of existing non-chemical and chemical options for management of Varroa.

2. Identification of research projects needed to enhance non-chemical management of Varroa in Australia

<table>
<thead>
<tr>
<th>Day 1 Program (19 August)</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic for presentation &amp; discussion</strong></td>
<td><strong>Presenter</strong></td>
</tr>
<tr>
<td>09:30 Registration and tea &amp; coffee</td>
<td></td>
</tr>
<tr>
<td>09:50 Welcome</td>
<td>Gerald Martin</td>
</tr>
<tr>
<td>10:00 What is Varroa – where did it come from and why is it a serious pest of honeybees?</td>
<td>Denis Anderson</td>
</tr>
<tr>
<td>10:30 Review of chemical options for management of Varroa internationally</td>
<td>Mark Goodman, NZ</td>
</tr>
<tr>
<td>11:30 Review of chemical options for management of Varroa within Australia</td>
<td>Kevin Bodnark APVMA and Karl Adamson</td>
</tr>
<tr>
<td>12:30 Lunch</td>
<td></td>
</tr>
<tr>
<td>13:30 Review of non-chemical options for management of Varroa</td>
<td>Des Cannon, Mark Goodman, Medhat Nasser, &amp; Ben Hooper</td>
</tr>
<tr>
<td>a. Varroa sensitive hygienic behaviour</td>
<td></td>
</tr>
<tr>
<td>b. Breeding for resistance to Varroa</td>
<td></td>
</tr>
<tr>
<td>c. Drone brood control</td>
<td></td>
</tr>
<tr>
<td>d. Screen bottom boards</td>
<td></td>
</tr>
<tr>
<td>e. Temperature control</td>
<td></td>
</tr>
<tr>
<td>f. Organic acids</td>
<td></td>
</tr>
<tr>
<td>g. Pathogen control and integrated pest management</td>
<td></td>
</tr>
<tr>
<td>15:00 Afternoon tea</td>
<td></td>
</tr>
<tr>
<td>16:00 What research is needed to enhance non-chemical options for management of Varroa in Australia or is novel research needed? – workshop</td>
<td>Mike Williams - Facilitator</td>
</tr>
<tr>
<td>17:00 Close</td>
<td></td>
</tr>
<tr>
<td>18:30 Dinner (18:00 for 18:30 start)</td>
<td></td>
</tr>
</tbody>
</table>
Desired outcomes

1. Raise awareness among the honeybee industry participants of non-chemical and minimum chemical use options in Australia for management of Varroa.

### Day 2 Program (20 August)

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic for presentation &amp; discussion</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30</td>
<td>Registration and tea &amp; coffee</td>
<td></td>
</tr>
<tr>
<td>09:50</td>
<td>Welcome</td>
<td>Gerald Martin</td>
</tr>
<tr>
<td>10:00</td>
<td>Varroa – why it’s a problem and how it is spread – Affects on overseas beekeeping and pollination industries and likely impact in Australia</td>
<td>Denis Anderson / Saul Cunningham</td>
</tr>
<tr>
<td>10:45</td>
<td>Research needed to enhance non-chemical options for management of Varroa in Australia – results from first day workshop</td>
<td>Gerald Martin</td>
</tr>
<tr>
<td>11:15</td>
<td>Living with Varroa – minimum chemical use options for Australia &amp; implications for beekeepers of their use on queens and drones</td>
<td>Medhat Nasser, Canada</td>
</tr>
<tr>
<td>12:30</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>13:15</td>
<td>Living with Varroa – non-chemical options</td>
<td>Des Cannon, Mark Goodman, Medhat Nasr &amp; Ben Hooper</td>
</tr>
<tr>
<td>14:45</td>
<td>Revisiting research needs in light of today’s discussion</td>
<td>Mike Williams – facilitator</td>
</tr>
<tr>
<td>15:00</td>
<td>Afternoon tea</td>
<td></td>
</tr>
<tr>
<td>15:30</td>
<td>Key communication messages – workshop</td>
<td>Mike Williams</td>
</tr>
<tr>
<td>16:30</td>
<td>Close</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 2: List of Participants

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karl</td>
<td>Adamson</td>
<td>Australian Pesticides and Veterinary Medicines Authority (APVMA)</td>
</tr>
<tr>
<td>Dave</td>
<td>Alden</td>
<td>RIRDC</td>
</tr>
<tr>
<td>Denis</td>
<td>Anderson</td>
<td>RIRDC Honeybee Advisory Committee</td>
</tr>
<tr>
<td>Tiffane</td>
<td>Bates</td>
<td>Queen breeder, Churchill Fellow</td>
</tr>
<tr>
<td>Kevin</td>
<td>Bodnaruk</td>
<td>Research consultant</td>
</tr>
<tr>
<td>Lindsay</td>
<td>Bourke</td>
<td>RIRDC Pollination Advisory Committee</td>
</tr>
<tr>
<td>Ben</td>
<td>Brown</td>
<td>Almond Industry</td>
</tr>
<tr>
<td>Chris</td>
<td>Buller</td>
<td>Pestat Pty Ltd</td>
</tr>
<tr>
<td>Des</td>
<td>Cannon</td>
<td>Chair, RIRDC Honeybee Advisory Committee</td>
</tr>
<tr>
<td>Michael</td>
<td>Clarke</td>
<td>Facilitator</td>
</tr>
<tr>
<td>Paul</td>
<td>Cooper</td>
<td>Researcher, ANU</td>
</tr>
<tr>
<td>Saul</td>
<td>Cunningham</td>
<td>Researcher, CSIRO</td>
</tr>
<tr>
<td>David</td>
<td>Dall</td>
<td>Pestat Pty Ltd</td>
</tr>
<tr>
<td>Mark</td>
<td>Goodwin</td>
<td>Presenter, Plant and Food Research NZ</td>
</tr>
<tr>
<td>Ben</td>
<td>Hooper</td>
<td>Beekeeper and Nuffield Scholar</td>
</tr>
<tr>
<td>Kim</td>
<td>James</td>
<td>HAL and RIRDC Pollination Advisory Committee</td>
</tr>
<tr>
<td>Danny</td>
<td>Le Feuvre</td>
<td>Australian Bee Services</td>
</tr>
<tr>
<td>Gerald</td>
<td>Martin</td>
<td>RIRDC Pollination Advisory Committee</td>
</tr>
<tr>
<td>Mike</td>
<td>McDonald</td>
<td>DAFF</td>
</tr>
<tr>
<td>Helen</td>
<td>Moffett</td>
<td>RIRDC</td>
</tr>
<tr>
<td>Trevor</td>
<td>Monson</td>
<td>RIRDC Pollination Advisory Committee</td>
</tr>
<tr>
<td>Medhat</td>
<td>Nasr</td>
<td>Presenter, Provincial Agriculturist Alberta, CAN</td>
</tr>
<tr>
<td>Murali</td>
<td>Nayudu</td>
<td>Researcher, University of Canberra</td>
</tr>
<tr>
<td>Ben</td>
<td>Oldroyd</td>
<td>RIRDC Honeybee Advisory Committee</td>
</tr>
<tr>
<td>Bill</td>
<td>Trend</td>
<td>WA Department of Agriculture and Food</td>
</tr>
<tr>
<td>Bruce</td>
<td>White</td>
<td>RIRDC Honeybee Advisory Committee</td>
</tr>
<tr>
<td>Max</td>
<td>Whitten</td>
<td>Wheen Foundation</td>
</tr>
<tr>
<td>Mike</td>
<td>Williams</td>
<td>Facilitator</td>
</tr>
<tr>
<td>Linton</td>
<td>Briggs</td>
<td>Beekeeper</td>
</tr>
<tr>
<td>Mark</td>
<td>Cozens</td>
<td>QLD, Dept of Primary Industries and Fisheries</td>
</tr>
<tr>
<td>John</td>
<td>Davies</td>
<td>Better Bees</td>
</tr>
<tr>
<td>Peter</td>
<td>Detchon</td>
<td>Queen breeder, WABA</td>
</tr>
<tr>
<td>Joe</td>
<td>Horner</td>
<td>Queen breeder, Mudgee</td>
</tr>
<tr>
<td>Wayne</td>
<td>Horner</td>
<td>Queen breeder, Mudgee</td>
</tr>
<tr>
<td>David</td>
<td>Leyland</td>
<td>Beekeeper</td>
</tr>
<tr>
<td>Daniel</td>
<td>Martin</td>
<td>Beekeeper</td>
</tr>
<tr>
<td>Peter</td>
<td>McDonald</td>
<td>Beekeeper</td>
</tr>
<tr>
<td>Vicki</td>
<td>Simlesa</td>
<td>NT, Department of Resources</td>
</tr>
<tr>
<td>Michael</td>
<td>Stedman</td>
<td>SA, Primary Industries and Resources</td>
</tr>
<tr>
<td>Trevor</td>
<td>Weatherhead</td>
<td>Queen breeder, AHBIC</td>
</tr>
</tbody>
</table>
# Appendix 3: Presentations

1. Denis Anderson – Varroa and its Implications ................................................................. 20  
2. Denis Anderson – Varroa and its Implications (2nd Session) ........................................... 31  
3. Saul Cunningham – Pollination Dependent Industries .......................................................... 37  
4. Mark Goodwin – Chemical Options to Manage Varroa ...................................................... 48  
5. Karl Adamson – Chemical Regulatory Requirements ........................................................... 62  
6. Kevin Bodnaruk – HAL Project to Assist Chemical Registration ........................................... 67  
7. Des Cannon – Non Chemical Options .................................................................................. 71  
8. Ben Hooper – Temperature Control to Manage Varroa ...................................................... 77  
9. Mark Goodwin – Non Chemical Options to Manage Varroa ................................................. 87  
10. Medhat Nasr – Practical IPM for Varroa Management .......................................................... 100  
1. Denis Anderson – Varroa and its Implications

What is Varroa?
Where did it come from and why is it a serious pest of honeybees?

Denis Anderson
CSIRO Entomology
19 Aug 2010

This-Morning

• An brief overview of host/parasite relationships and genetics of Varroa mites

• Varroa pathology – mites are just part of it!

• What to consider for R&D activities into mite control
Primary hosts

Apis cerana  Apis koschevnikovi

What is Varroa? Varroa update
What is Varroa?

Host-parasite relationships

**What is Varroa?**

Anderson & Trueman (2000); Anderson (2000); Anderson et al (In Preparation)

---

Which Varroa have switched host to the European honeybee?

Varroa underwoodi
Varroa rindereri
Varroa jacobsoni
Varroa destructor

Anderson & Trueman (2000); Fuchs et al (2000); Anderson (2004); Solignac et al (2005); Anderson (2008); Navajas et al (2010)
Where did Varroa come from?

Anderson & Trueman (2000); Solignac et al (2005); Anderson (2008); Navajas et al (2010)

What is Varroa?

Why is varroa a serious pest of honeybees?

European honeybees do not have a long history of evolution with *Varroa destructor* or the PNG strain of *Varroa jacobsoni* and therefore do not have highly developed defenses against them.
What is Varroa?

Bee damage begins when mites start feeding

On European honeybees female Varroa mites feed while:
   (1) inside the spaces between abdominal sternites on adult bees (during the phoretic phase)
   (2) Inside capped brood cells (in the reproduction phase)

Effects of feeding

- Damage directly associated with feeding mites
- Damage caused by viruses associated with feeding mites
1. Damage directly associated with feeding mites

Physical damage is caused to individual bees when female mites pierce soft tissue of capped brood & adult bees with their chelicerae and remove blood. First observable affect is a loss of bee weight.

Female mites can draw about 0.1 mg of blood during a single feed (an adult worker bee weights roughly 100 mg)

There is strong correlation between weight loss in newly emerged adult bees and numbers of female *V. destructor* mites that infested those bees as pupae:

<table>
<thead>
<tr>
<th>No. mites</th>
<th>Mean % Weight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>6.5</td>
</tr>
<tr>
<td>2</td>
<td>10.6</td>
</tr>
<tr>
<td>3</td>
<td>14.5</td>
</tr>
<tr>
<td>4</td>
<td>16.4</td>
</tr>
<tr>
<td>5</td>
<td>16.2</td>
</tr>
<tr>
<td>6</td>
<td>21.3</td>
</tr>
<tr>
<td>7</td>
<td>23.9</td>
</tr>
<tr>
<td>8</td>
<td>25.4</td>
</tr>
<tr>
<td>9</td>
<td>24.3</td>
</tr>
</tbody>
</table>

(Data from De Jong et al. 1982)
Some other pathological effects associated with mite feeding

- Adult bees infested with *V. destructor* as pupae show a 15-20% decline in protein content. They are also smaller (shorter) than adult bees that develop from non-infested pupae.

- Worker bees that emerge with up to 3 mature female *Varroa destructor* have berry-shaped cells clusters of the brood food glands that are greatly reduced in size. Most of these bees rarely lived longer than 16 days.

- Worker bees that emerge with >3 mature female *Varroa destructor* rarely leave the colony to forage. Worker bees infested as pupae have reduced wax secretion and reduced lifespans.

- Drones that emerge with 3-4 mature female *Varroa destructor* produce 40% and 50% less spermatozoa respectively than drones that emerge with no mites.

- Queens that emerge from *Varroa destructor* infested cells are more often than not ‘runts’.

---

Feeding damage (summary)

- Runts
- Reduced life-span
- Less emergence
- Less spermatozoa
- Weight loss
- Loss of protein
- Damaged bodies
- Damaged glands
- Odd Behavior
- Reduced life-span
- Quick death (rare)
- Death of colony (not common)

What is Varroa?
2. Damage caused by viruses associated with feeding mites

Five viruses shown to be associated with feeding *Varroa destructor*:
- Kashmir bee virus (KBV)
- Israeli acute paralysis virus (IAPV)
- Acute bee paralysis virus (ABPV)
- Deformed wing virus (DWV)
- Slow paralysis virus (SPV)

There is strong correlation between percentage of newly emerged adult bees with deformed wings and numbers of female *V. destructor* mites that infested those bees as pupae:

<table>
<thead>
<tr>
<th>No. mites</th>
<th>% Deformed Wings</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>5</td>
<td>7.7</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
</tr>
</tbody>
</table>

*De Jong et al (1982)*
Virus damage (summary)

- Weight-loss
- Loss of protein
- Damaged bodies
- Damaged glands
- Odd Behavior
- Reduced life-span

Slow growing viruses: DWV SPV

Fast growing viruses: ABPV KBV

Quick Death – CCE? – Death of colony (common)

Martin (2001)

Damage threshold

Invasion, fast reproductive rate, susceptible host, etc

Colony damage (possible colony collapse)

Individual bee damage

Migration, slow reproductive rate, mite mortality, host resistance, etc

Mite buildup

(Bee & mite genetics, presence or absence of pathogens, etc)
What is Varroa?

Colony collapse due to *Varroa destructor* infestation always results from a single cause: **PRESENCE AND BUILDUP OF THE MITE POPULATION** - therefore avoid colony death by keeping mite populations low (below damage thresholds).

Death of honeybee colonies due to *Varroa destructor* infestation does not usually result from a single cause. It results from a combination of effects, such as:

- MITE FEEDING DAMAGE
- MITE TRANSMITTED AND/OR ACTIVATED VIRUS INFECTIONS
- LACK OF BEE DEFENSES (e.g. hygienic behavior)
- MITE INDUCED SUPPRESSION OF BEE IMMUNE SYSTEM
- ENVIRONMENTAL CONDITIONS (nutrition & climate)
- BEE & MITE GENETICS
- BEEKEEPING PRACTICES
etc, etc

What to consider for R&D activities into mite control

- PREVENT THE MITES FROM ENTERING AUSTRALIA (Improve the National Port Surveillance System)
- DEVELOP NEW CHEMICALS (Synthetic or organic)
- DEVELOP IMPROVED HIVE MANAGEMENT METHODS
- DEVELOP MICROBIAL PATHOGENS THAT KILL VARROA MITES
- BREED FOR BEE TRAITS THAT MAY HELP THE RAPID DEVELOPMENT OF “TOLERANT” OR “RESISTANT” BEES ONCE VARROA HAS ARRIVED (Hygienic behaviour, virus resistance, bees with improved immune responses, etc)
- DEVELOP NOVEL APPROACHES TO MITE CONTROL (For example, what chemical signals trigger varroa reproduction? - use this information together with information from the bee and mite genome to produce a resistant bee)
- IMPROVE BEEKEEPER MANAGEMENT SKILLS

What to consider for R&D activities into mite control (con’t)
2. Denis Anderson – Varroa and its Implications

- Why Varroa is a problem (affects on overseas beekeeping)
- How Varroa is dispersed
- Likely impact of Varroa in Australia

1. Why varroa is a problem
(affects on overseas beekeeping industries)

“The most significant event affecting 20th century apiculture has been the human-assisted spread of the parasitic mite, Varroa destructor”

“Without doubt, introduction of the parasitic mite Varroa destructor has been catastrophic for North American beekeeping”

(M. Sanford, 2001)
• Varroa mites are parasites that feed on the blood of European honeybees. In doing so, they kill bees and bee colonies and cause hardship for beekeepers.

• European honeybees do not have a long history of evolution with varroa mites and therefore do not have highly developed defenses against them. Therefore varroa mites must be controlled to make beekeeping viable.

Bee damage begins when mites start feeding

On European honeybees female Varroa mites feed while:
1. inside the spaces between abdominal sternites on adult bees (during the phoretic phase)
2. Inside capped brood cells (in the reproduction phase)
Feeding damage

- Runts
- Queens
- Reduced life-span
- Drones
- Less spermatozoa
- Workers
- Weight loss
- Loss of protein
- Damaged bodies
- Damaged glands
- Odd Behavior
- Reduced life-span

Quick death

Death of colony

Virus damage

- Weight-loss
- Loss of protein
- Damaged bodies
- Damaged glands
- Odd Behavior
- Reduced life-span

Slow growing viruses:
- DWV
- SPV

Fast growing viruses:
- ABPV
- KBV

Quick Death

Death of colony

Slow Death

Martin (2001)
In the US, Europe and New Zealand varroa mites have:

- Killed-off the bee colonies of many hobby beekeepers;
- Caused beekeeper production costs to rise, often with no affiliated increase in honey prices;
- Led to gradual decreases in the numbers of beekeepers;
- Led to a continuous effort to control them;
- Helped to produce better beekeepers

2. How varroa is dispersed (Globally)

(a) Japan strain of Varroa destructor (on Apis mellifera)
2. How varroa is Dispersed (Locally)

- By individual foraging honeybees (not well studied);
- By robbing bees;
- By drifting bees (worker bees play a major role);
- By swarms (swarms can removing a lot of mites from an individual colony, about ¼ of the mite population).

Sakofski (1989); Greatti et al (1992)

Pathway of exotic bees and mites into Australia

FOR HONEYBEES:
- The arrival of Apis mellifera or Apis cerana to Australia as assisted swarms of bees on international seas vessels is “High”. Their arrival as unassisted swarms is “Extremely Low”

FOR MITES:
- V. destructor with A. cerana by assisted entry is “Low”
- V. destructor with A. mellifera by assisted entry is “High”
- V. jacobsoni with A. cerana by assisted entry is “High”
- V. jacobsoni with A. mellifera by assisted entry is “Low”
- Tropilaelaps spp. with A. mellifera or A. dorsata by assisted entry is “Very Low”

Barry et al (2010)
3. Likely impact of Varroa in Australia

EXPECT SIMILAR IMPACTS TO THOSE OBSERVED OVERSEAS

IN SHORT, THERE WILL BE NEGATIVE IMPACTS ON LOCAL HONEYBEES AFFECTING:

- *The Australian honeybee industry*
- *Agricultural industries that depend on honeybees for pollination*

Varroa mite
Varroa: likely impact on pollination in Australia

Saul Cunningham
CSIRO Ecosystem Sciences
20 Aug 2010

Pollination Benefits?

- Can increase number of seeds, number of fruit, size and shape of fruits
- Can shorten the time to between flowering and harvest
  - money saved, reduced risks, early access to market
- Can improve other quality traits
  - (e.g. storage potential in apples)
- For some crops important to seed production, but not to ultimate product (e.g. carrots, onions, clovers)
Pollination spectrum

Surprisingly poorly understood
Experiments often change the understanding
Benefits can be felt even in selfing crops

Honeybee *Apis mellifera* – Agriculture’s favourite

- Manageable, transportable
- Flexible
- Social and strongly recruiting --has an advantage in servicing large number of flowers
- Successful as a feral, worldwide
Australia’s reliance on *Apis mellifera*

- Widespread as a feral in all Australian ag. Landscape
- Most common observed visitor
- Nectar rich flora (*Eucalyptus*), mild winters, high *Apis mellifera* densities
- No other social bees
  - except feral *Bombus* in Tasmania, native stingless in the coastal subtropical zone
- Australian agriculture gets a huge free service from feral honeybees
- But even with abundant ferals, evidence suggest many crops would yield better with more pollination

Faba beans

Pollination benefits poorly understood
Managed pollination – under used in Australia

- Yield data: 5 transects, 3 properties
- Full model includes site and historical variation
- >20% yield benefit near hives

Precision ag yield data – including spatial variation in absence of managed pollinators
Data from La Feuvre and Long

Where are we now?

- Australian agriculturalists have tended not to manage pollination
- They have been lulled into a false sense of security by free pollination from feral bees
- Pollination industry is consequently not well developed (although some significant operators in this room)
- Many farmers already fail to reap possible benefits
Varroa arrives: lessons from overseas

• Varroa will knock back the feral bees
  “feral bee colonies have effectively disappeared..” Wenner & Bushing 1996, USA
  “ferals, what ferals?” Mark Goodwin, NZ

• At the same time it will give beekeepers new headaches

• The smart growers will realise they need something to replace the “lost ferals”

• Demand will go up for managed bees, at the same time that beekeepers are dealing with a new disease

Cost of pollinator bees

• COST WILL GO UP

• At least two forces:
  1) Varroa control costs money, costs are passed on to customers
  2) Demand for pollinators goes up faster than supply can increase
Data source: California State Beekeeping Association Pollination Surveys
Figure from Sumner and Boriss 2006

Expected impacts of Varroa

Cook, Cunningham Anderson et al 2007 Ecol Appl

Cost of substitution – across a mix of 25 crops
Average over $30million per year, over 30 yrs
July – flowering in the tropics

Source: “Pollination Aware” RIRDC/HAL

Aug – spreading out

Source: “Pollination Aware” RIRDC/HAL
Sept – peak demand (esp. in east)
Source: “Pollination Aware” RIRDC/HAL

Oct – WA comes on line
Source: “Pollination Aware” RIRDC/HAL
What would this take?

- Peak demand is 480,000 hives in September
- Current number of hives in Australia approx 572,000
- It will take more than this many bees to satisfy all possible pollination demand
- Exactly how many is a complex question, given that you need to move between crops, between locations, and maintain hive strength on non crop resources
- Not all growers will engage pollination services
- Not all beekeepers will get in the pollination business

Management option space
### Three impact groups

<table>
<thead>
<tr>
<th>Current use of paid pollination</th>
<th>Already routine</th>
<th>Some users</th>
<th>Rare</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current reliance on feral bees</strong></td>
<td><strong>Zero</strong></td>
<td><strong>High</strong></td>
<td><strong>Modest</strong></td>
</tr>
<tr>
<td><strong>Example crops</strong></td>
<td>Almonds, Lucerne</td>
<td>Pome, Stone fruit</td>
<td>Canola, Faba beans</td>
</tr>
<tr>
<td><strong>Expected impacts</strong></td>
<td>Cost of paid pollination will increase.</td>
<td>Hive shortages in the short term.</td>
<td>Yield declines, but might not be noticed.</td>
</tr>
<tr>
<td></td>
<td>Cost of paid pollination will increase.</td>
<td>Hive shortages in the short term.</td>
<td>Already would often experience underpollination</td>
</tr>
<tr>
<td></td>
<td>Some growers receive a big shock</td>
<td></td>
<td>Lost opportunity</td>
</tr>
</tbody>
</table>

| **Vulnerability** | **High** | **Highest** | **Low** |

### Bottom line

- **Bad news:**
  - Short term chaos
  - Increased costs for growers
  - Impacts depend on the crop and the environment in which it is grown
  - In some cases yield will suffer

- **Good news:**
  - With time, expect development of a bigger professional pollination industry
  - With good management, potential for increased yields in long term (compared to current practice)
4. Mark Goodwin – Chemical Options to Manage Varroa

Chemical Control of Varroa

Chemical control of varroa
RESISTANCE ?
Concentration (mg/kg)

Percent of varroa alive

Fluvalinate
Flumethrin

Resistance
Residues

Agrochemicals
Varroa control chemicals

1000 hives

$100 / year
$32,000 / year
Chemical control of varroa
Chemicals (beekeepers)

- Synthetic/Organic
- Cost - Product
  - Labour
- Effectiveness
- Residues
- Resistance

Chemical control of varroa
Organics

![Graph showing percent varroa killed across 20 hives]

- X-axis: Hives (1 to 20)
- Y-axis: Percent varroa killed (0% to 100%)

The graph indicates the percent varroa killed across different hives, with hives 11 and 12 showing significantly higher varroa kill rates compared to others.
Chemical control of varroa
<table>
<thead>
<tr>
<th>Strips</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Apistan</td>
<td>4</td>
</tr>
<tr>
<td>Bayvarol</td>
<td>8</td>
</tr>
</tbody>
</table>
A graph showing the percent of varroa killed against the percent of a full treatment. The graph compares the performance of different formulations:

- **Apistan 4 Wax - High**
- **Bayvarol 8 Wax - Low**
- **Apivar 4 Wax and honey**
<table>
<thead>
<tr>
<th>Strips</th>
<th>Residues</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Wax - High</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>Wax - Low</td>
<td>High</td>
</tr>
<tr>
<td>4</td>
<td>Wax and honey</td>
<td>Not tested</td>
</tr>
</tbody>
</table>
Timing of Treatments

<table>
<thead>
<tr>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
</table>

[Image of a plant and a bee]

Timing of Treatments

<table>
<thead>
<tr>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
</table>

[Image of a plant and a bee]
Timing of Treatments

Resistance Management

- Proper use of strips
- Alternating chemicals
Summary

1. Varroa resistance may remove choices
2. Avoid Agricultural chemicals
3. Registration removed some
4. Effectiveness remove most
5. Maintain effectiveness
6. Manage residues
What is and isn’t an Agvet chemical

- Legislative Definition:
  An AgVet chemical product is any substance used for the purposes of:

  - destroying, stupefying, repelling, inhibiting the feeding of, or preventing infestation by or attacks of, any pest in relation to a plant, a place or a thing; or

  - preventing, diagnosing, curing or alleviating a disease or condition in the animal or an infestation of the animal by a pest or modifying the physiology of the animal; or

  - modify physiology of a thing so as to alter its natural development, productivity, quality or reproductive capacity
Key Regulatory Requirements

To successfully gain a registration or permit approval the use must meet the following criteria;
• not pose unacceptable risks to;
  • people,
  • environment, and
  • target crop or animal
• be effective, and
• not adversely affect international trade.

Chemicals Currently Permitted for Use

• Quarantine monitoring
  • Bayvarol (Flumethrin)
  • Apistan (Tau-fluvalinate)
  • Apiguard (Thymol)

• Quarantine Destruction
  • Permethrin
  • Unleaded Petrol
**Registration or Permit Approval**

- Registration of products for exotic diseases
  - Chemical Manufacturer driven
  - “Shelf registration” is possible
  - Stringent requirements prior to activation

- Permit approval
  - Bee/Pollinator Industry driven
  - Stringent requirements prior to activation

- APVMA Assessment
  - Similar requirements for either route

---

**Supporting data and information**

*Key message - ‘Assume nothing’*

*APVMA assessment is based on supplied data*

*IT IS the applicants responsibility to source information to enable support of the proposed use*
Finding supporting data and information

Look locally and internationally for:

- Existing registrations - databases
- MRLs (databases – MRL Database FAS)
- Industry R&D projects
- Other trial information
- Published papers
- Manufacturer support via data provision

General Issues

- Veterinary Use Patterns
- Eradication/Management Phase transition arrangements
- Efficacy and OH&S
- Residues and Market Access
- Integrated Pest and Resistance Management
- Control of Use
- Minor Use or Registration
THANK YOU

Karl Adamson
Ph: 02 – 6210 4831

karl.adamson@apvma.gov.au

www.apvma.gov.au
Review of chemical options for management of Varroa within Australia

- Eight options have been nominated:
  - Chemicals
    - Apistan (tau-fluvalinate), Bayvarol (flumethrin) & Apivar (amitraz)
  - Oils
    - Api-Life-var, Apiguard (thymol) & thymol crystal
  - Organic acids
    - Formic acid, oxalic acid
Review of chemical options for management of Varroa within Australia

- Issues to be considered
  - Use pattern required
  - Data requirements
  - Co-ordination
  - Long-term objectives

- Use pattern required
  - Approach to be taken
    - Acute vs chronic
      - How are the options to be deployed?
  - Specify preferred options,
    - e.g.,
      - Thymol crystals –
        - Frakno frame or Brookes/Knight frame
      - formic acid –
        - pads or fumigator
Review of chemical options for management of Varroa within Australia

- **Use pattern required**

- **Management programs or alternatives**
  - Are the options sought to be used in programs?
  - Or provided as alternatives

- **Resistance**
  - How will resistance be addressed
    - Resistance testing?
    - Resistance management program?

Review of chemical options for management of Varroa within Australia

- **Satisfy APVMA data requirements**

- **Data needed to support the preferred options**
  - Efficacy & bee safety
    - Extrapolation from OS approved uses
  - Residues
    - Use pattern linked data needed
      - Consumer exposure
      - Wax
  - OH&S
    - User exposure
  - Trade
Review of chemical options for management of Varroa within Australia

• **Co-ordination**

  • How will APVMA permit data requirements be addressed?

    • Sources of information
      • Manufacturers, regulators, researchers, OS contacts
    • Data generation
    • Ongoing liaison

• **Long-term objectives**

  • Progression to registration?
    • Will require manufacturer support

  • Product supply
    • How will supply be managed

  • Integration with existing management systems
7. Des Cannon – Non Chemical Options

Review of non-chemical options for management of Varroa
Points to Consider

- Every country that has gone down the (synthetic) chemical pathway in controlling Varroa has eventually been met with resistant mites
- Every country that has gone down the (synthetic) chemical pathway in controlling Varroa is now experiencing problems with contaminated beeswax, as well as growth of queens and viability of sperm being affected

- The possibility of Australian beekeepers misusing/overusing/abusing these chemicals (in the same way that Americans have) is high, which will lead to the same results and associated problems. The reputation of Australian honey, both domestically and internationally, will be irrevocably damaged
- Many countries are now moving towards organic treatments, physical methods (such as drone culling) and breeding of resistant bees to deal with Varroa
The use of synthetic chemicals
- Props up susceptible colonies
- Does nothing towards breeding resistant bees

At some stage, in order to reduce reliance on chemicals, our bees will have to be exposed to Varroa, in order to develop Varroa-resistant stock

Even if resistant stock from overseas is brought to Australia, the difference in climate may mean the resistant stock is not as effective in Australia as it was in its 'home' climate

Avignon → Germany → Avignon
Breeding and selection programmes are
– difficult and expensive to implement (Europe's program, for example, cost €600K to set up and took 3 years to implement),
– and require an enormous amount of coordinated input (Germany, for example, has 130 queen breeders all working to a common set of selection criteria, with isolated mating conducted on island mating stations)

We must move as quickly as possible to identify resistant stock and set up an effective programme for breeding and distributing this resistant stock

Reality

While I believe it would be in Australia's best long-term interests to survive without chemicals, the reality is that by the time we found resistant bees, bred from them and distributed that stock throughout the industry, there would probably be no industry left.

Therefore, we must aim to minimise the use of chemicals as much as possible (both in absolute terms and in time)
The Options

- Varroa sensitive hygienic behaviour
- Breeding for resistance to Varroa
- Drone brood control
- Screen bottom boards
- Temperature control
- Organic acids
- Biological control
- Pathogen control and Integrated Pest Management

Integrated Pest Management

- The single most important factor is the ability of the beekeeper to accurately count the mite level, and to be dedicated to doing it regularly!

This enables the beekeeper to know

- When to treat
- Whether the treatment was effective
Identified R&D Needs
(from Denis and Mark)

- On arrival of Varroa, *immediately*
  - Test for resistance to known chemicals
  - Instigate widespread educational DIRECTED program/workshops for beekeepers to ensure they do the right thing - meaning
  - treat effectively
  - Rotate chemicals
  - Do not mix ‘homebrews’

Questions?
8. Ben Hooper – Temperature Control to Manage Varroa

• WHAT IS NUFFIELD?
CRITERIA

• Qualify - Self Employed In Agriculture
  - Generally 28 and 40 years of age
  - Have a concept

Focus on Agricultural Production, Innovation and Culture and promotes personal growth in leadership along with a knowledge base in Global Trade and Policy.

THE SCHOLARSHIP

Compulsory 16 weeks abroad

2 weeks international conference of 50 scholars

6 week global focus program

France, Belgium, UK, Ireland, Canada, Texas, China and the Philippines

8 weeks of your own study
My Scholarship

Was Awarded on the Basis I study pest and disease management in the Apiary Industry
With a focus on Cold Storage

The Basic Concept is:

To house hives in a climate controlled environment
a constant temperature of 4°C
for a period of up to 4 – 5 months

• Before I get too far, I would just like you to note that its not an exact science yet.
• Diversity throughout the Australian states
• = no specific management system
What the hell are you thinking!

• 1\textsuperscript{st} reason for considering this is the fact that I'm getting ready to build a new shed with a large cool room.

• 2\textsuperscript{nd} In considering a business expansion one of our limiting factors is sufficient wintering sites.

• 3\textsuperscript{rd} is the sheer inconsistencies in winter condition both weather and flora.

• 4\textsuperscript{th} as a potential tool in the fight against Varroa.

Pre Varroa

• Main aim is Capacity Building

• Running more hive using less resources
Post Varroa

• The Major attribute, is that cold storage will create a significant break in the brood cycle.

• With the main aim of reducing the reliance on synthetic chemical.

• Possibility of climate control for temperature sensitive treatments

• Evaporative cooling system
• Along with solar/refrigerated boost
• With a sprinkler system
• Will Maintain 4° C
Rough Cost

A refrigeration unit to keep a 10mx 10m x 5m at 0°C is around $75 000

Based on 40 year average temperate upper south east

April 21.7
May 18.3
June 15.6
July 14.9
August 16.0

= $3 - 5 per day = $350 - $600 for 4 months

American Experience

• Weight of the colony is essential. The starting weight is generally no less than 35kg
• Currently those using cold storage are only experiencing loses of 5-10%
• With average shed housing 5000 hives
Added benefits

- helps optimise longevity of the queens
- Less moving
- Less wear and tear
- Capacity building / increasing hive numbers
- Reduces reliance on natural resources along with access to public and private land

What needs to be done

- Feasibility study on Power cost as the major difference between practices in the Northern hemisphere and here are that cold storage is used to minimise the cold as here it would have to be induced
- Accuracy on temperature generation and oxygen consumption of a hive would need to be quantified.
**Trials**

- I have enough information to begin.
- The most important element is air flow and with that adequate oxygen.
- Measuring cluster movement. Mats/excluders
- Weight loss
- Nosema levels
- Build up after storage.

**Something to Consider**

- There is a lot of undocumented information out there.
- Naturally occurs in the northern hemisphere
- For minimal use of chemicals this concept as radical as it may seem certainly has merit.
TACTIC / Agri Amitraz

One chemical away from bankruptcy

5 year comb rotation

Randy Oliver

Sue Cobey
Impractical

But a balanced IPM

• Thanks
Non Chemical Control

Options

• Small cell size
• Mesh floor boards
• Drone trapping
• Organics
• Breeding
• Biocontrol
$8 - $32 / hive
Small cell size

Mesh Bottom
Boards
Oxalic Acid

Formic acid
Thymol
Breeding for resistance
Drone Trapping
Biocontrol
Control Isolate A Isolate B Isolate C

Average number of dead varroa

Control | Isolate A | Isolate B | Isolate C

Treatment
Summary

- Small cell size
- Mesh floor boards
- Drone trapping
- Breeding
- Biocontrol
10. Medhat Nasr – Practical IPM for Varroa Management

Beekeepers: Playing it Smart in Challenging Times

Medhat Nasr

In past years, beekeeping conditions were on the brink of industry disaster. Varroa mites were out of control due to resistance to miticides. When beekeepers resorted to formic acid in various formulations it was unable to provide sufficient control because of cold temperatures. When oxalic acid was used, it only killed the mites on bees after irreversible damage had been done to winter bees by Varroa. Moreover, Nosema Ceranae, an internal fungal parasite spread across the province and became a deadly disease for honey bees damaged by Varroa. These unfavorable conditions resulted in a loss of 30% of Alberta’s bee colonies per year for the past three years.

Currently, beekeeping management practices have drastically transformed. From what I’ve seen, beekeepers are beginning to adopt the practice of monitoring their pest populations throughout the year. This enables them to respond immediately to any outbreaks. Several operations are now making educated choices when it comes to what to use for mite and Nosema control. Another trend that I’ve observed is the feeding of bees with pollen supplement and sugar syrup to boost the colony population with healthy bees. On the other end of the spectrum, we have some operations that continue to do what they have been doing for years. They stick Apivar strips in their colonies to control mites without any knowledge of what their mite levels actually are. It will be interesting to see what will result from this practice in the coming years.

The shake-up in the beekeeping industry has come as a result of several positive steps taken by the stakeholders including Alberta Agriculture – Apiculture program, Alberta Beekeepers Commission- Hive Health Committee, Hybrid Canola Pollination companies, private beekeeping operations and major financial support from Alberta Crop Industry Development funds (ACIDF), and Growing Forward- Agriculture Canada. The first positive step was emergency registration of Apivar for immediate use for Varroa control. The second step was establishing a surveillance pest monitoring system to monitor pests and educate beekeepers on how to adopt an integrated pest management system in daily management of their bee colonies. The third step is the evaluation of new miticides and practices for managing Varroa to keep our pest control tool kit ready for the future. This program has allowed Alberta beekeepers to move beyond the big hammer mentality: chemicals, chemicals and more chemicals.

From my mixed experiences, I will try to highlight the smart moves that helped the winners. These lessons should be of interest to all beekeepers including the winners and the losers. It is time to play it smart.

Ten smart moves that have been important factors in meeting the challenges faced by Alberta Beekeepers:

1. Monitor and track pest population.
2. Allow for a comfort range. When monitoring, make decisions to allow you to harvest your honey crop without compromising winter bee health or the need to treat in the middle of the honey flow.
3. Integrate your information with time of the year to manage bee health.
4. Be judicious in using pesticides or medications; since using these treatments means you may affect the quality of your honey and allow pesticide resistance to develop faster.
5. Don’t mess with homemade recipes. It is a recipe for disaster. These concoctions can contaminate your honey and also will allow pesticide resistance to develop faster, which affects not only you but the rest of the industry. Use only registered formulations as needed.
6. Use alternatives to miticides whenever possible to reduce any residues in the hive, environment, and produced honey.
7. Think broadly. While focusing on Varroa and Nosema, don’t forget to look at other diseases such as American Foul Brood (AFB).
8. Schedule and perform regular maintenance of beehives. Reduce residues and disease spores in your hives by replacing brood combs at least once every four years.
9. Think nutrition. Not all bee kill is caused by pests. Starvation can be a serious problem. Pollen supplements and sugar syrup are fuel for increasing productivity.

Look at ways to improve your management skills. Managing a beekeeping operation is in many ways the equivalent of a honey bee queen running a colony. Education is a key to enable beekeepers to learn new skills. End result: beekeepers can anticipate maximum return for their dollar.
LIVING WITH VARROA

Dr. Medhat Nasr
Pest Surveillance Branch
Agriculture Research Division
Alberta Agriculture and Rural Development
Edmonton, AB, Canada

VARROA INVASION TO NORTH AMERICA
HONEY BEE PESTS

- American Foul Brood & rAFB
- Nosema apis Nosema cerana
- 18 known viruses (PMS)
- Tracheal mites
- The small hive beetle
- Chalk brood
- Varroa mites

- Southern Alberta Beekeepers

- Putting the Pieces Together

- Living with Varroa – minimal chemical use options for Australia.
- Building a Sustainable Winning Varroa Mite Control Strategy.
First Option

- Effective
- Simple to apply
- Less dependant on the environment
- Not too many chemicals to alternate
- Please register’em all to give beekeepers a chance to alternate

Chemical Option

BUZZ OFF

IN YOUR' HIVES. OFF YOUR MIND

RESISTANCE MOVEMENT

Chemical War
Treat 'em.......Kill 'em all..
Residues migrate from comb wax into honey

Contaminated cell wall (ppm)
Fluvalinate Residues in Wax Samples from Brood Chambers in Relation to Number of Years (1998)

Fluvalinate Residues (ppm) in Honey and Wax Samples from Ontario (1998)

<table>
<thead>
<tr>
<th>Samples</th>
<th>N</th>
<th>% samples W/residues</th>
<th>Average Residues (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>12</td>
<td>0*</td>
<td>n.d.</td>
</tr>
<tr>
<td>Honey from brood chamber</td>
<td>9</td>
<td>11.1</td>
<td>5 ppb**</td>
</tr>
<tr>
<td>Wax from capping</td>
<td>2</td>
<td>0</td>
<td>&lt;dl</td>
</tr>
<tr>
<td>Wax from combs from honey supers</td>
<td>11</td>
<td>36.4</td>
<td>1.04</td>
</tr>
<tr>
<td>Wax from combs from brood chamber**</td>
<td>12</td>
<td>91.7</td>
<td>2.41***</td>
</tr>
<tr>
<td>Slum gum from honey supers’ combs</td>
<td>12</td>
<td>15.4</td>
<td>0.93</td>
</tr>
<tr>
<td>Slum gum from brood chambers’ combs</td>
<td>12</td>
<td>66.7</td>
<td>4.57</td>
</tr>
<tr>
<td>Control 20 years old Wax</td>
<td>2</td>
<td>0</td>
<td>n.d</td>
</tr>
</tbody>
</table>

* One honey sample had Phosphoester (8 ppb)
** One sample had fluvalinate residues (5ppb) in honey from brood chambers
*** One sample of wax had coumaphos residues (0.7ppm)
<table>
<thead>
<tr>
<th>Samples</th>
<th>N</th>
<th>Coumaphos (PPM)</th>
<th>Fluvainate (PPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>4</td>
<td>5-8</td>
<td>n.d.</td>
</tr>
<tr>
<td>Wax from combs from colonies with falling queens</td>
<td>4</td>
<td>48-52</td>
<td>1-4</td>
</tr>
<tr>
<td>Wax from combs from colonies with non-failing queens</td>
<td>12</td>
<td>24-32</td>
<td>2-6</td>
</tr>
<tr>
<td>Control 20 years old Wax</td>
<td>2</td>
<td>n.d.</td>
<td>n.d.</td>
</tr>
</tbody>
</table>

WHAT HAVE PESTICIDES GOT TO DO WITH IT? (2007 & 2008)

(van Engelsdorp et. al. 2007 & 2008,)
Resistance to CheckMite and Apistan in NJ, 2002

Development of CheckMite Resistant Varroa Mites in ME, FL, and NJ in 2001-2002
Slow spring build up of bee population
Reduced queen cell acceptance and queen development
Decreased sperm viability
Increased queen supersedure
High risk to beekeepers
- Collapse of a control system
- Contamination of the Environment
- Food safety & marketing

SECOND OPTION
Living with Varroa
Long Term Option = Sustainable = IPM
What is IPM?

IPM is the intelligent selection and use of pest management tactics.

IPM Components:

- Monitoring Pest Population
- Action (Tool box)
Monitoring Varroa Population

[Images of individuals and equipment used in monitoring Varroa population]
HAND SHAKER FOR MONITORING VARROA MITES (2008)

ASSOCIATION OF STANDARD LAB SHAKER METHOD TO VARROA HAND SHAKE METHOD (Spring 2009) (0-25% Infestation - Hand shake)

\[ y = 1.4593x \]

\[ R^2 = 0.93 \quad n = 1590 \]
IPM Tool Box:

1. Regulatory methods
2. Genetic methods
3. Cultural methods
4. Physical & mechanical methods
5. Biological Methods
6. Chemical methods
1. Regulatory methods:
   A. Quarantine    B. Eradication

2. Genetic methods:
   - Breeding and use of the available stocks known for resistance

<table>
<thead>
<tr>
<th>Strain</th>
<th>% Removed pupae (Mean ± std error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian</td>
<td>75 ± 3</td>
</tr>
<tr>
<td>Ontario x Russian</td>
<td>73 ± 2</td>
</tr>
<tr>
<td>Russian * Ontario</td>
<td>71 ± 3</td>
</tr>
<tr>
<td>Ontario</td>
<td>53 ± 3</td>
</tr>
</tbody>
</table>
3. Cultural and Physical Methods:
   A. making splits and requeening
   B. Provide suitable winter protection

   A. Drone pupae removal  B. Screen bottom board  C. Others

4. Chemical methods:
   - Smart Chemicals (Miticides):

   Use'em......When you need'em
4. Chemical methods:
   B. Dumb Chemicals:
      1. Essential oils:
         - ApiLife Var
         - Apiguard
         - ThymoVar
         - Exomite

   2. Formic acid:
Optimization of Miticides Use

Varroa-xx - Sublimation of Oxalic Acid for Varro Control
Efficacy of Sublimated OA Using Mitexx: Treatment of Wrapped Hives Fall 2004 in Alberta

Before:  
M=19.08±9.00

After:  
M=1.37±1.42

Efficacy:  
M=93.8±7.4

Dumb Chemicals are effective but they require target practice
Living with Varroa
Low-Risk IPM Program

- Spring
  - 10 mites/24h
  - 3% varroa
  - 10% HBTM
  - (Apistan, CheckMite, or Apivar if needed)
  - Formic acid, Oxalic acid Liquid
  - 2 rounds of drone brood trap removal
    - Splits & replace combs
    - Requeening with queen cells
    - Requeen using mated queens from Resistant stock

- Summer
  - Formic acid
  - (Apistan, CheckMite, Apivar if needed)

- Fall
  - 10 mites/24h
  - 3% varroa
  - 10% HBTM

- Oxalic acid sublimation
Living with Varroa

Cost

Risk

Benefits

Living with Varroa

Think Logically, Safety & Innovation

Southern Alberta Beekeepers
Research Needed to Enhance Non-Chemical Options for Varroa Management

Key Research Outcomes - Pollination Program R&D Advisory Committee Workshop 19 August 2010

Research Themes

- Industry profitability
- Prevention
- Pre-incursion
- Genetics
Industry Profitability

• R&D to improve pollination profitability, efficiency
• Technical advice and support for beekeepers
• Extension to increase beekeeper productivity, profitability and capacity to control Varroa
• Labour saving monitoring of treatments & hive health
• Chemical application tools for non synthetics (organic chemicals)
• Extension to stop the misuse of chemicals – resistance and residues

Prevention

• Strengthen the sentinel hive program
• Test sensitivity of method used on sentinel hives
• Improve Apis cerana capture techniques
• Increase number of bait hives (A. mellifera)
• Remote surveillance of sentinel hives
Pre-Incursion Option Evaluation

• Testing organic and synthetic chemicals
• Testing under Australian conditions
• Ensuring data available for APVMA to provide use permits for Varroa control options
• Bee safety
• Climatic variability
• Suitability Australian long honey flow
• Non target species effects
• Understanding the impacts of viruses spread by Varroa

Genetics

• Identify the bee ‘signal’ that permits Varroa reproduction (Denis)
• Understand bee genotype and host path interactions
• Genetic selection and the breeding of Australian types with international resistant stock (eg Russians)
• Inserting RNA into bees to interfere with Varroa virus RNA