

Analyzing Beekeeping in Aotearoa New Zealand: Changes in Climate, Calendars, and Culture

Responses from New Zealand Beekeepers to Three CALENDARS Questions

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Responses from New Zealand Beekeepers to Three CALENDARS Questions:

1. What climate change indicators and vulnerabilities are reported?

Direct effects of climate change, including increased rainfall and warmer temperatures, create uncertainty and vulnerability for beekeepers. The shift in seasons and inconsistency in temperatures make it nearly impossible for beekeepers to plan around natural events. Due to increases in the severity of extreme storms, such as Cyclone Gabriel, beekeepers must reevaluate safe apiary locations rather than relying on past benchmarks (Foster, 2023, p. 6). This is a difficult adjustment, considering many beekeepers rely on previous knowledge from what has been successful in the past. Without the past as guidance, beekeepers can only take an educated guess of what environments will be safe, leaving their hives vulnerable to future climate disasters.

Beekeepers Report Climate Change Vulnerabilities and Indicators

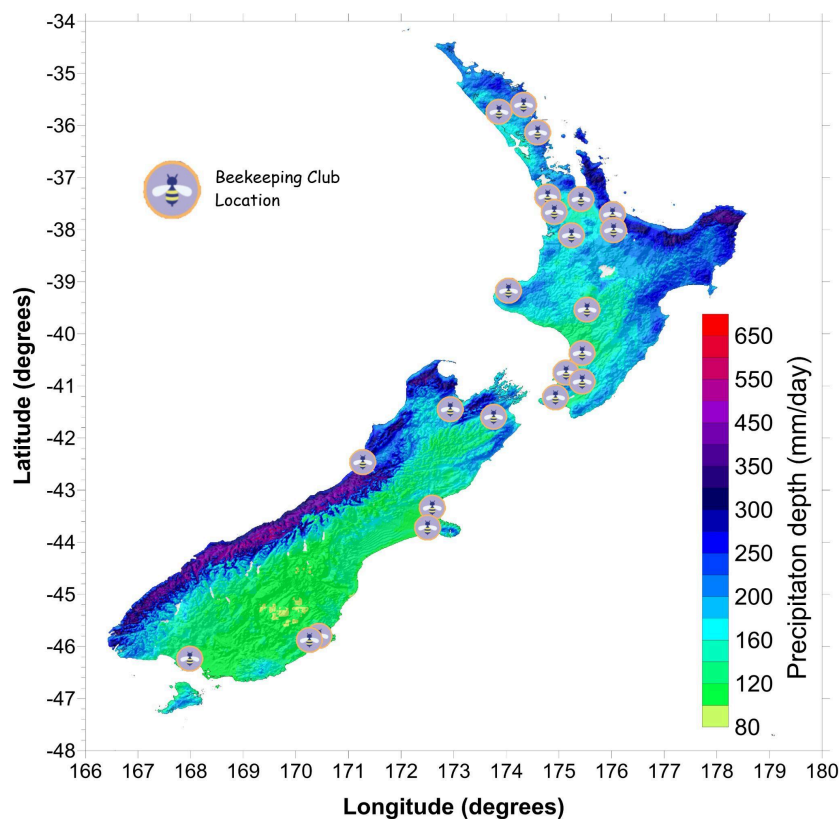
Warmer Temperature as an Indicator

Many beekeepers are experiencing changes in weather that echo climate change science. New Zealand has experienced a warming trend and record heat over the past decade. Beekeepers have noticed this temperature increase, including Steve Heal, a hobbyist North Island beekeeper, who noted that “The winters have been warmer.” Six out of nine Wellington Beekeeping Association Conference hand-drawn calendar participants experienced a warmer winter as well. Experienced beekeepers, such as Frank Lindsay, a 50-year beekeeper from Wellington, are increasingly concerned with this trend, as he stated, “Last year was so warm” and that “it was just so warm.” These changes influence beekeeping practices, as increased heat results in flowering throughout winter. Continued flowering causes bees to remain active and require feeding during the winter period. Unfortunately, this shift can result in beekeepers missing feeding windows, including Frank Lindsay who lost six hives due to this shift. Increased heat can even lead to flowering being shifted by years, as some biannually flowering species are now flowering every fourth year instead of every second year. This shift affects the foraging resources available to honeybees and can create temporal and recognition mismatches, in which bees do not know when to look for certain species.

Increased Precipitation as an Indicator

Climate change has a direct effect on precipitation intensity and frequency which can influence bees and beekeeping. In interviews, hand-drawn calendars, and Calendar Tool submissions, many key informants noted increases in rainfall that were out of the ordinary. Carlos Zevallos, Head of Apiary Development for Comvita New Zealand, explained that he observed “double the normal amount of rain” last year in his region. From the hand-drawn calendars we received at the Wellington Beekeeping Association conference, Michele Vandaalen, an Upper Hutt hobbyist beekeeper, made note that “last year was very wet.” This makes it more difficult for beekeepers to do inspections because the bees do not leave the hive as much due to the rainfall. This leads to many problems for beekeepers especially for the checking and treating of Varroa mites. Similarly, another hand-drawn calendar from hobbyist beekeepers Jill Dalton and Jim Hepburn stated that they had gotten “lots of rain” in Porirua, which was unusual for their area. They also supported the idea that this made inspections more difficult and increased the threat of Varroa mites in hives. In addition, this increase in rainfall causes losses in honey, as rain dilutes nectar on flowers and plants leaving bees with nothing to harvest. This phenomenon was further confirmed by Karin Kos, chief executive of Apiculture NZ, as a critical threat affecting beekeepers. She described it as a “lack of nectar” due to “rain washing it away”, which is detrimental to beekeepers’ honey yields.

Rainfall is just one of the many climate indicators that the beekeeping industry has been increasingly aware of and many beekeepers are at risk due to increased rain and flooding. In the below overlay of beekeeping club locations and precipitation depth changes, each purple circle represents a beekeeping club location in New Zealand. The beekeepers in these clubs may be at risk of increased rain and flooding due to climate change as evident by the precipitation depth values. Increased rain poses a significant vulnerability to beekeepers by altering the important beekeeping events of Varroa mite treatment and honey harvest, threatening both the health of the beehive and livelihood of the beekeeper.



Overlay of beekeeping club locations in New Zealand on a map of precipitation depth (Bird et al., 2023; Design & Harasym, 2022).

Severe Storms as an Indicator

Storms and flooding are also disrupting beekeeping practices due to the increased severity of extreme weather. A notable instance was Cyclone Gabrielle in February 2023. Gisborne beekeeper Barry Foster, former president of the National Beekeepers Association, told us that six months before the cyclone, he sold a site of hives to a friend. These hives were later wiped out by flooding from Cyclone Gabrielle. Foster explained, “This was a site I’d been on for at least 20 odd years. I’d spoken to the farmer, and I thought it was a safe site. It was high enough above a creek. There was no indication that it would flood. Well, 27 hives disappeared overnight.” Foster also recalled that same site being completely safe from Cyclone Bola in 1988. Dr. Michelle Taylor, research scientist at NZ Plant & Food Research, shared similar concerns with inclement weather increasing the risk of flooding in stating that, “having your hives next to a stream is not a great idea anymore.” This theme of vulnerable hive locations is corroborated by

Wellington beekeeper Frank Lindsay with over 50 years of experience. He shared that, “we in the south of the North Island have experienced three massive storms in the last year. The last one causing slips and mud to the extent that some hives could only be seen by the straps on the lids.” Flooding and storms are a severe threat to beekeepers, as the increase in the severity of extreme weather-related events has made areas that were not affected by previous events, such as Cyclone Bola in 1988, no longer safe (Foster, 2023). Beekeepers are increasingly vulnerable to dangerous climatic events and are facing uncertainty as a result.

Beekeepers Adapting in the Face of Climate Change

Some beekeepers are attempting to eliminate unpredictability. As Carlos Zevallos, Head of Apiary Development at Comvita, explained, “We still have the challenges due to climate changes. But we have to adjust. We have to adjust management, routine, our program, our plan. It needs to be adjusted according to what we are having.” Carlos Zevallos and Comvita are aware of the challenges presented by climate change and have been proactive in taking steps to avoid the negative effects of it. Comvita has begun to “record data every year on how the temperature is fluctuating during the season.” They then “review [it] every year and see what is going to happen in the following year.” This attempt to counteract vulnerabilities is an innovative adaptation and may eliminate some of the uncertainty caused by climate change.

Additional Climate Change Indicator Quotes

Speaker	Title	Location
Barry Foster	Retired Commercial Beekeeper	Gisborne
Quote 1: “If there is one stark lesson for all beekeepers in New Zealand ... it is that past benchmarks on where it is safe to locate apiaries no longer apply.”		
Dr. Michelle Taylor	Research scientist at NZ Plant & Food Research	Te Puke
Quote 1: “It’s flowering too early. It’s kind of out of balance.”		
Carlos Zevallos	Head of Apiary Development Comvita	Hamilton

Quote 1: “What we used to do in the past, we cannot do anymore. We need to adjust to what the weather is bringing us. Now it’s unpredictable.”

Quote 2: “We still have the challenges due to climate changes. But we have to adjust. We have to adjust management, routine, our program, our plan. It needs to be adjusted according to what we are having.”

Quote 3: “Years ago, we knew exactly where the honey flow kicked off. Now its unpredictable.”

Dave Henderson	Hobbyist Beekeeper	Wellington
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Quote 1: “Warmer winters mean I need to treat for Varroa at least twice per year instead of once.”

Janine Davis	Hobbyist Beekeeper	Porirua
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Quote 1: “Over the past few years the winters have been milder (warmer) than in previous years. This has resulted in brood being in the hives all through the year.”

2. How have beekeeping practices and technological tools that support beekeeping changed?

Numerous beekeepers indicated a technological intervention and then related it to a change in practice. This structure shows the interconnection between technological advancements and changes in beekeeping practices.

Varroa Mites are Forcing Beekeepers to Adapt New Technologies

One of the most significant changes in New Zealand and global beekeeping industries is the threat of *Varroa destructor* to bees. Varroa mite specialists and beekeepers alike agree that it is currently the most prominent issue in the industry. As Dr. Phil Lester, a Varroa mite researcher at Victoria University in Wellington put it, “Varroa is probably the biggest problem facing the bee industry around the world.” Beekeepers have been looking at different ways to deal with this growing issue, including increasing the use of both synthetic and organic treatments. The use of oxalic acid “10 years ago was very seldom used, but now it's becoming one of the more common approaches to Varroa management.” Oxalic acid is an organic treatment for Varroa mite that can

be used year-round at a relatively cheap cost (Rod, 2022). Beekeepers are having to treat more frequently and oftentimes with multiple treatment types in order to effectively reduce the Varroa mite populations in their hives.

Research surrounding *Varroa destructor* has increased and new treatment technologies are emerging as a result. Dr. Phil Lester is currently researching “double-stranded RNA” and “gene splicing”, which uses dsRNA sequences that target reproductive genes in the Varroa mites. It is not harmful to the host or the parasite and prevents Varroa mites from reproducing, but the effects are not permanent. Hence additional research would be necessary to make it an effective treatment for Varroa mites (*Using RNAi to Control Varroa Mites*, 2023). Beekeeper Frank Lindsay also explained a new method of taking “60-second or 30-second recordings using [artificial intelligence (AI)] to determine the level of mites and [American foulbrood]” in the hive. This technology, which is still in the research phase, would use images and videos of the hive along with an AI algorithm to measure the amount of Varroa mites and AFB present in the hive (Kaur, 2021). Rae Butler, a queen breeder with more than 25 years of experience, has grown accustomed to these changes and stated “I always say beekeeping used to be an art, but now it's more of a science.” As Varroa mites and other disease-causing organisms continue to pose a major threat to beekeepers, many are turning to research and science to better understand these issues and adjust their practices accordingly.

Mānuka Honey Influences Beekeeping Practices

Research and economic gain associated with Mānuka has greatly altered the beekeeping landscape in New Zealand. According to Bill McDonald, owner of Bee Fresh Farms, “The biggest technological change that's happened in my time has been the invention of Mānuka honey and the research behind it.” This not only changed the industry and economics of honey in New Zealand, but it also changed the practices of commercial beekeepers. They began incorporating migrational beekeeping practices into their routine in order to move their hives closer to the Mānuka plants. Rae Butler, a queen breeder with more than 25 years of experience, estimated that “75% of the [commercial] beekeepers do migrational” beekeeping, moving their hives to maximize their production and sale of Mānuka honey due to its high market value. This idea was echoed by Karin Kos, the Chief Executive of Apiculture New Zealand, who mentioned that once Mānuka honey became very profitable, it became commonplace for commercial

beekeepers to relocate to areas that were best for Mānuka honey. As research on the beneficial properties of this specialty honey and the demand for it increased, beekeepers moved their hives closer to Mānuka dense locations. This had not previously been the case before the boom in the Mānuka honey industry. This practice also highlights the different practices of hobbyists and commercial keepers, as only commercial keepers practice migrational beekeeping.

Changes in Farming Technologies Disrupt Honey Production

Another technological change noted by honeybee queen breeder Rae Butler was about how changes to farming practices influence beekeeping. Butler explained that farmers' shifting to sprinkler irrigation systems was the most significant technological change she had seen in beekeeping. The increased amount of water washes the nectar off of flowers and plants and decreases honey production, similar to the effects of increased rainfall washing away nectar. While not a change to beekeeping technology specifically, beekeepers need to be aware of farming practices as the change in farming technology directly influences honey production.

All of these changes draw attention to the ever-changing landscape of beekeeping; beekeepers must adjust to threats with interventions and new technology for their practices.

Additional Technology and Practices Quotes

Speaker	Title	Location
Rae Butler	Bee Smart Queen Breeder	Ashburton
<p>Quote 1: “We then had to understand more about the lifecycle, the whole dynamics of the hive and how it has interacted with the mites.”</p> <p>Quote 2: “The biggest change is with farming. Farmers don’t grow as much clover.”</p> <p>Quote 3: “The biggest change is with farmers changing to irrigation systems. Everything’s wetter, so nothing’s yielding as much honey.”</p>		
Alastair Little	Hobbyist Beekeeper	Auckland
<p>Quote 1: “Before Mānuka was valuable, it was considered a rubbish honey.”</p>		

3. What is the future outlook for beekeeping as described now by beekeepers?

Diseases and Pathogens Present a Threat to Beekeepers

The future of beekeeping contains increasing challenges for beekeepers. The biggest threat to beekeepers worldwide is *Varroa destructor*, as almost all honeybee colony losses in New Zealand, apart from starvation, can be credited to Varroa mites (*New Zealand Colony Loss Survey*, 2022). In addition, Tropilaelaps mites, currently found across Asia and in Papua New Guinea, are a looming threat.

Two species of Tropilaelaps mites (*Tropilaelaps clareae* and *Tropilaelaps mercedesae*) can parasitize honey bees. Tropilaelaps mite infestation causes severe damage to honey bee colonies such as deformed pupae and in adults (stunted and damaged wings, legs, and abdomens), parasitic mite syndrome (PMS), and colony decline. The colony may also swarm, further spreading the mite to new locations. Tropilaelaps mites can also spread viruses which influence the colony's health and disease susceptibility. (*Tropilaelaps Mites «Bee Aware*, 2020). This parasite is a vector similar to Varroa mites but spreads much faster through brood rather than staying on the bees themselves. (*Tropilaelaps mites: What Are Tropilaelaps Mites?*, 2022). Beekeepers in New Zealand are worried that these mites will eventually spread to New Zealand, and if they did, it would be “absolutely devastating” for honeybee populations (Barry Foster, personal communication, January 30, 2024). While harder to detect than Varroa mites, many of the treatments effective in treating Varroa mites also work for Tropilaelaps mites. Tropilaelaps mites can only survive for 48 hours without food or bee brood cells to feed off. Their spread to New Zealand can ideally be prevented if beekeepers wait 48 hours before introducing imported bees to their colony (*Tropilaelaps | Bee Culture*, 2023).

There Are Mixed Opinions on the Future of New Zealand Beekeeping

There are mixed attitudes in the beekeeping community towards what lies ahead, but one thing is consistent: New Zealand needs to have bees. Some people “don't think there's a sense of optimism in the beekeeping community in New Zealand at the moment” because of the threat of Varroa mite (Dr. Phil Lester, personal communication, January 19, 2024). Others are very confident that the future “is bright. And we're always gonna say that because New Zealanders

tend to be a find-a-way people. We may lose some colonies in the interim, but we will find a way. We need to have bees” (Dr. Michelle Taylor, personal communication, January 25, 2024). Human life would be greatly hindered without bees due to the wide range of plants they pollinate.

Others viewed this question more pragmatically, thinking of proactive ways the beekeeping community can advance in modern society and a changing environmental landscape. CEO of Bee Fresh Farms, Bill McDonald is wondering, “What else can you do with honey? What are the other products you can use it for? How can we find more and more rather than it just being a commodity? So I think we have to find ways to be smarter.” Considering other avenues will help beekeepers adapt to an ever-changing industry.

Additional Outlook Quotes

Speaker	Title	Location
Rae Butler	Bee Smart Queen Breeder	Ashburton
<p>Quote 1: “At the moment, honey prices are too low and it's unsustainable for beekeepers because technology costs money. I think it's going to do a bit of a dive, there's going to be less and less beekeepers. But I think the ones that are able to survive, like hopefully the ones that embrace new research and everything, they will survive.”</p> <p>Quote 2: “And then we're dependent on how farmers irrigate. So the biggest change for beekeeping, I would say, is with farmers chain changing to irrigation systems.”</p> <p>Quote 3: “But what's happening now is that changing, farmers don't grow as much clover. They're growing other crops. And they're bought in irrigation systems. And so everything's wetter, so nothing's yielding as much honey.”</p>		
Alastair Little	Hobbyist Beekeeper	Auckland
<p>Quote 1: “It'll keep going. But just with a lot less hives. It'll balance itself out eventually. But there's going to be a bit of tragic sort of stories in the meantime.”</p>		
Dr. Michelle Taylor	Research scientist at NZ Plant & Food Research	Te Puke
<p>Quote 1: “We need to have bees because otherwise I really don't want to be eating, you know, wind pollinated foods. I really like fruit. And other vegetables that require bee pollination.”</p>		

Frank Lindsay	Hobbyist Beekeeper	Wellington
Quote 1: “Another couple of years and then we'll be back to normal.”		
Barry Foster	Retired Commercial Beekeeper	Gisborne
Quote 1: “We vitally need them, so there's no question about that.”		
Quote 2: “Yes, there are some significant challenges out there in the future. And yeah, it does worry me a bit.”		