INTRODUCTION

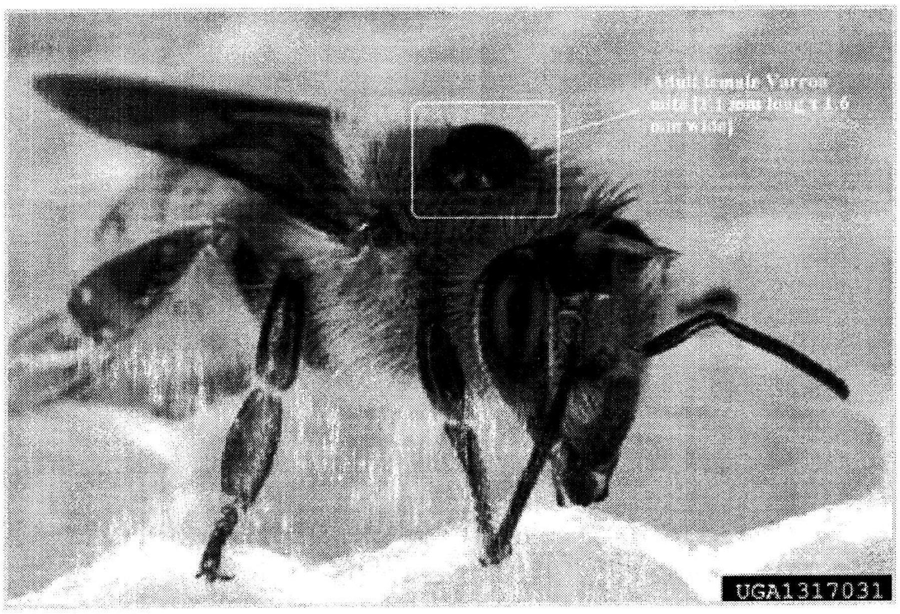
The European honey bee (*Apis mellifera*) makes an important contribution to agricultural production in Australia. The industry produced $90 million of honey and bees wax in 2009–10 (ABARE-BRS, 2010) and provided pollination services to Australian crop industries. Honey bees contribute directly to between $100 million and $1.7 billion of agricultural production a year (Gordon and Davis, 2003). This estimate refers to the pollination benefit to 35 of the most responsive crops to honeybee pollination.[1] If all agriculture is included the estimates may run as high as $4-$6 billion (Thomson, 2007). The broad range of estimates reflects differences in how much crop yield the reports apportion to honey bee pollination (versus pollination by other insects) and how much crop yield is apportioned to other inputs (irrigation, nutrient and pest management) to crop production.

Thanks in part to its geographic isolation, an effective biosecurity system and good fortune, Australia is free of many serious honey bee pests, such as Varroa mite (*Varroa destructor:* Photograph 1).

The parasitic mite, **Varroa destructor*****, is the most detrimental honey bee parasite in the world today. It can safely be assumed that all honey bee colonies within the mite's range harbour Varroa mites. As a consequence of mite infestation, dramatic colony losses have repeatedly occurred in affected countries (vanEnglesdorp and Meixner, 2010).***

Varroa spread worldwide during the 20th century and is regarded as the major threat to beekeeping internationally. In Europe and the US most hives die within three to four years without regular treatments. The need to control the pest has increased the costs of beekeeping and has contributed to a fall in the number of beekeepers, creating problems with crop pollination (Rosenkranz et al., 2010).

A Varroa mite on a honey bee



1 Crops can be pollinated by the wind, insects or other animals. This document pertains to those crop industries that are responsive to pollination by European honey bees and other insects.

(2).

Given the establishment of the most widespread *V. destructor* genotype (K), and that Australian bees are *A. mellifera* M and C branch sub-species, we can expect about 95 to 100 per cent of unmanaged and feral colonies to be killed within three to four years of infestation by Varroa in temperate and Mediterranean areas of Australia. Varroa may be less damaging in tropical and subtropical areas but evidence from scientific literature is conflicting.

THE LIKELY EFFECT OF VARROA ON THE HONEY BEE INDUSTRY

In 2006–07 the Australian honey bee industry comprised about 10 000 registered beekeepers operating 572 000 hives (Crooks, 2008). Around 1700 beekeepers, each operating 50 or more hives, accounted for more than 90 per cent of Australia's honey bee products. The physical and financial characteristics of the commercial Australian honey bee industry (those 1700 beekeepers with 50 or more hives each) are presented in Tables 1 and 2.

Varroa can be effectively controlled by natural and synthetic chemical treatments, husbandry practices and maintaining tolerant bees. However, managing and monitoring hives increases beekeepers' costs, especially labour. New Zealand beekeepers have experienced increased costs of $40 to $50 per colony per year (Monck et al., 2008). Based on this, total cash costs for an average-size Australian beekeeping operation could increase by around 30 per cent, more than halving the cash operating surplus for the average operation, with some small operations operating at a cash loss.

table 1 Physical characteristics of Australian honey bee businesses during 2006–07 (Crooks, 2008)

Size of operation	Number of beekeepers	Proportion of beekeepers	Average number of hives	Proportion of total hives
hives		%		%
50–250	1 023	60	121	24
250–500	340	20	320	21
500–1000	264	16	632	32
More than 1000	74	4	1 592	23
Total	1 701	100	304	100

table 2 Financial performance of Australian honey bee businesses during 2006–07 (Crooks, 2008)

Size of operation hives	Total cash receipts $	Total cash costs $	Cash operating surplus $	Profit at full equity $	Rate of return %
50–250	24 343	19 757	4 587	-24 440	–4.7
250–500	77 375	46 224	31 151	-27 297	–4.4
500–1000	144 199	87 933	56 266	-778	–0.1
More than 1000	412 328	242 654	169 673	49 887	4.8
Average					
304	71 386	45 860	25 526	-17 971	-3.0

③

As well as increased costs, there are likely to be increased financial returns to the honey bee sector from the establishment of Varroa because of:

- **Increased honey yields.** Feral honey bees currently compete with managed honey bees for nectar. Varroa will significantly reduce the number of feral bees and this may lead to increased nectar and honey yields from the managed bees. Yield increases of 25 per cent were reported in New Zealand (Somerville, 2008). This effect may be moderated by competition from *A.cerana*.
- **Increased pollination receipts.** The fall in pollination from feral honey bees will lead more farmers to procure paid pollination services from beekeepers. However, not all honey bee operations in Australia offer pollination services, so not all operations will benefit from increased pollination receipts.

Many hobby and some part-time commercial beekeepers affected by Varroa are likely to stop beekeeping. Varroa led to a 50 per cent reduction in New Zealand beekeepers (MAF, 2007; Somerville, 2008) and a 60 per cent reduction in the United States (Daberkow et al., 2009). On this basis, for the whole of Australia the number of beekeepers to exit the sector may be in the order of 5000 to 6000.[4] Affected beekeepers will be deprived of the pleasure or additional income that hobby or part-time commercial beekeeping gives them.

Larger commercial operations are likely to be less affected by Varroa. The decrease in the number of commercial hives is likely to be small (2 per cent in New Zealand; little change in the United States[5] or Europe; MAF, 2007; Daberkow et al., 2009; Moritz et al., 2010). The number of managed hives in New Zealand and the United States has grown in recent years (although both countries have Varroa), because of the expanding Manuka honey industry in New Zealand (MAF, 2010) and the expanding pollination services industry in the United States (Champetier, 2010).

Other challenges that may indirectly affect the Australian honey bee industry's ability to adjust and manage Varroa include:

- reduced flowering of native vegetation because of drought

  reduced access to floral resources because of government regulation and competing land uses
- other pests and diseases
  - nosema
  - small hive beetle
  - foul brood
  - viruses
- the increasing average age of industry members with fewer trained replacements
- a lack of skills and finance act as barriers to new entrants to the industry.

It is not within the scope of this strategy to address these challenges.

4 Cheaper, more effective and easier-to-apply Varroa management options may reduce this figure.

5 Economic forces were already causing a decline in beekeepers and hive numbers in the United States before the establishment of Varroa. The rate of decline in hive numbers was not increased by Varroa (vanEngelsdorp and Meixner, 2010).

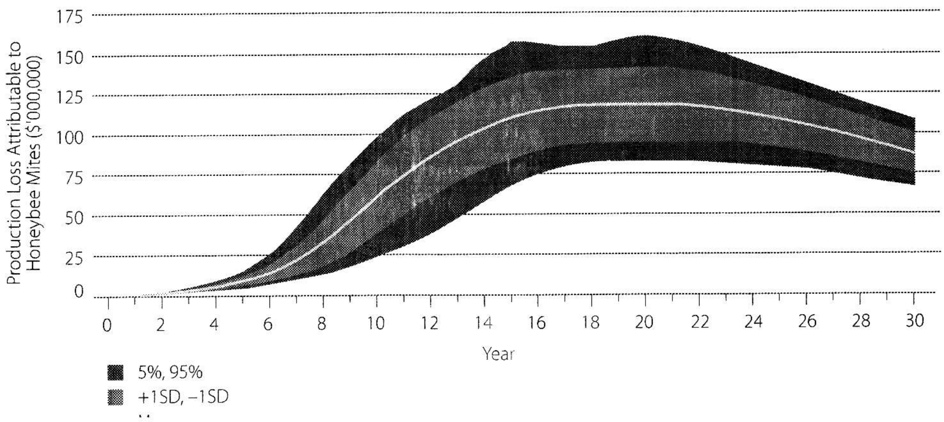
The likely effect of Varroa on crop industries

The impact that Varroa destructor *naturalisation would have on the delivery of pollination services in Australia is expected to be particularly severe (Cook et al., 2007).*

Varroa's likely effect on Australia's crop industries cannot be directly inferred from overseas experience: there are few reports from other countries on falls in crop pollination or yield caused by Varroa. Instead of direct observations, economic models are used to estimate the range or magnitude of possible effects on crop industries. These models include assumptions about the proportion of crop yield attributable to feral honey bees, the efficacy and cost of replacing feral honey bees with commercial pollination services and the rate of Varroa spread.

Figure 3 presents the outcome of one approach to modelling the impact of Varroa on Australia's crop industries (Cook et al., 2007; Barry et al., 2010). Losses to 25 pollination-dependent plant industries over the next 30 years are presented, including potential yield losses and cost increases because of the need to purchase commercial pollination services. These are expected losses in the sense that they reflect that Australia is currently (i.e. year 0) free of honeybee mites, including Varroa.[6] It assumes a likelihood of entry and establishment of 20–70 per cent per annum. Losses are expected to peak at around $115 million per year, but may exceed $135 million. On average, annual losses over the 30-year period simulated by the model were around $70 million (Barry et al., 2010).

figure 3 Estimated loss of plant industry production (decrease yields and higher input costs) over time attributable to honey bee mite incursion, establishment and spread (Barry et al., 2010[7])



Although it is difficult to accurately predict incursion scenarios, the model anticipates a gradual spread of the honey bee mites through feral honey bee colonies over the first two to five years, before accelerating rapidly and spreading throughout Australia[8] within about 10 to 15 years of their introduction. Owing to the nature of the Varroa mite it is likely to be some time (10 to 24 months) after it enters Australia before it is detected (Barry et al., 2010), decreasing the amount of time for industry to adapt after the initial discovery.

6 Cook (et al., 2007) modelled the economic impact of a *V. destructor* incursion. Barry (et al.,2010) modelled the economic impact of a honey bee mite (*V. destructor; V. jacobsoni* and *Tropilaelaps*) incursion; but the model is largely unchanged from Cook et al., 2007.

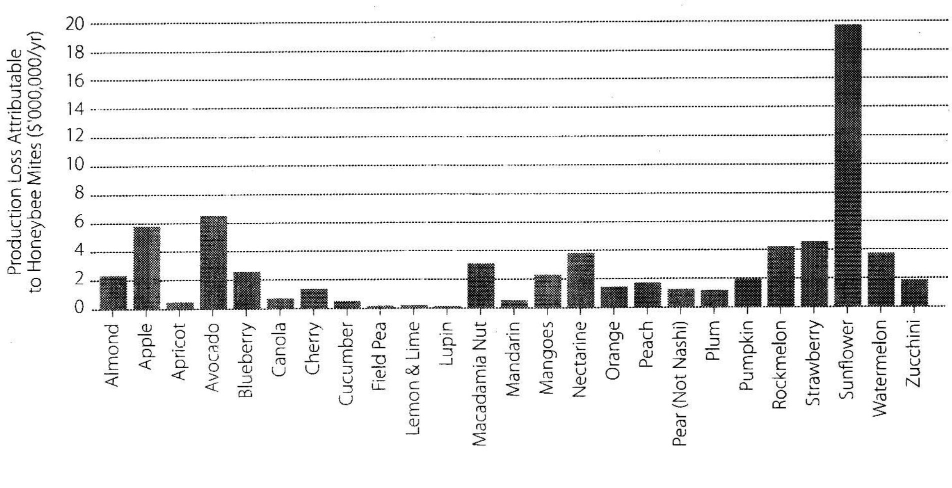
7 Refer also to Cook et al., 2007 for additional details about the modelling methodology.

8 The spatial spread model does not take into account natural barriers to spread in Australia, such as Bass Strait or the Simpson Desert.

A number of horticultural industries will incur losses from Varroa (figure 4). Following a fall in feral honey bee numbers, horticulturalists who do not already use commercial pollination services are likely to start using them (Monck et al., 2008). Hive rental fees range from $60 to $120 a hive and stocking rates between three and five hives per hectare; total crop pollination costs are in the range of $180–$600 a hectare. Increased demand may drive pollination hive rental costs higher shortly after the establishment of Varroa (Monck et al., 2008). Nevertheless, in most high-value horticultural crop industries these costs are a relatively small proportion of the total costs (fixed + overhead) per hectare. These extra costs may be offset through benefits from using pollination services including increased product yield and quality, or lengthening the economic life of tree crops (Monck et al., 2008).

The losses to broadacre oilseed and grain legume crops from Varroa are likely to be small (figure 4). Estimated average losses to lupins and field peas from Varroa are negligible, and amount to around $600 000 a year for the canola industry (Barry et al., 2010). Modern hybrid sunflower varieties grown in Australia are largely self-pollinating (Serafin et al., 2010) and as a result of this, costs to the sunflower industry are likely to be much smaller than suggested by the analysis of Barry et al., 2010 (figure 4). Producers of these crops are unlikely to be major purchasers of commercial pollination services as the benefit of paid pollination services will be much lower than for horticultural crops—in most cases this will be too low to warrant paid pollination services (Monck et al., 2008).

figure 4 Estimated annual costs to selected crop industries from the establishment of Varroa in Australia averaged over the 30-year period presented in Figure 3[9,10] (Barry et al., 2010)



In considering the costs of Varroa to New Zealand agriculture, the NZ Ministry of Agriculture and Forestry (MAF) suggested that the pastoral industry would face significant costs. These costs would arise from the need to apply more nitrogen fertiliser and clover seed to mitigate the falling clover content in pastures in the absence of feral honey bee pollination (MAF, 2000). It will take a decade for any affects of Varroa on clover productivity to appear because of clover's ability to vegetatively reproduce and its large seed bank in the soil. Effects are not yet apparent in New Zealand. Pastures were not included in the model used by Barry (et al., 2010).

9 The estimated annual costs are based in part on 2004 Australian Bureau of Statistics crop area data. Crops areas are likely to be different now. In particular, the almond industry, a large user of paid pollination services, has grown substantially since 2004.

10 Modern sunflower hybrids are largely self-pollinating and, as a result, the costs to the sunflower industry are likely to be much less than reported by Barry et al., 2010.