



The
Mānuka
& **Kānuka**
Plantation Guide

April 2017

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PREFACE

Across New Zealand, there is strong interest in growing mānuka (*Leptospermum scoparium*) and kānuka (*Kunzea* species) to diversify or supplement farm incomes, or as a new primary income. Along with environmental benefits, landowners are considering the potential for mānuka and kānuka to generate income from honey or oil production. These products have unique and highly valued properties, so the potential income can be substantial. Income can also be earned from other sources such as carbon credits and regional councils may provide funding assistance for new plantations, especially for conversion of erosion-prone land. However, there are many variables that determine the income actually achieved and the highly publicised revenues may not materialise if a site does not have the right conditions.

Mānuka and kānuka are fast-growing, robust plants ubiquitous in scrub, shrublands and forest margins throughout the North Island, and thrive in almost all land types from geothermal areas and wetlands, to dunes and dry hill slopes. While mānuka is the smaller and shorter lived of the two, both will ultimately be overtaken by native forest after fulfilling their role as a colonising plant.

Mānuka and kānuka have a long history of a wide range of practical and medicinal uses. These uses have ultimately led to extensive research into the bioactive compounds present in oil and honey. Only mānuka has the bioactive component in its nectar that produces the Unique Mānuka Factor (UMF®) and most research to date has focused on mānuka and mānuka honey.

Producing mānuka honey requires a plantation site and flowering season with specific conditions to maximise bee foraging and limit nectar dilution, while maintaining hive health. Plantation sites that are large, north facing, with a moderate climate during flowering, will achieve the best results. Plantations without these characteristics, however, may achieve poor results or fail to produce mānuka honey at all.

Both kānuka and mānuka produce oil with valued bioactive compounds. While the plantation characteristics required for producing oil are simply good access for harvesting, highly specialised equipment and training are needed for oil distillation.

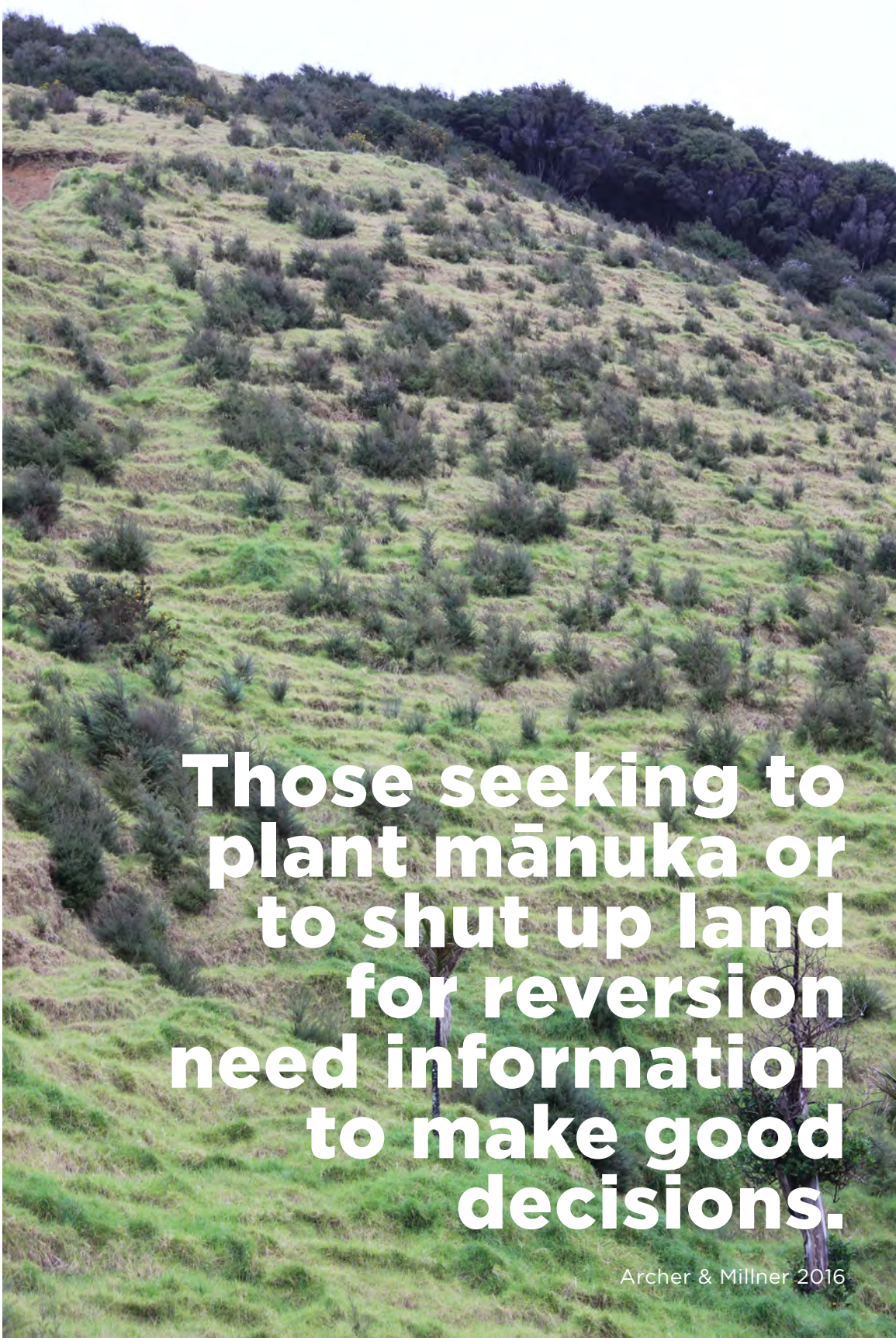
Despite the uncertainties with oil and honey production, the increased pollination activity of the numerous insect species that use mānuka and kānuka as habitat is a notable benefit to productive land. Making up for the limitations of honey bee pollination, pasture and crop productivity improvements can be substantial. Mānuka and kānuka plantations also produce notable environmental gains, harbouring some of New Zealand's greatest biodiversity in rural landscapes, effectively reducing erosion, and providing numerous benefits for streams.



Although mānuka and kānuka are among our best known, most hardy, and most easily grown plants, establishing a plantation that generates mānuka honey income or income from oil requires the right conditions. Like any other crop, landowners must carefully consider the characteristics of the plantation site, as well as the requirements for planting, management, harvesting, and plant life span. Of crucial importance are the regulatory controls on activities such as vegetation clearance. Establishing a mānuka or kānuka plantation in the right conditions does present a worthwhile revenue opportunity; in the wrong conditions, it presents a significant risk of financial losses. If the business case for plantation establishment is marginal, landowners can also factor into their decision-making the range of environmental benefits.

To assist with the business case for plantation establishment, this Guide provides objective, market-verified information on the factors affecting performance, costs, and revenues for small plantations (generally 50ha or less). To prepare the Guide, we reviewed literature from a wide range of sources. More importantly, though, we interviewed people with current real-world experience in the industry. This included nursery growers, planting contractors, oil producers, beekeepers, honey producers, landowners, and plantation managers. Their combined knowledge and experience, along with industry insights, has given us the basis for delivering an objective guidance document to assist landowners with decision making.

The following sections describe plant characteristics (including how to tell them apart!), honey production, oil production, other important benefits of plantations, plantation establishment techniques, and long term maintenance considerations. The Appendix condenses the information from each section into a series of questions to ask as you build a business case and move towards decision making. The purpose of the Guide is to provide information on the factors that affect plantation performance and yield, but landowners must bear in mind that every site is unique. Seek information, data, and answers specific to your site to ensure that you have an accurate understanding of costs, a realistic timeframe for generating revenue, and a conservative estimate of income.



**Those seeking to
plant mānuka or
to shut up land
for reversion
need information
to make good
decisions.**

Archer & Millner 2016

1. HISTORY AND USES

Ever since people arrived in New Zealand, mānuka and kānuka have been used for a wide variety of purposes, perhaps the most diverse set of uses of any New Zealand plant.

Māori referred to mānuka and kānuka collectively as mānuka but recognised the differing properties of each. They used the wood for tools, weapons, hunting, and building, and bark for water containers, water proofing, and dye. Seedlings and branches were used to capture freshwater crayfish (koura).

Mānuka was used to brew tea and beer (with rimu) by explorers and early settlers. Settlers also used mānuka and kānuka branches as brooms, splints for broken bones, fencing, and tool handles. The larger kānuka timbers were also used for wagon wheel spokes and posts.

The timber of both is known as a long burning firewood producing a fragrant smoke and the sawdust is prized for infusing flavours into smoked game and fish.

Extracts of mānuka and kānuka were well known for their medicinal properties, including as an intestinal worming medicine and as an antibacterial poultice. Māori and early settlers used kānuka shoots, seed capsules, bark, ash, and gum to cure a range of bacterial, viral, and inflammatory ailments. New Zealand's native parakeet, the kakariki, chews mānuka and kānuka leaves and then preens itself, indicating a specific anti-parasitic and anti-worming function.

Although traditionally reviled by farmers as an invasive weed, these historic and cultural uses have stimulated scientific research into the beneficial properties of mānuka and kānuka, and how those properties can be extracted for use by people.

This research has culminated in the mānuka honey industry and the development of health support, medicinal, nutraceutical, and cosmetic products using mānuka and kānuka extracts. Today the bioactive components of mānuka and kānuka are better understood, but there is much more to be discovered about these important New Zealand species.

2. PLANT DESCRIPTIONS

Mānuka and kānuka are ubiquitous New Zealand tree species, found throughout the country from the coast to subalpine forests. Both are successful colonising plants, with large numbers of seedlings establishing rapidly and covering large land areas. Currently the North Island has over 720,000ha of vegetation cover classified as mānuka/kānuka, which is 6% of the total land area.

As the plants grow, mānuka and kānuka seedlings become a scrub or shrub layer, which self-thins and opens up as weaker and smaller plants die. The resulting gaps in the scrub canopy allow seedlings of other successional species to establish and grow within the scrub cover. Mānuka and kānuka therefore perform an important revegetation function as a nursery crop for the establishing native forest, persisting decades until forest species take over.

Mature specimens of both species can become a permanent part of the forest canopy in some places, sometimes as a stunted canopy where there is little or no topsoil. However, mānuka and kānuka are more common as scrub species colonising disturbed ground. Seedlings establish rapidly after fire, slips, or earthworks where they stabilise bare soils and start the forest regeneration process.

Mānuka and kānuka also establish in pasture, especially on low producing hill country grasslands, because livestock prefer not to eat the seedlings. However, because they are unpalatable to stock, the persistent re-growth of scrub in pasture is regarded as a major weed control problem in parts of the North Island.

2.1 MĀNUKA

Mānuka is a very common shrub or small tree, found throughout New Zealand including off shore islands, Stewart Island, Chatham Islands, and in Australia. Its scientific name is *Leptospermum scoparium* and it comes from the Myrtle family. Mānuka is tolerant of almost all growing conditions including the harshest wetlands, geothermal areas, dry exposed ridges, coastlines, and sub-alpine forest.

Mānuka seedlings do not tolerate shade, and grow better on wet soils and low-fertility soils than kānuka. It is common in wetlands (including swamps, peat bogs, and salt marshes), lake margins, exposed sites, high altitudes, and areas with high annual rainfall. Stunted mānuka will even colonise sites with little or no topsoil, where only lichen and moss grows, and does better on stony soils compared to kānuka.

On harsh sites, mānuka can form permanent shrublands where other native plants cannot survive. On better soils, mānuka is often one of the first colonising plants, later outcompeted by taller native plants including kānuka.

Although recent mānuka varieties bred for the home gardener have larger and more colourful flowers (typically red and pink), mānuka flowers are naturally small and white. Only the North Cape variety is slightly pink at the base of the petals. In its natural setting, mānuka flowers prolifically and from an early age, with seedlings as small as 5cm producing flowers and setting seed.

Flowering season is relatively short, usually 6 to 12 weeks (and often less) between September and March. The timing and length of flowering varies between regions and between seasons, and cold wet weather can delay its onset. Flowering commences in September or October in Northland. However, in Taranaki, the flowering season does not commence until late December or early January and usually lasts less than six weeks. Mānuka seed capsules release seeds en masse after fire, but more usually burst when dry and the light seed is distributed by the wind.

Mature mānuka is relatively short-lived, with a life span of 30 to 60 years. It is usually succeeded by forest species because the seed requires high light for germination. It cannot germinate in the low light

environment under the canopy of the dying parent or emerging forest. The mature height of mānuka varies considerably depending on the site, with mature plants in harsh conditions having a shorter stature than plants in sheltered, favourable sites. The typical mature height is 4-8m.

2.2 KĀNUKA

Found almost throughout New Zealand and in parts of Australia, kānuka also comes from the Myrtle family. The scientific name of kānuka was *Leptospermum ericoides* until 1983 when Australian botanists reclassified it as *Kunzea ericoides* based on flower and seed capsule differences.

In 2014, kānuka was divided into 10 distinct species of which four are relatively common in the North Island. The other species are confined to specific locations (e.g. Whale, Great Barrier or Three Kings Islands) or environments (geothermal areas or active sand dunes). The same species differentiation will eventually occur for mānuka, and the differences between species are already recognised by mānuka specialists in differing growth forms and leaf characteristics.

Like mānuka, kānuka is a common species occupying a variety of conditions and does not tolerate shade. It grows best on soils of moderate-to-good natural fertility and drainage where it out-competes mānuka. Unlike mānuka, kānuka is not found in south Westland and southern districts of the South Island, and does not tolerate wet soils or sub-alpine areas.

When colonising bare ground, kānuka tends to do better on fine silty soils compared to mānuka. Because kānuka seed is destroyed by fire, it does not proliferate after fire as mānuka does. However, kānuka is taller and longer-lived than mānuka, to at least 160 years and possibly as old as 300-400 years. As for mānuka, the mature height of kānuka depends on the site conditions. The typical mature height is around 15m.

Where they establish together, kānuka outcompetes mānuka after around 20 years when its canopy begins to shade the shorter mānuka. By the time a mixed mānuka/kānuka stand is 40 years old, the stand will contain almost no mānuka.

PLATE 2: MATURE WAIKATO KĀNUKA STAND

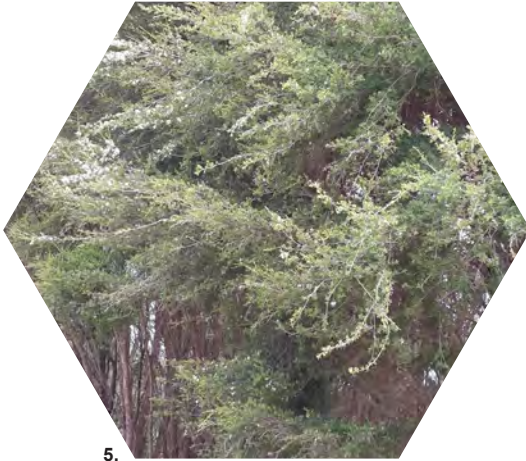




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IDENTIFICATION

To the untrained eye, kānuka and mānuka appear very similar. They are, however, very different and the distinguishing features are set out below. At a distance, the easiest way to distinguish the two species is whether or not seed capsules are present. Mānuka tends to carry capsules all year round, whereas kānuka only has seed capsules immediately after flowering.

2.2.1 LEAVES

- Kānuka has small narrow parallel-sided leaves several times longer than wide. The foliage is soft to the touch. Mānuka leaves are generally larger and more ovoid but sharp-pointed ('lanceolate'). The foliage feels harsher and more prickly to the touch.
- The foliage colour of both plants varies with the seasons and regionally. Kānuka foliage tends to be olive-green, whereas mānuka foliage tends to be grey-green and darker. However, this distinction may be subtle or non-existent depending on the season and plant age.

PLATE 3: KĀNUKA FOLIAGE IS NARROW, LONG, AND SOFT

PLATE 4: MĀNUKA FOLIAGE IS MORE "OVOID" WITH A SHARP POINT

PLATE 5: KĀNUKA FOLIAGE IS OLIVE GREEN

2.2.2 BARK AND WOOD

- Kānuka bark is a light brown and comprised of long narrow strips. Mānuka bark is darker with a reddish tinge, comprised of thin flakes that are wider and less regular than kānuka bark.
- The bark of mānuka branches often have a covering of sooty mould (which thrives on the sugary excretion of an introduced scale insect). Sooty mould is less common on kānuka.
- Historically kānuka was known as white tea tree and mānuka as red tea tree. This refers to the colour of the freshly cut wood colour which is pinkish in mānuka compared with the white wood of kānuka.



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PLATE 6: MĀNUKA BARK

PLATE 7: KĀNUKA BARK

PLATE 8: KĀNUKA SAPLINGS AFTER CANOPY CLOSURE



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11.

PLATE 9: MĀNUKA HAS BRIGHT WHITE SINGLE FLOWERS THAT ARE LARGE COMPARED TO THE LEAF SIZE

PLATE 10: KĀNUKA HAS CREAMY WHITE FLOWERS IN CLUSTERS THAT ARE SMALL COMPARED TO LEAVES

PLATE 11: KĀNUKA FLOWER CLUSTERS

PLATE 12: MĀNUKA FLOWERS SCATTERED OVER THE PLANT

PLATE 13: KĀNUKA FLOWER CYMES

2.2.3 FLOWERS

- Kānuka flowers are 4-5mm across, creamy white in colour, with stamens that are longer than the petals. Mānuka flowers are 10-12mm across and generally pure white, except the North Cape variety that has a pink-red tinge.
- Kānuka flowers are carried in dense long clusters (or 'cymes') on branchlets whereas mānuka flowers are more evenly scattered over the plant as single flowers.
- Kānuka usually flowers once a year only, from late spring to midsummer (September to February), but most strongly from December onwards. Mānuka flowers strongly earlier than kānuka, most prolifically in late spring (October/November), and irregularly throughout the year.
- Kānuka flowers are fragrant compared to mānuka flowers which have little or no fragrance.



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2.2.4 SEED

- Kānuka seed capsules are soft, not woody, 2-3 millimetres across and carried on branches in late summer after flowering. The capsules with their seeds are shed in autumn.
- Mānuka has a hard woody seed capsule 5-6 millimetres across which stays on the plant for a year or more after flowering. Mānuka plants usually carry seed capsules of various ages throughout the year.

PLATE 14: KĀNUKA YOUNG SEED CAPSULES

PLATE 15: KĀNUKA MATURE SEED CAPSULES

PLATE 16: MĀNUKA YOUNG SEED CAPSULES

PLATE 17: MĀNUKA MATURE SEED CAPSULES

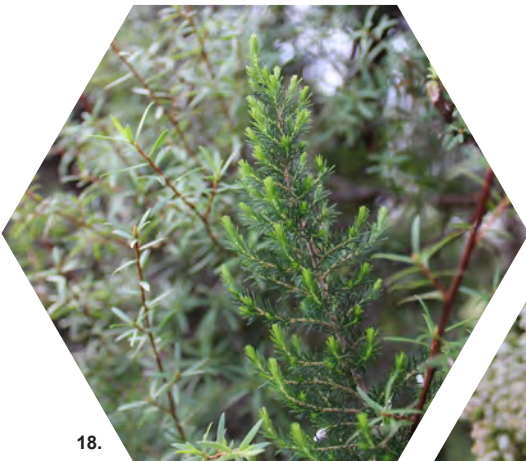
2.2.5 GROWTH

- Kānuka generally has slightly faster growth rates and reaches a larger size, compared to mānuka.
- The growth forms of kānuka and mānuka are slightly different. Kānuka has more droopy branchlets compared with more erect mānuka. However, growth form varies with site, stand density, altitude, exposure, and tree age.

2.2.6 OTHER SPECIES

Kānuka and mānuka may sometimes be confused for Spanish heather (*Erica lusitanica*) when young, because of heather's fine foliage. However, the flowers and plant appearance are very different when viewed together.

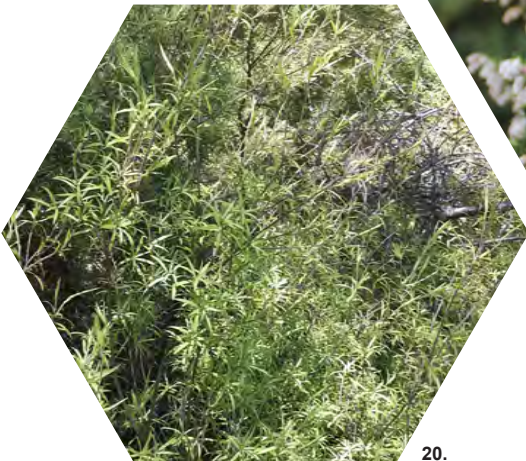
Likewise, mānuka and kānuka can be confused for mingimingi because of their superficially similar foliage. Mingimingi remains a shrub of 2-5m tall with non-flaking bark. Compared with mānuka and kānuka, its long foliage is very soft and delicate, and dull yellow-green in colour.



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PLATE 18: SPANISH HEATHER (MIDDLE) AND MĀNUKA SEEDLING

PLATE 19: SPANISH HEATHER FLOWERS

PLATE 20: MINGIMINGI FOLIAGE



PLATE 21: MĀNUKA
SEEDLINGS CAN ESTABLISH
WITHOUT TOPSOIL

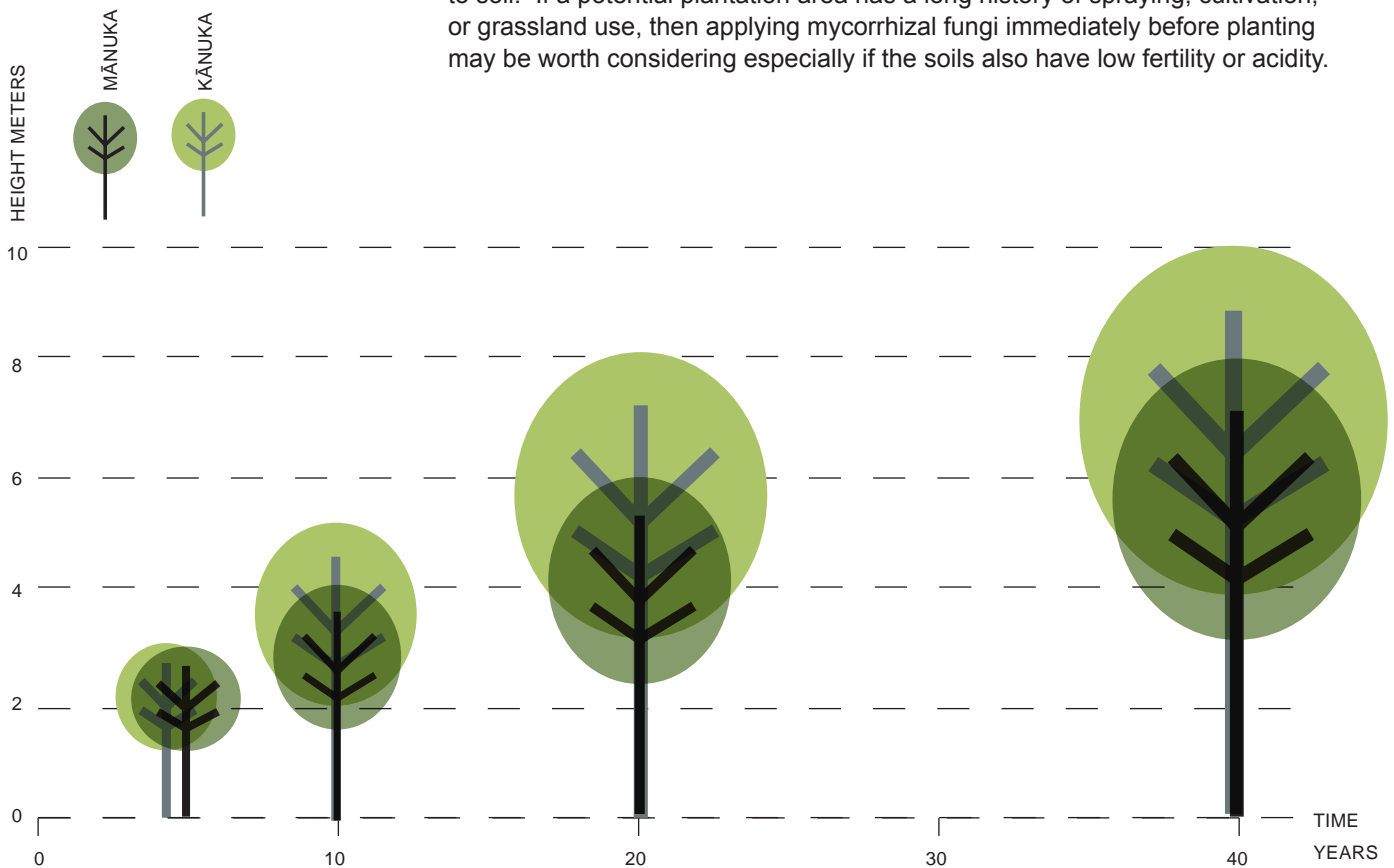
2.3 GROWTH FACTORS

For both mānuka and kānuka, the most important factors in plant growth recognised by industry specialists and plantation managers are:

- **Sunlight:** Both species need full sunlight to germinate seed and for seedling growth, as the tiny seed has few internal reserves. Plantation managers and planting contractors note that seedlings grow faster on warm north facing slopes.
- **Climate:** Mean annual temperature and rainfall determine the speed of seedling growth, but the seedlings can germinate and grow in an extremely wide range of conditions. Both species have woody roots that make them drought tolerant.
- **Frosts:** Once established, both species can withstand hard frosts and snow. However, young seedlings can be stunted or killed by a series of very heavy frosts that kill growing tips.
- **Wind:** Both species are highly tolerant of wind, including salt spray, and will form contorted shapes as a result of wind shear. In extreme and persistent conditions, wind may affect growth rates where growing tips are regularly desiccated by wind and flowering may also be affected. However, plants at the leading edge of the plantation can provide sufficient shelter for down-wind plants, reducing wind effects through the interior of the plantation.
- **Soil fertility:** Both species are highly tolerant of low soil fertility (i.e. amount of plant nutrients in soil), although kānuka will outcompete mānuka in soils with higher fertility and vice versa. The seed of both plants will even germinate and grow in the absence of soil (e.g. rock crevices).

However, both species grow faster in moderately to highly fertile soil compared to poor soils, and plant growth can be stunted in very poor soils.

- Soil pH (acidity):** Both species are tolerant of soils ranging from alkaline to acidic. Mānuka is more tolerant of acidic soils than kānuka, especially acidic wetland soils, although growth rates may be slow. However, soils with near neutral pH have the most diverse and abundant microbiological and invertebrate communities, and the best soil chemistry, which enhances soil structure and maximises nutrient availability. As a result, both species grow fastest in near-neutral soils.
- Soil drainage:** Both plants have varieties found only in wetland soils and varieties found only in sand dunes. While both plants can grow in a wide range of drainage conditions, unless the seedling cultivar is known to be adapted to such soil drainage extremes, plant survival and vigour is likely to be poor in these land types. In general, the commonly available cultivars will grow best in well drained soils.
- Soil fungi:** A less obvious growth factor is the presence of mycorrhizal fungi in soil which facilitates and/or increases plant uptake of nutrients. Almost all New Zealand plants, including mānuka and kānuka, have a symbiotic relationship with fungi so the absence of fungi at a site may impact on plant growth. Mycorrhizal fungi are a natural and important component of forest soils, but are often sparse in grassland soils and absent in soils that have been repeatedly cultivated or sprayed with herbicides. Kānuka and mānuka growth and uptake of plant nutrients has been shown to be improved by adding mycorrhizal fungi to soil. If a potential plantation area has a long history of spraying, cultivation, or grassland use, then applying mycorrhizal fungi immediately before planting may be worth considering especially if the soils also have low fertility or acidity.



2.4 GROWTH RATES

When establishing naturally from seed at high density, mānuka and kānuka plants have single spindly naked stems that grow rapidly up to 8.0m tall as a competitive response to outgrow the surrounding plants. On very exposed or wet sterile sites, both plants have prostrate or creeping mat forms to cope with the harsh conditions. Plantation seedlings are not subjected to these conditions.

For plantation with planted seedlings, there is very little difference in the growth rate of mānuka and kānuka, and both are fast growing in favourable conditions. For 300-400mm tall seedlings planted at 1.5-3.0m spacing, initial growth rates are often 600-700mm per year. That results in 1.0m plants at Year 1 after planting and 1.5m plants at Year 2 after planting. This rate of growth is experienced in sheltered sites with high soil fertility, whereas exposed sites with poor soils typically experience slower growth of 400-500mm per year. However, plant height is not as important as plant vigour (bushiness and health) when establishing a plantation for productive uses.

At typical seedling growth rates, the increase in plant spread is 150-300mm² per year in Year 1. This doubles in the second and subsequent years, resulting in canopy spread of around 900mm² at Year 2. If seedlings are planted at 1.0m spacings, this growth rate will result in canopy closure in Year 3 after planting. By Year 4-5, plant canopy spread will typically extend to 2.0m diameter.

In warm temperate conditions, mānuka has rapid growth (average of 410mm/yr, maximum of 470mm/yr) continues for the first ten years and then decreases over time (300mm/yr at 30yrs, 210mm/yr at 40yrs). A healthy mānuka plant will be around 3.0m tall at 4-5 years old, 4.0m tall at 10 years old, 6.0m tall at 20 years old, and 8.0-10.0m at 40 years old if it has not been outcompeted by forest species.

Kānuka also grows rapidly in warm temperate conditions, (average of 460mm/yr, maximum of 560mm/yr). This continues for the first ten years and decreases over time (350mm/yr at 30yrs, 220mm/yr at 40yrs). Like mānuka, growth records vary considerably. A healthy kānuka plant will be around 5-6m tall at 10-12 years old, 7m tall at 20 years old, 8-12m tall at 30-40 years old. Fully mature kānuka commonly grows to 15m tall and sometimes as tall as 20m, and very old specimens (300-400 years old) have been measured at close to 25m tall with 1m diameter trunks.

Based on the data above, the graph on the facing page shows the approximate growth rates for both species.

FOR QUESTIONS TO ASK ABOUT PLANT GROWTH, SEE THE APPENDIX.



3. HONEY PRODUCTION

Honey made from nectar mainly from one plant species is referred to as monofloral honey. Honey made from many nectar sources is multifloral honey. To produce mānuka honey of commercial quality, bees must have obtained most of their nectar from mānuka flowers. Honey is made from the nectar collected from flowers by bees. Bees remove most of the water from nectar and add enzymes that change the nectar's sugar composition and create acids. These acids contribute special properties which mean that all honey has a healing action for wounds and infections. This fact has been known and documented since ancient times, and the medicinal use of honey is not a new phenomenon. Honey's wound healing, antibacterial, and antifungal properties come from its low pH (acidity), low water action, and a chemical called hydrogen peroxide. Honey also encourages the body's own healing processes by stimulating the immune system and healing for wounds or infections.

Hydrogen peroxide, the main antibacterial component of honey, is formed by an enzyme called glucose oxidase which comes from the bees themselves. However, glucose oxidase is not stable and can be degraded by light and heat. Hydrogen peroxide can also be broken down by another enzyme called catalase which comes from pollen. As a result, the beneficial healing properties of honey resulting from hydrogen peroxide can be unreliable.



3.1 MĀNUKA HONEY

3.1.1 UNIQUE MĀNUKA FACTOR® = MGO

In the 1950s, researchers discovered that antibacterial activity remained in some honeys even when hydrogen peroxide had been removed. Attention began to be focused on mānuka honey and the mysterious non-peroxide antibacterial action that was labelled Unique Mānuka Factor or UMF®. It wasn't until 2008 that researchers identified that the UMF® measured in mānuka honey came from a chemical called methylglyoxal (MGO), which is not usually present in honey from other plants. MGO has also been found in the honey from Australian *Leptospermum* species, but honey from any other genus is yet to yield MGO.

MGO is created from a component of mānuka nectar called dihydroxyacetone (DHA). DHA is slowly converted to MGO during honey maturation. To optimise the conversion process and maximise the amount of MGO, mānuka honey is stored at a constant temperature of around 22-37°C over a period of 12-22 months. After reaching their peak during honey maturation, both DHA and MGO decrease in mānuka honey over time so managing honey storage to maintain MGO levels is therefore very important.

The level of DHA in mānuka nectar usually determines the level of MGO in mānuka honey. Mānuka nectar with low DHA cannot produce honey with high MGO, and mānuka nectar with high DHA is more likely to produce honey with high MGO. However, the conversion of DHA to MGO is not certain and research into influencing factors is ongoing.

Mānuka honey is marketed on the amount of UMF® or MGO present, with high UMF®/MGO honey being sold for premium prices for consumption or medical use. As a result, the goal of honey producers is to source mānuka with high DHA nectar. Much plant research and breeding is currently focused on identifying and propagating mānuka cultivars with high levels of DHA, greater nectar volumes, and more flowers. Plant selection objectives do not currently include plant lifespan, vigour, or adaptability to different environments.

Although it has not been quantified, industry specialists and plantation managers have identified a potential relationship between soil characteristics and DHA content in mānuka nectar. Soils with low fertility and low (acidic) pH may increase nectar DHA content. However, these same characteristics also impact plant growth rates. Temperature may also influence DHA content. Mānuka from Northland and Eastern Bay of Plenty typically has nectar with higher DHA than elsewhere.

Regardless of nectar DHA content, the biggest influence on honey MGO content is how much mānuka nectar has been diluted by nectar from other plants. To have sufficient MGO activity, bees must obtain most of their nectar from mānuka. The highest grade medicinal honey has extremely high MGO levels meaning the hive sourced its nectar almost exclusively from high DHA mānuka flowers.

3.1.2 OTHER BIOACTIVE COMPOUNDS

Hydrogen peroxide and MGO are not the only components of honey that produce health or medicinal benefits. Phenolic compounds exert a strong anti-inflammatory action and are found in a wide range of honeys. The investigation of kānuka honey use for inflammatory health conditions such as rosacea is yielding positive results. There is also ongoing research into bioactive compounds such as antioxidants, lysozyme, polyphenols, flavonoids, and peptides with potential to deliver health or medicinal benefits unique to both mānuka and kānuka honeys.

Other native plants with known medicinal benefits (for instance, rongoa plants used by Maori such as kawakawa) may also yield honey with unique properties. If new biologically active constituents in honeys from New Zealand native plants are identified as being beneficial for a wider range of human and animal health problems, then the honey industry could benefit from diversification across species that would moderate the uncertainties experienced by landowners relying on mānuka honey alone.

3.1.3 MĀNUKA HONEY GOLD RUSH

New Zealand's mānuka honey exports were worth \$285 million in 2015, a significant increase on the previous year. The high value of the product, its popularity worldwide, and rapidly increasing demand have led to problems in the fledgling industry. There has been controversy over fake product imported into Europe, concern over measurement, standardisation and labelling of MGO levels, and bee hive theft, vandalism, and "poaching" of honey from hives on mānuka blocks. Industry commentators and interviewees have likened the fledgling mānuka honey industry to a "gold rush".

This is a situation similar to other new primary production industries widely promoted at their inception for their income potential, such as deer, goats, emus, alpacas, kiwifruit, and blueberries. Although the unregulated activity of early industry development is eventually reined in as the industry matures, regulation is developed, and markets are established, early entrants to the Mānuka honey market must be wary of the gold rush mentality and extravagant income claims.

The Ministry for Primary Industries Science Programme is developing a science-based definition for mono-floral mānuka honey. That definition will form the basis for industry regulation of mānuka honey labelling and allow verification of mānuka honey exports. New regulations for hive management may also rein in some of the currently questionable practices identified by industry specialists.



PLATE 22: HONEY BEES
PERFORM ESSENTIAL
SERVICES FOR THE RURAL
ECONOMY

3.2 HONEY BEES

European honey bees (*Apis mellifera*) perform two essential services to our rural economy: pollination of crops and pasture, and honey production. They share pollination services with numerous wild insect species but are unique in their ability to produce honey in large enough quantities for harvesting.

As well as a suitable hive, bees need three resources to stay healthy and produce honey: water, nectar, and pollen.

If any of these essentials is missing, hives will have low honey yields and may become diseased. Nectar is a source of carbohydrates and micronutrients, while pollen provides high energy fats, protein and minerals. Pollen with a high protein content provides bees with high quality energy sources for foraging, but neither kānuka nor mānuka pollen is particularly high in protein.

The foraging area around the hive can extend out to more than 5km. Within that range, bees choose which plants they get nectar and pollen from, and have preferences for some plants over others. Experienced apiculturalists (beekeepers) confirm that mānuka is not a favourite of bees and if the hive foraging area has flowers they prefer, bees will obtain nectar from those flowers as well as, or instead of, mānuka. Since bees need both nectar and pollen, they will also seek flowers with high protein pollen sources to supplement the low-protein mānuka pollen. When the hive has a pollen deficit, pollen foraging will occur to the detriment of nectar foraging.

As a result, the MGO content of the resulting honey can be reduced or diluted. If the dilution of mānuka nectar is high, the resulting honey may become a multi-floral honey. Industry specialists and plantation managers agree that this is one of the most important factors in the success of a plantation in producing mānuka honey. The ease with which bees can obtain nectar from sources other than mānuka determines the size of plantation needed to produce monofloral mānuka honey.



NZ
BUSH

3.3 NECTAR SOURCES

In the New Zealand rural landscape, popular flowers for bees include clover, gorse, and seasonal NZ bush species. In horticultural areas, bees will take advantage of flowers in orchards and market gardens.

Near urban areas, bees have an array of garden flowers to choose from with blue/purple flowers such as lavender, borage, and rosemary being favourites.



PLATE 23: HONEY BEES FORAGING IN AN APPLE ORCHARD

PLATE 24: HONEY BEE ON ROSEMARY IN AN URBAN GARDEN



ODU
HCNE



PLATE 26: BEES WILL BYPASS MĀNUKA IF CLOVER IS AVAILABLE

In the Waikato, clover dominated pastures are one of the most common vegetation types. In hill country, gorse is also very common. Both clover and gorse are easily accessible alternative nectar and pollen sources for bees. As a result, the minimum plantation size required to achieve monofloral mānuka honey in much of the rural North Island is >40ha, a size which makes it less likely that bees will fly beyond the plantation boundaries. The experience of some plantation managers is that even 40ha is insufficient, and plantations areas >50ha are needed before hives can produce monofloral mānuka honey especially if surrounded by clover and gorse.

At >40-50ha, bees from hives located at the centre of the plantation are less likely to fly outside the plantation to find non-mānuka nectar. Even then, if hive placement is too close to alternative nectar sources and there are no physical barriers to bee foraging outside the plantation, production of high MGO honey may not occur. Likewise, if the plantation site is long and narrow or fragmented, bee foraging outside the plantation is likely. Some plantation managers suggest that intensive grazing of adjacent clover and ryegrass pastures during the mānuka flowering season may reduce the impact of mānuka nectar dilution, but there is no data to verify the effectiveness of this strategy.

The kikuyu-dominated pasture of Northland, northern Waikato Region, Coromandel Peninsula, and Bay of Plenty produces a dense sward leaving little space for clover or herbaceous flowering plants (e.g. dandelion) unless intensely managed. If other nectar sources (e.g. gorse) are also limited or there are physical barriers, plantation managers suggest monofloral mānuka honey may be successfully produced from 20-30ha mānuka plantations in these locations.

Anecdotal evidence suggests that physical barriers such as hills, shelter belts, or large water bodies may limit bee foraging outside a plantation. There is currently no verifiable data on the effectiveness of these barriers (e.g. effective shelterbelt height, width, or density).

Isolated small mānuka plantations located within a *Pinus radiata* plantation have been known to produce monofloral mānuka honey. Plantation managers surmise this is because bees prefer mānuka nectar to pines and are physically isolated from non-mānuka nectar sources by the pine plantation. These physical characteristics are likely to be relatively rare in the North Island's highly productive rural landscape, and such small sites may become unviable for monofloral mānuka honey as soon as the pines are harvested.

Generally, industry specialists and plantation managers agree that landowners with mānuka plantations less than around 40ha are unlikely to produce mono-floral mānuka honey with sufficient MGO content to achieve premium prices. Unless the site has a significant physical, topographical, or botanical barriers to bee movement, plantations of 40ha or less are more likely to produce multi-floral honey or a monofloral mānuka honey with low MGO content.

PLATE 25: HONEY BEES FORAGE OVER LARGE AREAS WHEN CONDITIONS ALLOW

3.4 BEE FORAGING ACTIVITY

Hive honey yield (and crop pollination) varies widely due to a wide range of climatic factors affecting bee activity. Honey bees can forage at temperatures above 10°C and up to 43°C, with most foraging activity occurring in the temperature range of 18-30°C. Optimal bee foraging conditions vary from place to place in conjunction with humidity and wind conditions. Honey bees generally do not forage in high humidity. Cloudiness can also reduce flight activity due to low light.

However, given New Zealand's generally temperate climate, the principal limitations on bee activity are rain and wind which can severely curtail foraging.

Bees will not leave the hive on rainy days and foraging is limited at wind speeds above 20-30kph. As wind speed increases from still conditions, the number of bees foraging decreases and foraging behaviour may change such that bees only visit flowers close to the hive, in sheltered areas, or in certain directions. In windy conditions, bees expend more energy in flight, reduce foraging, and consume more nectar.

The impact of wind and rain is not limited to bee activity. Strong winds can injure flowers by stripping petals and causing pollen loss. Rain dilutes or washes off nectar which takes several days to be replenished.

When windy, cold, and rainy weather coincides with the mānuka flowering season, honey yields can be heavily impacted. This is not limited to mānuka honey, as evidenced across New Zealand in 2016/17 when the volume of all honey types was only 25-50% of normal volumes due to a high number of windy, wet, and cold days during the spring/summer season.

Although temperature and rain cannot be controlled, lower wind speeds could be achieved through careful orientation and placement of shelterbelts around and within mānuka plantations if the topography is suitable. However, this requires careful design to ensure that placement does not adversely affect other factors such as shade and temperature.

There are also factors relating to the bee colony itself that affect nectar foraging and therefore honey yield. These include the colony strength, brood rearing, pollen status, and disease. The impact of insecticide spray drift may be a consideration in some areas (for instance near market gardens and crops), as can competition from wasps.



PLATE 27: HONEY BEES FORAGE ON A RANGE OF PASTURE SPECIES INCLUDING DANDELION

3.5 HONEY YIELDS

In New Zealand, honey yields generally range from 25-35kg per hive per year on average, with high variability between years. Mānuka honey yields are equally variable, ranging from 15-52kg per hive per season, with an average of around 23kg per hive. Mānuka honey yield generally occurs from Year 3 after planting and reaches its maximum at Year 6 after planting. Unless mānuka trees are specifically managed to maintain flowering vegetation (e.g. by trimming), flowering naturally decreases from around Year 9 or 10 as the plant matures with a defined trunk, overhead canopy, and fewer flowers. Without vegetation management, honey incomes are generally limited to Year 3 to Year 15, with maximum yields at Years 6 and 7 following planting. However, the effectiveness of vegetation trimming at maintaining flower numbers as plants age has not been verified, so honey yield reduction may be an unavoidable consequence of plantation age.

It is important to note that reported hive yields vary significantly between regions. Eastern Bay of Plenty generally has low yields of 15-16kg per hive, with 20kg/year considered to be exceptional. Likewise Northland hives have low yields of around 20kg/year. Taranaki hives have yields around the average of 23-25kg. By contrast hives in Waikato plantations typically deliver 35kg per hive in a normal year and up to 50kg/year in drought conditions. The highest recorded North Island hive yields are from the Whanganui at up to 60kg/yr.

As noted (see Bee Foraging), hive yield can be severely impacted if adverse weather conditions occur during the flowering season. Every day of rain, cold, or high winds over the short mānuka flowering season results in lost production. Northland is particularly prone to this because flowering occurs from September to mid-October, so honey yields from Northland plantations are typically lower. Conversely Taranaki, Whanganui and Wairarapa hives have consistently high yields because mānuka flowering coincides with more settled, drier weather in early summer.

The impact of colony pests and diseases, such as American foul brood and the varroa mite infestation which was widely felt throughout the honey industry, can also be severe and requires careful management (see Managing Beehives).

Industry best practice is typically to allocate one hive per hectare of mānuka plantation. Plantations of some mānuka cultivars are reported to support two hives per hectare. However, there is no data to verify whether increasing hive density increases total honey yield or whether hives produce proportionally less honey and total yield is unchanged. Some plantation managers observe that greater hive density contributes to poorer hive health and lower honey yield. They speculate that the increased competition from a greater number of bees in the same area means there is less nectar resource available for each hive and/or bees have to travel further to find nectar, consuming more nectar for flight and leaving less available for honey production.

The increase in domestic beehives (i.e. beehives owned by enthusiasts and individuals for non-commercial use) and unregistered movement of commercial hives also impact on the nectar and pollen resources available for hives within a plantation if they compete for resources.

“Boundary stacking” or “boundary riding” is a controversial practice whereby commercial hives are placed immediately adjacent to a plantation on neighbouring land, competing with hives inside the plantation for mānuka nectar and (anecdotally) reducing honey yields. These impacts have not yet been quantified but beekeepers observe honey volume reductions when boundary riding occurs. Likewise reports of hive and honey theft have received increasing publicity in recent years and may present a risk to honey yields in some areas.

FOR QUESTIONS TO ASK ABOUT MĀNUKA HONEY POTENTIAL, SEE THE APPENDIX.



PLATE 28: UNDERSTANDING THE ROLE OF BEEKEEPERS IN HIVE MANAGEMENT IS IMPORTANT

IMAGE:
RUSSEL STREET ON FLICKR
BEEHIVES
KAINGAROA FOREST

3.6 MANAGING BEEHIVES

The scope of this Guide does not include technical detail of apiculture (beekeeping). Managing beehives is a time-consuming occupation in its own right. Rather than owning and managing hives, most plantations have a contract with a beekeeper to provide hives during the flowering season. However, an understanding of some aspects of hive management is useful in maximising the success of a plantation. And understanding the integral role of beekeepers in generating honey income will highlight the importance of establishing and maintaining good business relationships.

Purchasing beehives with the box and starter bees for a colony can cost as much as \$1,100 per hive, while operational costs are generally \$250-\$350 per hive per year although this can increase with remote hive sites. In addition to this, beekeepers require specialist equipment and training to manage and maintain the hives year round for honey production and pollination services.

Beekeepers are also legally required to manage hives and beekeeping equipment to reduce the spread of American Foul Brood (AFB), a highly persistent bacterial disease of bee larvae that spreads rapidly and destroys hives. Under the Biosecurity Act 1993, all beekeepers, their hives, and apiary sites must be registered and beekeepers pay levies to MPI for government surveillance and regulatory programmes. There are ongoing legal obligations for registering hive movements, maintaining and inspecting hives and equipment, and dealing with AFB. In 2015/16, reported incidents of AFB occurred throughout the North Island, including all major mānuka and kānuka growing areas.

The impact of AFB and other hive diseases such as varroa mite infestation on hives can be devastating. As a plantation manager or owner, ensuring that beekeepers contracted to provide hives are registered and meeting their



Biosecurity Act obligations is an important step in managing honey incomes long term.

As well as disease management, honey bees need ongoing sources of high quality nectar and pollen, so hives must have access to or be moved to other floral sources when mānuka and kānuka flowering ceases. It is crucial to hive health that overstocking does not occur. If bees have limited floral resources available, they will focus on the most attractive flowers. This means that greater numbers of bees will visit the favoured flowers within the foraging area, potentially leading to hive malnutrition and disease. However, there are informative websites advocating planting tree species to provide year-round food resources for bees and other pollinators (type *Trees for Bees nz* into an internet search engine).

In addition to this, hives may need supplementary feed in winter when food resources are scarce and temperature or weather prevent bee foraging. Feeding hives sugar water as a food source every few days is a significant outlay of time and resources to maintain colony health until spring to ensure that bees are well fed and ready to forage when mānuka and kānuka flowering starts. Ensuring that multiple flowering sources are available throughout the year can therefore be a large saving in hive management costs.

Plantation managers can assist beekeepers by planting pollen rich species and winter-flowering species around hive site margins to reduce the need for winter feeding or hive movement. Appropriate native species include five-finger (*Pseudopanax arboreus*), flax (*Phormium* species), cabbage tree (*Cordyline australis*), and lemonwood (*Pittosporum eugenoides*). Appropriate exotic species include tree lucerne (palmensis), apple (*Malus* species), oak (*Quercus* species), maple (*Acer tataricum*), and flowering ash (*Fraxinus ornus*).

Experienced beekeepers know which site characteristics influence hives performance and yield, and understand that hive positioning impacts directly on colony health. Warm, sheltered, north-facing sites have a notable



PLATE 29: HIVES ON WARM, SHELTERED, NORTH FACING SITES TEND TO PERFORM BEST

advantage over cooler south-facing sites and exposed sites for hive health and honey production. Site aspect is one of the key factors in determining hive performance.

The other important aspects of hive placement include position relative to plantation boundaries to minimise mānuka nectar dilution, access to water, and access to hive maintenance and honey harvesting.

Registered hive numbers are increasing rapidly in New Zealand, with a 53% increase in the five years to 2015. The lucrative mānuka honey market and short flowering season have greater numbers of beekeepers moving hives outside their local area, following the mānuka flowering season and placing greater pressure on limited nectar resources. Because of the implications of hive overstocking for colony health and reduced honey yields for local landowners and beekeepers, there are increasing calls for hive movements and stocking rates to be regulated.

3.7 HONEY CONTRACTS

If a landowner or plantation manager chooses not to own hives, contractual arrangements with beekeepers are required to supply hives. The contract can be on the basis of a royalty or percentage on gross hive income or a fixed hive rental fee, or both. Contracts with both a fixed component and percentage component are reported to be increasingly common. Hive royalties are reported to range from 10-30% of honey income paid to the landowners. The percentage may be stepped, increasing over a period of time or in relation to the length of the contract.

Almost all beekeepers sell honey at a set price on the wholesale market to buyers who prepare, brand, and sell honey products for retail sale. However, there is an increasing drive to form plantation owner groups (collectives) with contractual arrangements that provide the beekeeper a proportion of the honey yield while allowing the collective to retain and market most of the honey for sale at retail prices (see Plantation Collectives). This is supported by strong international demand for retail packed and branded honey, rather than bulk supply honey.

Mānuka honey prices depend principally on UMF[®]/MGO content, ranging from \$16/kg for low UMF[®]/MGO honey to \$60+/kg for high UMF[®]/MGO honey.

FOR QUESTIONS TO ASK ABOUT HONEY CONTRACTS, SEE THE APPENDIX





OIL PRODUCTION

4. OIL PRODUCTION

Working from the Māori knowledge base (matauranga Māori) of traditional uses, East Cape iwi worked with scientists in the 1990s to discover that mānuka leaf extracts had antibiotic properties. This is due to a high level of the natural chemical called leptospermone present in the distilled mānuka oil. Importantly they found that leptospermone acts against the methicillin-resistant bacterium *Staphylococcus aureus*, the original ‘super bug’ that is a serious problem in hospitals. Although it was later discovered that leptospermone is not present in all mānuka or in kānuka oil, this initial finding spurred wide ranging research into the beneficial properties of mānuka and kānuka products.



PLATE 30: HARVESTING ON
GREAT BARRIER ISLAND

4.1 OIL CHARACTERISTICS

Oil producers promote use of mānuka and kānuka oil for their anti-inflammatory, antiseptic, anti-viral, antifungal and insecticidal properties. The oils are promoted as a decongestant, muscle relaxant, pain reliever, and in the control of head lice and intestinal worms. Mānuka oil has been well researched in this regard. Research into kānuka oil properties is less developed and there remain questions over recent research findings.

Kānuka oil is considered to have smaller lighter molecules that penetrate the skin more easily when compared with mānuka oil. At a molecular level, the chemical makeup of oil varies not only between the species but also within species depending on the location, indicating that at least some oil characteristics are derived from environment in which the plant is growing.

Like mānuka honey, there appears to be regional and local differentiation in the qualities and characteristics of mānuka and kānuka oils. Oils from different locations have a unique aromas, colour, clarity, and texture. The concentration of bioactive ingredients such as triketones also varies. Oil extracted from different locations or land types is therefore thought to have a unique chemical composition or signature (known as a chemotype), but there is little publicly available information to verify this and testing oil composition is currently expensive.

Although there is considerable interest in the use of mānuka and kānuka essential oils and their potential economic value, the industry has not yet attained the commercial momentum of mānuka honey. However, the increasing number of studies into potential medical uses indicate that there is strong potential to develop the mānuka and kānuka oil industry along similar lines to mānuka honey.



4.2 HARVESTING

PLATE 31: FOLIAGE HARVESTING IS CURRENTLY A LABOUR INTENSIVE TASK

Harvesting is undertaken by trimming plant foliage by hand. Costs relate directly to the time it takes to harvest good quality foliage and harvesting comprises around 50% of production costs. Mānuka is considered to be more difficult to harvest than kānuka, so mānuka harvesting efficiency is slightly lower. Although landowners and plantation managers can reduce costs by undertaking harvesting themselves, this is a significant time commitment especially if undertaken regularly throughout the season.

Mechanical harvesting is being investigated for use in New Zealand plantations and some producers are starting to use this technology to reduce harvest costs. However, mechanical harvesting will only be viable where machinery access is possible.

Foliage harvesting for oil production is best suited to sites with easy access such as riparian margins, shelterbelts, hedges, and the outside margins of plantations, restoration or erosion control areas. Plantations can also be planted in hedgerows or with intersecting access tracks to facilitate foliage harvesting. Sites that are very remote, or difficult to access make harvesting uneconomic by increasing harvesting time or decreasing harvest efficiency. Mānuka or kānuka scrub reverting from pasture on easy terrain can provide efficient harvesting sites because plant density is often conducive to both foliage trimming and bushy plant growth forms.

Besides access, the main factor limiting harvest efficiency is wet weather. Rain makes harvesting more difficult and distillation of wet foliage takes longer.

Established and mature plants are generally unsuitable for foliage harvesting for a number reasons. Plants exceeding around 3m in height become too difficult to harvest effectively. The ratio of foliage to stems/branches decreases as plants mature, so there is less foliage per tonne harvested. Canopy closure is generally the point at which foliage harvesting becomes infeasible, because the proportion of foliage drops, height increases (as a competitive response for plant survival) and accessibility becomes more difficult. Mature plants may struggle to regrow or become more susceptible to disease after harvesting.

As a result, plantations are generally harvested for oil up to around 7 years old. However, regular foliage harvesting that keeps plants trimmed while maintaining healthy vigorous growing tips can extend the viable life of a plantation. Trimming generally occurs every year or two depending on plant growth rates, and typically occurs during the spring and summer season when the highest quantity of oil is present in foliage. Harvesting usually ceases in late summer and is not undertaken over winter. Although trimming itself is not a technically demanding activity, experience is required to ensure that foliage removal is optimised to ensure plant growth and flower production are not affected. There is little information on foliage tonnage per hectare of plantation so plantation managers wishing to pursue this income option should discuss expected harvest yields with experienced distillers to get a better understanding of income potential.



PLATES 32 - 37: OIL DISTILLATION EQUIPMENT AND VEGETATION PROCESSING

4.3 DISTILLATION

Oil is distilled from mānuka and kānuka foliage that has been cut from the trees. No other part of the tree (for instance wood or bark) contains significant amounts of oil, so maintaining high foliage growth is important for oil production. The oil is distilled from foliage typically using a steam distillation process where the steam is passed through the leaf material. The steam is then condensed and the oil floats on top of the condensed water from where it is drawn off. Distillation processes vary from the super-heated fast extraction method to the slower ambient pressure distillation at lower temperatures.

The equipment, construction and operation of a still is expensive and labour intensive. A distillery can cost around \$50,000 or more, and needs to be housed in a processing building with reliable power supply, and specialised equipment for processing and bottling the resulting oil. Depending on the distillery capacity, at least one tonne of foliage is typically needed for each production run. The distillation process requires at least two trained people, so the operational costs of equipment maintenance, power and labour can be 20-30% of total costs.

Mirroring the importance of beekeepers, distiller training and experience are vital to produce oils that retain the active ingredients. The various oil compounds are extracted from foliage at different temperatures during the distilling process due to, among other things, their specific gravity. Poorly executed, the distilling process can lose the very ingredients for which the oils are valued so an experienced distiller is vital.

Mānuka and kānuka oils are distilled separately, so the foliage must be harvested separately and cannot be mixed. Foliage from plantations in different regions or land types should also be distilled separately to maintain the integrity of the oil characteristics unique to each area. Foliage is best distilled within a day or two of harvesting so the timing of harvests in different locations is important to ensure that incoming foliage volumes do not exceed distillery capacity.



4.4 OIL YIELDS

PLATES 38: OIL DISTILLATION
REQUIRES SPECIALIST SKILLS

Mānuka foliage has a lower oil yield than kānuka, but there is currently more demand for mānuka oil because its bioactive compounds and beneficial qualities are relatively better understood. Like oil characteristics and honey yields, foliage from different regions and land types has varying oil yields. Foliage from the North Island's East Coast, Coromandel and Great Barrier Island can produce 3-5 litres of oil per tonne of foliage. Information on oil yields from other locations is limited.

4.5 OIL CONTRACTS

Currently there is comparatively little industry information on contracts for supplying mānuka and kānuka foliage for oil production, although it is generally accepted that distillers will pay around \$500-600 per tonne for good quality foliage. Generally, most plantations simply provide access to their plantations and are paid per tonne of foliage harvested, with no other involvement in the process. Some distillers have contracts that include ongoing plantation management. However, if harvesting is undertaken by the plantation manager/landowner, supply contracts with distillers may include provisions such as length of time from harvest to foliage delivery, foliage to wood ratio, and moisture content.

Researchers and interviewees suggest that a strong case can be made for groups of plantations forming distillery cooperatives to invest in the equipment, testing and branding of local and/or niche oil products. Foliage harvesting could be arranged on a rotation around the plantations owned by cooperative members by a harvest team to provide ongoing consistent supply to the distillery and improve economies of scale.

The cooperative would also employ the distiller to maintain a high quality oil product. Similar to the reputation attained by winemakers, a highly skilled distiller could add to the marketability of the brand. This kind of market differentiation is seen with local or regional brands of wine, olive oil, yoghurt, cheese, milk, skin care products and honey. However, this depends on verifying the bioactive ingredients present in mānuka and kānuka oil that deliver the bioactive properties, a task that involves an investment in testing unlikely to be met by individual landowners.

For generic mānuka oil, wholesale prices are around \$500-600 per kg and oil production costs are around \$400-450 per kg, but these values vary depending on oil properties and factors such as harvesting costs.

FOR QUESTIONS TO ASK ABOUT OIL CONTRACTS, SEE THE APPENDIX.

5. ENVIRONMENTAL AND AGRICULTURAL BENEFITS

In addition to the commercial opportunities in mānuka honey and mānuka/kānuka oil, establishing and maintaining mānuka and kānuka shrubland has significant environmental and agricultural benefits. Although the monetary value of these may be less well defined, consideration of these benefits should be included in the decision making process nonetheless. With the combination of social and political pressure to improve agricultural sustainability and the increasingly visible effects of climate change, these benefits are likely to assume greater importance over time.



40.



39.



41.



42.

5.1 BIODIVERSITY

Kānuka- and mānuka-dominant vegetation provides habitat for a diverse range of plants, fungi, and animals, particularly invertebrates (moths, beetles, millipedes, spiders, snails, etc.). Research has shown that the significance and diversity of the invertebrates in 60-year-old kānuka forest is as great as that in primary forest. With such high insect diversity, mānuka and kānuka are also excellent habitat for native geckos, skinks, and insectivorous birds.

PLATE 39: EPIPHYTIC PLANTS AND LICHENS GROWING ON MATURE KĀNUKA

Research has shown the presence of these species can have significant beneficial effects on pasture and crop yields because they contribute to increased pollination, pest predation, and enhanced plant nutrition.

PLATE 40: EPIPHYTIC PLANTS AND LICHENS GROWING ON MATURE KĀNUKA

Insectivorous species living in native shrubland can reduce populations of insect pests such as brown beetle, white butterfly, and grass grub. Greater terrestrial insect diversity means pests have increased competition and predators. This can significantly reduce the costs and environmental impacts of insecticide applications throughout the growing season.

PLATE 41: NEW ZEALAND STICK INSECT (CLITARCHUS HOOKERI) ON MĀNUKA FOLIAGE

PLATE 42: NATIVE POLLINATORS ON MĀNUKA IN WINDY CONDITIONS

Besides honey bees, kānuka and mānuka flowers have a high diversity of other insect visitors. A Department of Conservation study found 32 insect species visited mānuka flowers, including honey bees, native bees, nectar feeding flies, pollen feeding syrphids, bumble bees, and wasps. This diversity of insect visitors increases crop and pasture yields because farms with greater numbers of wild insect species have enhanced pollination.



Although honey bees are the most widely recognised crop pollinator, their pollination activity is limited by many factors (as noted earlier) and is vulnerable to climate and disease impacts. The Ministry for Primary Industries¹ (in line with international research) recognises that:

- Pollination results from a wide range of pollinator insects,
- ...“*unmanaged pollinators contribute significantly to pollination*”, and
- ...“*maintaining pollinator diversity can be important for maximising crop yields*”.

Encouraging a greater diversity of insect pollinators can ensure crops and pastures are pollinated in most weather conditions even when honey bees are not active or if hives become diseased. In addition, wild insect pollinators ensure that a wider variety and greater numbers of flowers are pollinated throughout the year without the limitations of honey bee temporal, physical, and seasonal preferences. By encouraging a high diversity of insects, kānuka and mānuka plantations provide ideal habitat to achieve these benefits.

PLATE 43: NATIVE
POLLINATORS ON MĀNUKA

1. Howlett, B.G. et al. 2013. Impact of climate change on crop pollinator activity in New Zealand. MPI Technical Paper No. 2013/30

5.2 EROSION CONTROL

High density kānuka/mānuka scrub and forest is very effective at erosion control, maintaining the stability of steep slopes that typically slip when in pasture and reducing sediment runoff. Kānuka and mānuka roots have a combination of properties that make them especially good at preventing soil erosion. In addition to being strong, the roots are also flexible and elastic. The roots not only bind soils to a depth of 0.5 – 1.0m, they also maintain stability by resisting soil movement on slopes. In addition to the action of roots, erosion control is achieved through tree canopy rain interception, reducing the physical impact of rainfall on soil and maintaining a lower soil moisture content.

Kānuka/mānuka scrub on erosion-prone land protects soils from above, and makes soils stronger and more resistant to slipping. The erosion control benefits are greater with higher tree density through interlocking roots and canopy closure, so densely spaced plantations will provide more effective erosion control than widely spaced plantations.

Reverting kānuka and mānuka scrub often has naturally high density (>10,000 stems per hectare), as well as fast growth rates, and plantations can achieve the same benefits if plant density is appropriately high on erosion-prone parts of the plantation site. Because of their fast growth, mānuka and kānuka can achieve effective erosion control in as little as 5-8 years when closely spaced. This density of naturally reverted scrub will naturally self thin over several decades to a final density of around 1,600 stems per hectare comprised of mature kānuka trees, with mānuka being outcompeted.

Historically, kānuka and mānuka stands were highly effective at preventing shallow land slipping on steep terrain after the Cyclone Bola extreme weather event. Compared with pasture, kānuka/mānuka scrub had four times less erosion and land slippage than pasture. The erosion control effect of scrub increases with age and 30 year old stands had almost no land slips. When closely spaced, 15 year old kānuka stands are as effective at erosion control as close-planted pines, without the loss of soil protection associated with pine harvesting. With kānuka, slope stability can be maintained for centuries. If mānuka and kānuka are harvested or cleared, the remaining root mass retains its strength and soil binding capabilities for around 2 years. This means cleared areas could be replanted without reducing erosion protection provided the replanted area is closely spaced to achieve rapid canopy closure.

If erosion control is a plantation objective along with honey production or foliage harvesting, the high plant densities needed to achieve the former need to be balanced against the low plant densities typically recommended for the latter. It is important to note that the industry standard for honey production of 2.5 – 3.0m plant spacing (i.e. 1,111 – 1,600 stems per hectare) is unlikely to prevent land slippage with the same effectiveness as closely spaced stands (i.e. 1.0 – 1.5m). If a plantation site has areas of steep erosion-prone land, plant spacing should be increased across those areas to achieve both production and erosion control objectives effectively.

5.3 WATER QUALITY

When compared with pasture or crops, native vegetation can be an effective filter for surface water runoff and contributes significantly to stream habitats. By stabilising the stream bank (riparian margin) and shading the waterway, native shrublands can improve water quality and habitat quality over time. Because they grow quickly and are hardy, mānuka and kānuka are a popular choice for riparian plantings. Corridors of mānuka and kānuka contribute much needed organic matter and woody debris to streams, provide effective shade and wind protection, and their woody, fibrous roots bind stream banks to decrease instability.

Riparian corridors of mānuka and kānuka can significantly also increase local biodiversity, provide pest control for adjacent pasture and crops by attracting insectivorous birds and insects, while also providing shade and shelter to livestock. If planted in wide corridors, honey and oil production may provide a viable income while achieving important water quality benefits in productive landscapes.

5.4 CARBON STORAGE

Landowners can earn New Zealand Units (NZUs), commonly known as carbon credits, for any forest first established after 31 December 1989 ('post-1989'). NZUs are earned by entering one of two carbon schemes – the Permanent Forest Sink Initiative (PFSI) or the Emissions Trading Scheme (ETS). Carbon sequestration is a technical term for carbon storage where carbon is stored as organic material in the wood, foliage and roots of trees. One NZU is earned per tonne of carbon sequestered. To be eligible, the forest must:

- Be at least one hectare;
- Be at least 30m wide on average;
- Have tree crown cover of at least 30% in each hectare; and
- Those trees have the potential to reach a minimum of 5m height at maturity in the place they are located. Tree species includes mānuka and kānuka but excludes gorse and smaller native shrubs.

In addition, the land must not have had eligible forest on 31 December 1989. This can be tricky to determine, particularly if there is regenerating scrub. Where there is doubt landowners will need to provide evidence that the land did not have tree species capable of reaching five metres at that time. Providing MPI with photos, spraying receipts, log books, etc. will help with applications.

While mānuka and kānuka are considered tree species, if they are managed in a way that the forest will not reach the five metre height criteria at maturity then the forest will likely not be eligible for the ETS or PFSI. This is particularly important for trees planted for honey or oil production where height is managed.

The market value of NZUs has fluctuated over time but is currently at around \$18/t of carbon sequestered. A rule of thumb is that \$20/t is a conservative estimate for the future but like any commodity market there is uncertainty.

There are two methods to calculate the stock of carbon in a forest: Look-up tables for less than 100 hectares (providing pre-populated carbon values by forest type), or the Field Measurement Approach for more than 100 hectares. Both mānuka and kānuka are included in the indigenous look-up table which uses a national standardised value of total carbon stored in the forest at a particular age.

There are a number of eligibility criteria for landowners wishing to join the ETS or PFSI and an assessment process before the forested area can be registered to claim carbon credits. There are fees required for ongoing participation and regular administration designed to ensure landowners claim all the carbon credits they are entitled to. For full details on qualifying for the ETS or PFSI, contact MPI directly (www.mpi.govt.nz) or call 0800 CLIMATE and select option 3.

MPI is planning to release further guidance on mānuka and kānuka in relation to the Government's carbon schemes in the future.

5.5 REDUCED WEEDS AND PESTS

If the proposed plantation site is marginal land, weeds are likely to dominate and pests (rabbits, possums, goats, wallabies) may be common. Converting to a mānuka and kānuka plantation will reduce weed and pest populations as a result of plantation establishment. However, plantations also reduce the weed and pest pressure on adjacent higher-value farmland, particularly for very invasive weeds, reducing land management costs for weed control. The same benefit can also result for pests, although some pests reestablish once initial control activities are ceased.



PLATE 44: WELL MANAGED PLANTATIONS CAN REDUCE WEED PRESSURE ON ADJACENT FARMLAND



6. ESTABLISHING PLANTATIONS

When establishing a new plantation at a scale of hectares, most landowners use contractors for fencing, weed control, planting, plant maintenance, and pest control. Contractor experience can be invaluable in ensuring the successful and rapid establishment of a plantation, especially if they have undertaken similar work locally and can advise on the most cost-effective methods.

No one can guarantee performance but you can minimise your risk with careful site selection, variety selection and establishment practices.

Archer & Millner

PLATE 45: WIND SHORN
MĀNUKA ON THE
COROMANDEL COAST



6.1 PLANTING LOCATION AND SEASON

Mānuka and kānuka are highly adaptable robust plants that can be established on almost any soil type and in most climates. Both thrive in sandy soils, clay, silt, limestone, and volcanic soils. They tolerate dry hill slopes as well as coastal conditions, and can cope with high wind conditions and wind shear.

Mānuka is more likely to be successful in permanently wet soils, peat, and other highly organic swamp soils. Kānuka will be more successful than mānuka on silty alluvial soils, especially in riparian areas.

The sites typically selected for plantations are marginal land comprised of dry erosion-prone hillslopes or steep gullies not suitable for intensive primary production. Both mānuka and kānuka thrive in such locations as they fulfil their role as a seral species, so location is generally not a limiting factor in plantation success.

However, planting season can dramatically impact planting success. Although many species benefit from spring planting, the planting season to maximise plant success will vary depending on the region. In areas experiencing heavy autumn and winter frosts, losses can be as high as 50% in autumn-planted seedlings, especially if several frosts occur in series killing growing tips. Conversely in areas experiencing summer drought, seedling losses can be heavy on dry hill slopes as seedling roots have not yet achieved sufficient depth to survive drought conditions. Some planting contractors recommend using water gel to reduce the drought risk and this increases planting costs.

The climate of the plantation site should determine which season planting is most appropriate to minimise plant losses. Check with local planting contractors to confirm the usual planting seasons in plantations and revegetation projects nearby, and typical plant survival rates.

Plantation success is not just about growing plants, however. If the plantation objective is to produce honey, the plantation site needs warm, sheltered, and preferably north-facing slopes on which to locate the hives (see Maintaining Beehives). Plantation sites in windy areas may have only limited success for honey production if wind velocities routinely exceed the maximum wind speed for bee foraging (see Bee Foraging). A plantation site selected for erosion control may be too steep or remote for foliage harvesting to be economic. If income is a significant plantation objective, ask local beekeepers and the nearest oil distillery to help assess your proposed site to ensure that the site has the characteristics to generate income.



PLATE 46: WETLAND MĀNUKA HAVE A DIFFERENT GROWTH FORM AND FOLIAGE THAN MĀNUKA GROWING IN OTHER ENVIRONMENTS

6.2 PLANT SOURCING

6.2.1 GENETIC DIVERSITY

Genetic diversity is the variety that exists within the genes of all living things. Even individuals of the same species have slightly different DNA. DNA also changes over time or is expressed differently in response to changing environmental conditions.

Genetic diversity is crucial because it ensures survival of a species in the face of disease or disaster, and gives a species more resilience to thrive in the conditions to which it is adapted. Charles Darwin referred to this as “natural selection”, which is the process of stronger and smarter individuals surviving to breed, successfully passing on DNA to their offspring.

Genetic diversity applies equally to plants, particularly the survival of one species in a range of different environments. New Zealand has diverse soils, and climatic and environmental extremes. Our land types include islands, geothermal areas, wetlands and rivers, dunes and coasts, and mountains.

In 2014, botanists identified that kānuka was not three but at least ten distinct species, many of them unique to a particular location or land type. Mānuka occupies a similar variety of land types and is therefore very likely to have similar species differentiation, although the difficult task of revising the species has not yet been undertaken.

In mānuka and kānuka, genetic differences show up in many ways. Some plants are only found in specific locations. There is variety of growth forms, height, lifespan, and flowering times. Characteristics such as leaf shape, bark, seed size and shape, and flowers also vary and have been noted by plantation managers. These differences are borne out in genetic differences even though plants may look very similar.

Regional and local genetic diversity within both species is therefore an important consideration when sourcing plants for new plantations. Plantation managers confirm that seedlings sourced from plants found near a plantation site often have greater plant vigour and growth rate than seedlings from non-local plants.

Massey University researchers have observed that monocultures of a single cultivar are unwise given the variability of conditions within a site. They also note that much of New Zealand’s marginal land where plantations are most desirable are “*hostile to many of the mānuka varieties originating from outside regions - it is only the local variety which is well adapted to grow there*”.

Given the significant financial investment required to establish and maintain a plantation, maximising plant vigour by choosing the species or cultivar best adapted to the site is a key decision. Choosing the wrong cultivar for the site could result in poor plant survival and slow growth.

6.2.2 PLANT VARIETIES/CULTIVARS

Plant breeders identify desirable characteristics in individual plants and use selective breeding to create new plant varieties. For instance, garden centre varieties of mānuka and kānuka have been bred for larger flowers, brighter petal colours, more petals, and a smaller stature than their wild cousins.

If a wild plant flourishing in one location has a desirable trait, longer flowering season for instance, plant breeders propagate seed to produce seedlings to be planted in locations where the flowering season is short. The current focus of mānuka breeding and propagation is increasing the DHA content in nectar from new varieties to increase the MGO content in honey. Other breeding programmes are focusing on earlier flowering, greater flower numbers, and greater nectar volume.

Although cross-breeding between cultivars is commonplace, the result is a hybrid that loses the unique genetic diversity of the parent plants. Plant and animal breeders frequently find that while cross-bred offspring have the desired characteristics for which they were bred, they lose other valuable qualities such as vigour and disease resistance. They may also have unforeseen weaknesses such as poor reproductive success.

Plant breeders have reported that although they can propagate seeds from plants that have high nectar DHA, plant survival and vigour can be affected because the parent plants were specifically adapted to their local environment. Propagated seeds have been reported failing to thrive or being more prone to disease when seedlings are planted away from their natural habitat.

This is especially true for soil moisture and frost tolerancy, with plantation managers reporting high plant losses and seedling damage in cultivars with a different provenance to the plantation site. For example, seedlings from coastal populations with high nectar DHA introduced to inland locations had poor frost tolerance, and swamp mānuka seedlings planted on dry hill slopes did not survive at all.

Another example is early flowering mānuka from outside the region introduced to Taranaki plantations. While they did indeed flower earlier than their local counterparts, temperatures were still too cold for nectar flow to occur. When hardy plants with higher DHA content were introduced from outside the region and flowered in the Taranaki season, the outcome was more successful.

There are also conservation and industry concerns that nursery-bred mānuka and kānuka varieties and propagated seed planted in locations distant from its natural habitat will cross-pollinate with wild local plant populations, irreversibly changing natural genetic diversity. Many plantation managers and industry specialists are concerned that ecological and cultural values of natural plant genetics will be irretrievably lost if the industry continues to promote cultivar use.

FOR QUESTIONS TO ASK ABOUT HIGH VALUE CULTIVARS, SEE THE APPENDIX.



47.

PLATE 47: MĀNUKA CULTIVAR
FOR THE HOME GARDEN

6.3 ECO-SOURCING

“*Eco-sourcing*” means nurseries find local natural populations of a plant species and propagate the seed from trees within the stand so that the resulting seedlings can be planted in the same locale. Plant conservationists and ecologists advocate the use of properly eco-sourced plants for revegetation projects to preserve local genetic diversity and avoid inbreeding. Plantation managers and landowners, on the other hand, advocate the use of eco-sourced plants in plantations because they are observed to out-perform and out-live non-local cultivars. One plantation manager has found “*Eco-sourced plants are more likely to outlive, outbreed and outgrow any non-ecosourced plants*”. As noted in the Taranaki example in the previous section, local plants will also flower when local weather conditions are most likely to be conducive to nectar production and, therefore, pollination.

When contracted to grow plants for a new plantation, eco-sourcing nurseries will identify wild populations of mānuka or kānuka that are as close as possible to the plantation site from which to collect and propagate seed. This maximises seedling survival and vigour, and ensures that seedling genetics are well adapted to conditions at the new plantation.

There regionally-specific plant characteristics most often recognised by industry specialists is flowering season. Northland is considered to be the earliest flowering region whereas Taranaki, Manawatu-Wanganui and Wellington are late flowering. Nectar DHA is another commonly recognised plant characteristic that varies regionally.

However, an important trade off to consider is that eco-sourced seedlings may not have the desirable characteristics being bred into commercial high-value cultivars such as longer flowering season or high DHA nectar.

FOR QUESTIONS TO ASK ABOUT ECO-SOURCED SEEDLINGS, SEE THE APPENDIX.

6.4 SEEDLING SELECTION

Before choosing between high value cultivars, eco-sourced, or standard revegetation-grade seedlings, there are several things to consider.

High value cultivars bred or propagated for high DHA nectar or longer flowering typically cost more per plant than revegetation-grade seedlings. Eco-sourced seedlings can also cost more because the nursery has to source and propagate smaller numbers of seedlings, so the batch does not benefit from economies of scale applicable to standard mānuka or kānuka seedlings. Check with plant suppliers about the available options and cost per plant, while also considering which option has the lowest risk of plant failure given the site conditions.

Some industry guidance recommends planting high performance cultivars with eco-sourced or standard seedlings to achieve longer flowering durations or higher average nectar DHA across the plantation. This guidance may be appropriate if the cultivar has a similar survival rate to other seedlings, otherwise the gains from higher nectar DHA could be negated by fewer surviving plants.

It is also important to bear in mind that the start and length of flowering seasons can vary significantly from year to year in natural plant populations, without a regular pattern or duration, and this can also be true for high performance cultivars. Planting contractors observe that some of the high performance characteristics may not eventuate because of unknown site, seasonal, or climatic variables.

It is therefore important to check with plant suppliers about the provenance and performance of nursery-bred or propagated seedlings to increase the chances of good performance in your local environment.



48.



49.

PLATE 48: KĀNUKA
SEEDLINGS ESTABLISH
RAPIDLY ON BARE GROUND

PLATE 49: THE DENSITY OF
NATURAL KĀNUKA SEEDLING
ESTABLISHMENT CAN BE
VERY HIGH

If plantations fail, the economic losses are substantial so ability to establish and thrive is a primary consideration, more important than nectar quality.

Archer & Millner 2016

6.5 PLANTING

While there is readily available information on plant prices, the cost of the seedling itself is only one component. Other important price components include site preparation, planting, plant replacement, and site maintenance (weeding and pest control post-planting). Costs can be quoted per plant or per hectare on the basis of the site location and characteristics, seedling size and density, and other tasks requested. Because planting contractors and plant providers quote in different ways, it is important to understand exactly what is included and excluded from any price.

Ministry for Primary Industries (MPI) provides grants for planting from the Afforestation Grant Scheme (AGS) with the primary goal of reducing erosion. Within that, the Hill Country Erosion Fund provides funding specific to hill country. These grants are available to landowners directly. AGS Grants can preclude harvesting for the first 10 years and do not automatically ensure access to ETS and PFSI schemes, so it is important that plantation managers are sure of the requirements prior to receiving grants. Regional and district councils may also have funding available for farm afforestation, especially in priority catchments and on erosion-prone land. Check with council land management or farm sustainability advisors to find out more about funding availability and criteria.

6.5.1 SEEDS

Both mānuka and kānuka are grown from fresh seed and will germinate within a month of sowing. Each mānuka capsule contains an average of 300 seeds. Because the seed of both plants is small and light, it has little energy to sustain itself for long and does not survive more than a few months outside the seed capsule. The seed tends to germinate very quickly and in a wide range of conditions. Mānuka seed can germinate over a wide temperature range of 4.5-32°C, and germination is mainly dependent on light and moisture conditions.

Germination usually occurs over the 9 months from March to December, with very little or no germination over the summer months. Successful germination producing seedlings generally occurs from June to December, with most occurring in September and October.

Propagating plants from seed is straightforward and nurseries can easily grow plants for new plantations and revegetation projects within a few months. The plants are then grown on to the size required for planting out.

6.5.2 SLASH

Because of the ease with which seed germinates, mānuka and kānuka can both be established using the “seed-bearing slash” method which involves cutting seed-bearing branches from mature trees and placing them in layers directly onto soil. Using slash is the fastest and least expensive establishment method, provided there is an easily accessible source of seed-bearing material in sufficient quantities close to the site. The use of slash is generally only undertaken in small areas of bare soil and is ideal for providing eco-sourced high density establishment of plants on erosion-prone sites.

The layers of branches should be 30-40cm deep provide 80-95% soil cover. Seedlings germinate under the slash cover and emerge through the branches. Mānuka can also be established successfully using mulched slash.

If using slash, the greatest number of mānuka capsules will be available on branches prior to August so branches should be harvested in July, whereas kānuka seed will only be present on branches in February to April so branches should be collected in late summer. Branches should be immediately spread across the plantation site, with the expectation of optimal germination occurring in spring.

With slash establishment, greater germination and faster seedling growth occurs when vegetation cover is low. If the terrain allows, vegetation can be reduced or removed using herbicides, mowing, heavy grazing, or ploughing/discing. However, on steep sites, pasture is likely to be relatively sparse and limited by poor fertility and shallow topsoil so vegetation removal may not be required. Because germination occurs quickly, test several areas to determine whether vegetation removal is necessary. If so, bear in mind that sprays and soil exposure reduce or remove the mycorrhizal fungi in soil that positively effect seedling growth.

Slash establishment will not produce evenly spaced seedlings. Soil microclimates will result in high plant densities in favourable locations and low plant densities in less favourable sites. Transplanting seedlings has a low success rate as mānuka and kānuka seedlings respond poorly to disturbance.

To increase plant density where germination has been poor, place additional slash in low density locations, plant potted seedlings, or wait until adjacent seedling growth improves conditions for natural seedling recruitment to occur.

There is no information available on costs for establishing areas using slash. Industry specialists indicate that costs of this labour-intensive process probably relate primarily to the time it takes to physically complete the process of harvesting and laying the slash. Although that probably makes slash the cheapest option for plantation establishment, it is not suitable for all sites, requires vegetation removal, and requires an abundant source of mature plant material with seeds.

6.5.3 SEEDLINGS

Seedling quality is essential to the successful establishment of plantations and, in fact, any revegetation and planting project. Seedlings that are poorly grown, small, and spindly with weak trunks have a lower survival rate especially in harsh conditions. Plantation managers report that seedlings established from cuttings have far less vigour than seed-grown plants, so it is important to check how the seedlings were established.

Plants raised in containers can have distorted roots especially where they are not 'potted-on' before they become root bound. Root distortion can also occur when seedlings are incorrectly placed in pots with upturned roots. When free of these problems, however, seedlings raised in containers do better than open grown seedlings. Mānuka and kānuka seedlings perform poorly after root disturbance in natural ground so potted seedlings are generally a better choice than transplanting local seedlings.

When seedlings arrive from the nursery, check their appearance, root condition, presence of weeds and insect pests, to ensure you are accepting only good quality plants. The size of seedlings ready for planting varies depending on the species, variety, and location. Check with your nursery about the seedling size typically supplied for plantations.

Seedling size is determined by the size of container it is growing in, which is the most common reference for plant size as set out below.

- Hillson root-trainer: 150mm very small seedling with little stem development.
- Tinus root-trainer: 200-300mm small seedling with little stem development.
- T28 (0.5L): 400mm seedling with some stem development with a slightly bushy appearance.
- PB1: 400 -500mm seedling with good stem development and quite bushy appearance.
- PB2: 500-600mm with good stem development and very bushy vigorous appearance.
- PB3: The largest grade available for revegetation sites needing immediate plant cover over small areas but not usually used for plantation sites, very bushy plants up to 1m tall with excellent root development.

Plant survival is generally 80% or greater on planted sites for both species when planted seedlings are strong, healthy, and sourced from areas with similar conditions to the planting site. Although plant growing tips can be affected by heavy frost and wind in the first two years, this may temporarily affect plant growth but seedlings generally survive. However, seedling mortality is more likely if seedlings planted in harsh conditions are not of local provenance (see Eco-Sourcing).

It takes approximately a year for a nursery to contract grow seedlings for plantations, and can take longer if specialist or high value cultivars are requested. There can be high demand for seedlings when other large scale revegetation or roaming/infrastructure projects are also using mānuka and kānuka. As soon as plant selection and density decisions have been made, contact your nursery to confirm seedling numbers and when they will be available at the size and quality necessary.

Seedling costs vary principally based on the number of plants and plant size (grade) requested.

Plant orders below around 20,000 plants typically cost \$0.90 - \$1.10 per plant for root trainer seedlings, around \$0.60 -0.80 per plant for >20,000 plants. Larger seedling grades are typically more expensive and prices can be much higher for specialist or high performance cultivars.

Plant costs vary significantly between nurseries and regions, and depend partly on supply and demand in the local market, so it is important to get current prices from a local supplier. Because plant purchase is one of the biggest establishment costs and mānuka/kānuka plant propagation is relatively easy, some plantation managers and collectives have set up their own nurseries to control supply costs.

Many practitioners and planting contractors note that purchasing smaller less expensive seedlings may be a false economy, because they do not perform as well as larger grades which have better root mass and stem development. This makes larger seedlings more resistant to harsh conditions and faster to establish, which contributes to fewer plants losses and faster plant growth.



6.5.4 PLANT DENSITY

Traditionally mānuka and kānuka have been used throughout New Zealand as robust and vigorous species highly valued for restoration or revegetation plantings. Mānuka and kānuka are among the best revegetation species in terms of survival and speed of achieving canopy cover. When seeding naturally into bare ground or after fire, seedling survival and density can be very high, and weed invasion and dominance are low.

For revegetation, both species are typically planted 1.5–2.0m apart with the objective of achieving rapid canopy closure, i.e. the canopy of adjacent plants meets so that light penetration to the ground is reduced and weeds are outcompeted. This equates to 2,500 – 4,440 stems per hectare and typically includes at least one pre-planting weed control and twice yearly weed release for 3 to 5 years.

Where erosion is an issue, closer plant spacing of 1.0–1.2m will provide stability and allow for self thinning after canopy closure. Planting at spacings of 1.0m or less results in 80-90% canopy cover within 5 years, and weed control for plant release is only needed in the first year or two. At such dense spacings, self thinning (i.e. weaker plant density being outcompeted and dying off) occurs from 7 to 12 years with only the strongest plants surviving to form long term canopy cover. Due to costs, this is generally only used on small erosion prone areas of a site.

Conversely, low planting densities without intensive weed control have been found to result in poor survival of planted seedlings and sites becoming dominated by exotic weeds, and blackberry, compared to more densely planted sites.

PLATE 51: MĀNUKA PLANTING
AT 1.5M SPACING



Plantation establishment for honey or oil production requires plant spacings that maximise accessibility for foliage harvesting and/or light penetration for flower development. At closer spacings, canopy closure occurs more quickly, and the low light environment beneath the canopy means that foliage and flowers are produced only on the top of the plant. However, rapid canopy closure means post-planting weed control requirements are considerably lower than for plantations established with larger plant spacing. Closer plant spacings are also desirable for reducing or preventing erosion, for rapid carbon sequestration, and for enhancing indigenous biodiversity.

The decision about what plant spacing to use in the plantation depends on the primary purpose of the plantation and the site characteristics. A site with high weed density and poor accessibility may require high plant density to minimise weed control costs, while trading off longer term flower or foliage yields. Ideally, plantation sites should be mapped to identify areas of instability, high weed density, poor accessibility and/or steep slopes where plant spacings should be closer.

Where the terrain, land stability and accessibility allow, industry recommendations for honey and oil plantations are typically 2.5-3.0m plant spacings allowing each plant to maximise its foliage and flower growth. Some plantations are planted in hedgerows with plants at 1.5-2.0m spacing. These are more closely aligned to an orchard model than a revegetation model and allow dual purpose harvest for oil and honey. However, wider plant and row spacing will require more intensive weed control over a longer timeframe, especially where pre-existing weed density is high. Therefore, the high-maintenance orchard model is best suited to sites on easy terrain with good access and close to labour sources. On such sites, the expense of high-value cultivars may be justified if the plants and hives can be strategically managed to maintain optimal health, performance, and yields.

PLATE 52: MĀNUKA PLANTS AT
1.5M SPACINGS IN ROWS 3M
APART



6.5.5 PLANTING

Planting can be carried out by the landowners, plantation manager, or specialist planting contractors. Planting contractors generally do not have a fixed rate because costs depend on distance from the nursery, accessibility, terrain, site preparation, and planting density. Including seedlings, prices can range from \$2,500 to \$3,500 per hectare, with lower costs associated with larger plantation areas giving economies of scale.

Costs per plant typically range from \$2 per plant for very large scale plantation establishment with no post-planting maintenance to \$4-\$8 per plant for smaller more specialised plantations or difficult sites with intensive post planting maintenance. The mid-range for supply, planting and fertiliser tab for 0.5L grade plants is around \$2.70 per plant and for 1.0L grade plant is around \$3.70 per plant.

Planting costs vary depending on the number of plants, area, terrain, accessibility and services included (pre- and post-planting weed control, fertiliser, water crystals, etc.). Planting costs are generally around \$0.50-0.75 per plant, but may be higher for more difficult or remote sites.

6.5.6 FERTILISER

It is standard practice for nurseries to include slow release fertiliser in potting mix. Planting contractors can also include a slow release fertiliser tab in the planting hole, although this is an additional cost. As seral species adapted to colonising bare ground, mānuka and kānuka are adapted to surviving harsh conditions as seedlings, and perform well in terms of growth and survival in soils with low fertility, although seedlings in moderate to high fertility soils grow fastest.

Although there is some indication that mānuka grown in low fertility soils produces nectar with higher DHA levels, research into the relationship between soil fertility and the characteristics of nectar and oil has not been completed. However, a single application of fertiliser does not have permanent effects on soil fertility. Slow release fertilisers are a temporary measure intended to encourage seedling establishment. They therefore cannot impact on mānuka honey MGO levels or mānuka/kānuka oil characteristics, or indeed any long-term effect on plant characteristics once the fertiliser has been taken up or leached out of the soil. Recommendations to avoid fertiliser at planting to avoid effects on mānuka honey MGO are therefore misinformed. However, ongoing applications of soil amendments (fertiliser, lime, sulphur, etc.) should be considered very carefully in the context of water and soil impacts, and impacts on plantation performance.

If plantation objectives are driven by erosion control and/or water quality factors, then fast plant establishment and growth may be the most important factor and slow release fertiliser is recommended to maximise plant growth in the first two years. However, if cost is a factor, a soil test is an inexpensive way to determine whether soil fertility is adequate.

PLATE 53: POST-PINE HARVEST WEED CONTROL FOR PLANTATION ESTABLISHMENT MUST BE THOROUGH



6.6 SITE PREPARATION

FOR QUESTIONS TO ASK ABOUT PLANT ESTABLISHMENT AND COSTS, SEE THE APPENDIX.

6.6.1 INITIAL WEED CONTROL

Weed control prior to and during early plantation establishment should be considered when:

- Existing weed cover is high (e.g. gorse scrub, blackberry, vigorous pasture on fertile soil)
- Nearby seed sources of invasive weeds are present (e.g. blackberry, gorse, pampas, bindweed, etc.)
- Plant cover includes flowers competing with mānuka nectar (e.g. gorse, privet, etc.)

Plantation managers note that harvested pine forest has the most intensive weed control requirements and a robust approach to initial weed knockdown is necessary, with blanket spraying of a broad spectrum herbicide the recommended approach.

For woody weeds and vines, herbicides specific to the weed type should be used prior to planting to remove weed vegetation. Most of these herbicides leave an active residue for a period of time after application. Planting should occur after the withholding period has passed to ensure that new seedlings or seed germination are not affected by residual sprays.

For woody weed sprays, the withholding period is 12-30 weeks so planting may be delayed by 3-6 months after site preparation begins. If such control is required, careful attention to spray timing will be required to ensure that the end of the withholding period will coincide with the most appropriate planting time. Getting this wrong could delay honey production (and therefore income generation) by a year or more. If sprays affect seedlings or kill seedlings, this could result in a large financial loss, so care is required in herbicide choice.

Mechanical clearance can be effective for some woody weeds and for post-pine harvest clearance, but does not prevent rapid re-establishment of weed seeds. When mechanical clearance is needed, it should generally be used in conjunction with follow up chemical control.



PLATE 54: AS SERAL SPECIES, GORSE AND MĀNUKA/ KĀNUKA OCCUPY THE SAME ENVIRONMENTS



SCOTTISH PLANTATIONS

Mānuka and kānuka seedlings generally have highest growth rates when germinated in soils with low vegetation cover, and the cover that affects growth most is pasture. If dense pasture is present, germination may not occur or seedling growth will be poor due to competition for light and moisture. Once seedlings have exceeded the height of pasture, they require little further maintenance. The exception to this is kikuyu grass which can quickly smother seedlings and requires several releases.

PLATE 55: GORSE SHOULD BE REMOVED BEFORE PLANTING

Glyphosate is the least expensive herbicide for pasture removal and leaves minimal residue. The withholding period prior to planting is only a week although many planting contractors will wait several weeks to ensure that weed control at each planting site has been effective, especially for kikuyu grass for which broadcast spraying is required. However, heavy grazing at very high stocking rates immediately prior to planting is a non-chemical solution used by some plantation managers, especially when high plant densities are proposed.

Gorse occupies a similar ecological niche to mānuka/kānuka scrub so the presence of gorse can be an indicator that mānuka/kānuka plantings are well suited to a site.

If the plantation purpose is for commercial grade mānuka honey, gorse flowers will provide an alternative nectar and pollen source for bees, and elimination of gorse by the third year after plantation establishment will be necessary.

However, gorse scrub is an effective nursery plant and nitrogen fixer, so gorse could be retained in the first year or two to provide shelter and soil fertility for fast seedling establishment.

The cost of pre-planting weed removal varies significantly depending on the sprays used, methods of application, whether contractors are used, and the site characteristics including terrain, remoteness, and accessibility. With basic information on location, terrain and weed type and cover, weed control contractors can provide price estimates specific to the proposed plantation site and recommend the best approach to weed control timing and methods.

Blanket aerial spray of broad spectrum herbicide can cost \$250-400 per ha depending on the spray used.

Spot spraying isolated weeds or pasture in preparation for planting, and for plant release, can cost \$300-450 per ha. Pre-planting broadcast spraying of large areas can be less expensive.

Mechanical clearance costs vary significantly depending on the type of machinery needed, terrain, and accessibility.

6.6.2 ONGOING WEED CONTROL

After planting, the weeds impacting most on seedling growth are brush and vine weeds that compete with the seedlings for soil nutrients and water, and smother young plants. Industry standards for both revegetation and plantations generally require at least two or three releases (i.e. releasing seedlings from the weeds growing around them) for the first two years. In small areas with good accessibility and easy terrain, this could be undertaken by hand using a slasher or weedeater, although this is labour intensive and can result in high plant losses if the equipment is poorly used. More usually, chemical plant release is undertaken. On remote sites or difficult terrain, only a single release or no releasing might be more appropriate given the costs associated with weed control.

When using chemical plant release, it is important that the chemical used does not adversely affect seedling health. Research into plant tolerance of herbicides has focused on mānuka, not kānuka. However, the physical characteristics of the two are similar so herbicide tolerance can be expected to be similar. Glyphosate is typically the least expensive herbicide for removing pasture but new weeds become established after a short period (around 15 weeks). Residual herbicides such as haloxyfop and clopyralid control a wider range of weeds for longer, but are more expensive.

As well as plant release, repeated removal of gorse seedlings by blanket spraying or spot spraying may also be required if the objective of the plantation is mānuka honey production. However, in almost every plantation, a combination of methods will be required to achieve the optimal mix of plant survival and weed control.

Costs for plant release spraying over a two year period post-planting are typically around \$1.50 per plant. Prices vary with the type of spray required, the number of releases needed, and the terrain. By Year 3 after planting, mānuka and kānuka are usually sufficiently tall to outcompete weeds and further weed control is not required for plant growth, although it may be required to reduce DHA dilution for mānuka honey production.

Undergrazing the plantation is generally not advisable as cattle, deer, and goats will eat or pull out seedlings, and sheep will also eat young plants when pasture is limited. However, sheep grazing of widely spaced plantations may be an effective vegetation management tool once most growing tips are taller than sheep grazing reach, which is generally at around 2-3 years old.



PLATE 56: CAREFUL SPRAY TECHNIQUE IS REQUIRED TO AVOID SEEDLING DAMAGE

6.7 PESTS AND DISEASES

6.7.1 MAMMALIAN PESTS

Although mature mānuka and kānuka are generally considered to be unpalatable to most livestock and pests, mānuka and kānuka seedlings will be grazed by cattle, sheep, goats, deer, rabbits, hares, possums, and wallabies. The main pest will depend on the location but plantation managers report that goats and rabbits/hares cause most damage and the scale of damage can be substantial. As a result, stockproof fencing is essential and pest control is necessary for at least the first year after plantation establishment.

The standard and location of fencing depends on the type of livestock on adjacent land. With basic information on the location, accessibility and area, fencing contractors can recommend the most appropriate type of fence for livestock exclusion and provide a price per lineal metre. Prices vary significantly with fence type and increase in proportion to the number of corners required. As an example, a 5 wire 2 electric fence around a Waikato gully margin costs around \$8.50 – \$9.50 per metre excluding gates.

The cost of pest control varies greatly depending on the type and density of pests. Rabbits and hares are easily controlled with poison pellets spread across the site, while possums and wallabies require bait stations. Deer and goats are best controlled by culling. Regional council biosecurity officers are good sources of information on pest control methods and can advise on regulations controlling the use of poisons relevant to the plantation site.

Where a plantation site abuts Department of Conservation land, it is worthwhile contacting the local ranger to find out what pests are most prevalent, control methods are used, and when the next control operation is planned. Coordinating plantation pest control with the operations of adjacent properties can result in a more successful long term reduction in pests than sporadic control operations.

6.7.2 BIRD PESTS

Although birds are generally not a problem for seedlings, pukeko can be a pest in and near wetland plantations by pulling out small plants. Pukeko are native to New Zealand but can be hunted subject to Fish & Game NZ regulations on hunting season and bag limits. Pukeko are territorial birds so removing the local population will inevitably result in a new family moving into the vacated area. Ongoing control may be needed until plants have sufficient root strength to withstand pukekos. Alternatively, plant larger seedlings in wetland areas to minimise the problem.

6.7.3 INSECT PESTS

The mānuka beetle (*Pyronota* spp.) is a small, bright-green beetle native to New Zealand. The adult beetles feed on mānuka and this is not known to be a problem for mānuka growth. However, mānuka beetle larvae are small grubs that eat the roots of pasture and crops, and consideration should be given to the possibility of mānuka beetle damage.

Mānuka blight is caused by a scale insect introduced from Australia. The scale lives in the bark of mānuka and kānuka producing honeydew, which results in growth of sooty mould that forms a black coating on stems and leaves. Mānuka is susceptible to mānuka blight, and blight can severely reduce mānuka growth. Blight is less common on kānuka and seems to be unaffected by a blight infestation. There is no industry remedy to mānuka blight if it becomes established in a plantation. One industry specialist suggests that plants on harsh dry sites may be more susceptible to blight especially when placed under drought stress.

Leaf roller caterpillars roll up growing tips inside silk webs and then eat the plant material inside the web. Some species reproduce very quickly, with multiple generations in each season and therefore have the potential for rapid infestation and spread once established. Leaf roller caterpillars (various species) have been observed in some locations but do not appear to be a widespread or notable pest of mānuka and kānuka. However, significant damage has been experienced by kiwifruit and avocado orchards in many areas. Some insecticides target leaf roller caterpillar but, as expected for an insect with a fast reproduction rate, insecticide resistance has also been reported so caution must be exercised when deciding on chemical control.



PLATE 57: YOUNG MĀNUKA INFESTED WITH SOOTY MOULD



7. LONG TERM MANAGEMENT

7.1 LIFE SPAN

It is important to understand that mānuka and kānuka are “seral” species. A seral species is an intermediate stage in the succession or development of an ecosystem. Both mānuka and kānuka are first stage successional species which means they colonise bare or disturbed ground before other species, creating an environment suitable for tall shrubland and forest species to become established.

As seral species, the role of mānuka and kānuka is to eventually be outcompeted as the taller forest canopy overshadows the shorter stature colonising species. In some situations, kānuka may become the final forest canopy but this is not the outcome in most places. Usually mānuka and kānuka become established as colonising species and are outcompeted by forest canopy species between 15-30 years after establishment. In some locations (Coromandel, Great Barrier Island, Auckland Region, and northern Bay of Plenty), the rapid growth of broadleaf forest species means that mānuka can be outcompeted in as little as seven years. In harsh locations or where soil has low pH or fertility, mānuka and kānuka canopy may persist for much longer.

As a result of its status as a seral species, mānuka has a shorter lifespan than kānuka or forest canopy species with an estimated life of 30-60 years. However, there is currently no information on the lifespan of the recently developed mānuka cultivars and only anecdotal information about survival rates of cultivars planted outside the home range of the parent plants. Despite some industry claims, mānuka and kānuka plants cannot be maintained indefinitely and continuously trimming plants to a short stature will not change the natural lifespan, although it may extend the plant’s productive life.

Some plantation managers advocate trimming mānuka plants back to maintain a “juvenile state” at around 10 years old, thereby maximising flowering. However, the effectiveness of this method has not been measured and resulting improvements in floral quantity and nectar volume have not been quantified. Others suggest some plantations need to be replaced every 15 years to maintain honey production, but there is likewise no data to confirm the cost effectiveness of this management method.

Both characteristics of lifespan and seral status need to be considered in the context of income potential and long term plantation management. If local regulations (see Resource Management Act) restrict or prevent removal of indigenous plant species as the plantation develops, mānuka honey or oil income could be severely constrained as the plantation is overgrown by taller species. If intergenerational income is a primary driver of plantation development, regulatory restrictions on thinning and replanting mānuka and kānuka should be well understood and regularly reviewed as part of plantation management.



7.2 RESOURCE MANAGEMENT ACT

To meet Resource Management Act requirements, district and regional councils administer District Plans, Regional Plans, and Policy Statements. Many of these regulatory documents have policies, rules, and other methods to control vegetation disturbance and clearance. They may also have criteria to determine whether vegetation is considered to be “significant”, i.e. ecologically important such that control of its management is needed. These rules and criteria may mean that mānuka or kānuka plantings are protected, regardless of whether they were deliberately planted for primary production, especially as plantations mature. Such protection may mean management of mānuka or kānuka plantations becomes constrained. Removing foliage for oil, thinning, or harvesting and replanting to replenish plantations may require a resource consent or be prohibited. Conversion to another land use such as forestry may be difficult.

Many regional plans also have rules controlling vegetation removal on steep slopes and riparian areas (stream margins) as a means of managing erosion, land instability, and water quality. Such rules may mean that a resource consent is required to clear weeds prior to establishing a plantation or for a plant replacement programme for aging plantations.

Until there is industry-led or Government guidance on how to deal with indigenous vegetation managed for productive uses, landowners will need to take responsibility for keeping up to date with local plan requirements. As part of due diligence for establishing a plantation, discuss the relevant rules and policies with planners from your local district council and regional council. The district planner may not be fully conversant with regional council rules and vice versa, so it is important to speak to planning staff from both organisations.

All plans and policy statements are required to be regularly reviewed, typically every five years. Find out the review cycle for the plans relevant to your plantation and ask to be included in any future consultation regarding vegetation management. While the policies, criteria, and rules may permit vegetation management when you establish a plantation, subsequent plan reviews may change that.

In many cases, existing significance criteria mean that establishing mānuka/kānuka plantations is effectively permanent land retirement. Even when the plantation has become mature and production for honey or oil has slowed or ceased, clearance and replanting or conversion to an alternative crop may not be possible.

FOR QUESTIONS TO ASK ABOUT PLANNING RULES, SEE THE APPENDIX.

7.3 PLANTATION COLLECTIVES

Almost all plantation managers sell their honey at a set price on the wholesale market to buyers who prepare, brand, and sell honey products for retail sale. However, some plantation owner collectives (particularly on Maori-owned land) are developing novel contractual arrangements with beekeepers allowing the group to retain, brand and market their own honey, while providing the beekeeper a proportion of the honey yield. This allows plantation owners to increase returns by selling honey at retail prices rather than wholesale prices, but requires an investment by the collective in skilled staff, honey storage, packaging, branding, and finding retail outlets.

A similar arrangement could be applied to oil production, allowing the cost of distillery establishment, operation, and product testing to be spread across owners and the effective management of harvested foliage and branded oil products to maximise the return on investment. Owner-managed retail brands are required to adhere to product safety and hygiene, labelling, and packaging regulations (to name a few) so entering the retail market requires an investment in staff and resources not readily available to individual plantation owners.

Another benefit to plantation collectives is influence or control over the environmental and/or cultural ethic applied to plantation management as part of the contractual arrangement with members. Collectives focused on water quality or erosion control view honey revenue as a tool for encouraging marginal land retirement and preventing vegetation clearance.

Riparian margin plantations in particular are unlikely to be economically viable on a single property. However, at the scale of several properties, honey or oil production is more likely to be economically viable and achieve significantly better water quality outcomes.

Some collectives are focused on biodiversity, and rely on honey revenues in the early stages to fund a transition to carbon credit incomes as forest succession occurs, while requiring use of ecosourced plants only. Not only does this management ensure biodiversity benefits, it can also secure intergenerational income.

The collective management model allows members to improve the performance, profitability, buying power, and information base of the members. By working together, collectives benefit from economies of scale by spreading fixed costs among members, decreasing per unit costs, and sharing resources. Some collectives have invested in their own nurseries supplying all members with locally sourced plants, while others have used their scale to reduce plant supply costs for high value cultivars.

The collective management model also encourages faster knowledge and information transfer between members, allowing more effective management methods to be applied across large areas more quickly. And working within a collective allows more effective long term management, with members having a louder collective voice when needed to submit on regulatory and policy changes related to vegetation management.

8. CONCLUSION

Compared with the decision to stock hives or harvest foliage from existing shrubland, the decision to convert land to mānuka/kānuka plantations can be complex. The large financial outlay precedes potential income by 3-5 years.

Converting land for mānuka or kānuka plantations is also a decision based on numerous tradeoffs. Land conversion involves trading off one form of income for another, with a long delay until the new income commences and uncertainty about income levels. The costs of establishment are high and decisions about each aspect of plantation management have fundamental impacts on costs.

Clearly the trade-off between planting density and weed control is one of the decisions that requires careful consideration with regard to costs. High plant densities may suppress weeds, enhance biodiversity, increase carbon storage, and reduce erosion but have a shorter production life for honey and oil. However, if the plantation is on a steep south facing site with poor access, high weed control costs and relatively low projected oil and honey yields, then planting at high densities may be best solution for the site. Such a site could bank honey and oil incomes for the first 5 – 7 years, and carbon credit incomes thereafter.

North facing sites with relatively good access and/or better potential for honey and oil yields may justify wider plant spacings, more expensive plant cultivars, and higher initial weed control costs. Such a site would expect to bank honey or oil incomes for up to 15 years with careful management, but may not qualify for carbon credits if canopy cover is insufficient.

Although the complex science behind mānuka honey benefits is well established, much information on hive stocking rates, honey yield, viable mānuka plantation size, and establishment methods remains unverified and anecdotal. Data from industry specialists and plantation managers has not yet been captured in a structured manner to provide verifiable data. Likewise data on oil benefits and yields is largely anecdotal.

While the marketing and sales of honey products are receiving widespread publicity and government support, producing mānuka honey relies on the performance of one insect species, the honey bee, having access to one plant, mānuka, for a very limited flowering period. Most costs occur in Year 1 whereas income from honey does not commence until Year 3 at the earliest, and honey quality cannot be guaranteed.

Like all export-based primary industries, the sale of both products is subject to foreign currency fluctuations, tariffs, regulations and customs clearance requirements of importing nations, import restrictions, internal producer lobbying, food safety scares, and international politics.

Although the potential income could be substantial, we strongly recommend taking a conservative approach when calculating the potential outcome of land conversion.

The data quoted throughout the Guide is based on information available at the time of writing. However, costs vary substantially depending on the characteristics of the plantation site and changing conditions. The purpose of providing this information is to signal the costs applicable to plantation establishment that should be included in a business case. It is strongly recommended that each landowner get site-specific quotes for costs applicable to their site, rather than relying on information in the Guide.

Each site will have unique characteristics that require a tailored management regime... one size does not fit all. Like all farming enterprises, a plan assessing the characteristics of each part of the site to select the most appropriate plantation management methods is recommended.

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APPENDIX 1: BUILDING A BUSINESS CASE

Establishing a mānuka or kānuka plantation in the right conditions presents a worthwhile revenue opportunity; in the wrong conditions, there is the risk of financial losses. Every plantation site is unique and information from one site may not apply elsewhere. Landowners should build a business case based on information specific to their plantation site on which to base decisions.

The questions below condense the information from each section into a logical order to assist landowners in collecting information relevant to the revenue potential, other benefits, establishment costs, and potential constraints to establishing and/or managing a mānuka or kānuka plantation.

BASED ON THE INFORMATION IN SECTION 4, SOME QUESTIONS TO ASK ABOUT PLANT GROWTH ARE:

Does the plantation site have full sunlight or some south-facing areas that get less sun?

Is the plantation site drought prone?

Is the plantation site frost prone?

What growth rates have local plantations achieved?

How soon will mānuka or kānuka start flowering?

How soon will mānuka or kānuka have sufficient foliage for harvesting?

BASED ON THE INFORMATION IN SECTION 5, SOME QUESTIONS TO ASK ABOUT MĀNUKA HONEY POTENTIAL ARE:

Is the plantation site larger than 40-50ha?

Is the site long, narrow or fragmented, or is it a compact shape?

What is the main vegetation around the plantation site?

How exposed and windy is the plantation site?

On average, how many days of rain does the plantation site experience during the mānuka flowering season?

What is the average mānuka honey yield from hives near the plantation?

What are the lowest yields experienced at other plantations?

How common are hive diseases in local hives?

How close is the plantation site from local beekeepers?

If the plantation site is remote, does it have other pollen rich and winter flowering species to sustain bees outside the mānuka flowering season?

Does the plantation site have suitable access to a warm, north facing hive site near the centre of the plantation?

BASED ON THE INFORMATION IN SECTION 5, SOME QUESTIONS TO ASK ABOUT HONEY CONTRACTS ARE:

Is your local beekeeper and their hives registered with MPI? Do they have a disease management strategy?

What type of contract is being offered, fixed rate hire or percentage of hive income (royalty)?

If the contract includes a royalty component, what is the percentage? Does the percentage change for a longer contract, for honey with higher MGO levels, and for sites with high yields?

Can the plantation owner sample and test the honey independently to verify MGO levels?

Will the beekeeper provide honey extraction data from the hives and honey test results?

When is payment made?

Is the price per kilogram of honey based on actual or forecast prices?

What kind of contract and terms are other plantations using?

What is the process for resolving disputes or dealing with breaches of the contract?

BASED ON THE INFORMATION IN SECTION 6, SOME QUESTIONS TO ASK ABOUT OIL CONTRACTS ARE:

- How much foliage does the distillery require from each harvest?

- What time of year is harvesting needed to match distillery batch runs?

- Who does the harvesting?

- If the distiller undertakes the harvesting, what remedy is there if harvesting results in plant damage?

- How much of the plantation site has the access needed for harvesting?

- Is the price based on foliage weight, bioactive ingredient content, or volume of oil produced?

- What kind of contract and terms are other plantations using, if any?

- What is the process for resolving disputes or dealing with breaches of the contract?

BASED ON THE INFORMATION IN SECTION 7, SOME QUESTIONS TO ASK ABOUT ENVIRONMENTAL AND AGRICULTURAL BENEFITS ARE:

- Are there crops near the plantation site that are dependent on pollination?

- Are there clover-rich or forage-rich (plantain, chicory) pastures dependent on pollination to persist in pastures?

- What is the annual cost of pasture replacement or improvement?

- What is the value of crop/pasture losses from insect pests?

- Do the crops or pasture suffer from insect pest damage that could be reduced by encouraging more predators?

- What proportion of the plantation site is steep and/or erosion prone land?

- Are there waterways downstream that would benefit from reduced sediment runoff?

- Would waterways in the plantation site benefit from increased streambank (riparian) vegetation or improved bank stability?

- Is the plantation site in a regional council priority catchment or priority land management area for erosion?

- Does the plantation site meet the MPI criteria for earning carbon credits?

BASED ON THE INFORMATION IN SECTION 8, SOME QUESTIONS TO ASK ABOUT HIGH VALUE CULTIVARS ARE:

- Has that line of seedlings been planted at sites near your plantation site?

- Does the supplier have records of the survival and growth rate of those seedlings?

- Have those seedlings performed as well as their parent stock for the selected characteristics?

- What measureable difference to the selected characteristics make to plant performance?
 - For flowering duration, how many additional days of flowering have been measured compared with local plants?

 - For flowering density, what percentage of additional flowers have been measured compared with local plants?

 - For nectar DHA, what is the measured DHA in nectar compared with local plants?

- What percentage of plants survive to maturity?

BASED ON THE INFORMATION IN SECTION 8, SOME QUESTIONS TO ASK ABOUT ECO-SOURCED SEEDLINGS ARE:

Where were the seeds sourced from?

Do they have records of the parent plant location?

If the location is outside the plantation district or sub-region, or is a different land type or soil from the planting site, are closer seed sources available?

Can the supplier match seedlings to the different conditions at the plantation site? For instance plants from wetter areas for low lying gully areas, and dryland manuka for dry hillslopes.

BASED ON THE INFORMATION IN SECTION 8, SOME QUESTIONS TO ASK ABOUT PLANT ESTABLISHMENT ARE:

Is cost or timeliness a significant factor in establishing the plantation?

Can local nurseries provide the number of seedlings required at the time required?

Do we have the knowledge and resources to set up a nursery to provide quality seedlings?

Does the plantation site have small slip areas or bare soil where using slash would be appropriate? Is there a nearby source of mature seed-bearing foliage sufficient to cover the bare areas?

What size of seedling is recommended by nurseries and plant suppliers for the plantation site?

What is the trade-off between plant size and seedling cost? Will smaller cheaper plants survive and grow quickly compared to larger more expensive plants?

BASED ON THE INFORMATION IN SECTION 8, SOME QUESTIONS TO ASK ABOUT PLANT DENSITY AND ROW SPACING ARE:

What is our primary objective for plant spacing: honey production, oil production, erosion control, weed control, or something else?

Is access required for foliage harvesting?

What plant density will maximise flower numbers?

What plant density will achieve canopy closure for weed control?

What plant density will maximise erosion control or stream bank stability?

What are the implications of plant spacing on costs and potential income? For instance, at lower plant density, weed control costs may be a higher cost for longer than if plant density is higher. If plant density is higher, honey and oil yield may be lower than quoted industry maximums.

Based on decisions about plant density over the entire plantation area, how many plants are needed?

Is the plantation site eligible for planting grants from the Regional Council or MPI?

For that number of plants, what is the cost per plant for the preferred seedling type (eco-sourced, high value cultivar, standard seedling) and preferred seedling size?

If a planting contractor will complete the work, what does their price include? Seedlings? Transportation costs? Fertiliser tab? Initial weed control? How many releases? Is the price per plant, by area, or total plantation cost? Did they visit the plantation site before quoting?

What remedy is there if large numbers of plants fail?

If a weed control contractor will complete the work, what does their price include? Is it per plant, by area, or total plantation cost? Did they visit the plantation site before quoting?

What remedy is there if weed control damages plants either from residual herbicides in the soil before planting or over-spray after planting?

Is there a cost saving by purchasing seedlings and engaging individual planting and weed control contractors, or by engaging one contractor to complete all the work?

Who will carry out ongoing weed control? If a weed control contractor will complete the work, what does their price include? How many releases per year? Over how many years?

Is fencing required to exclude stock? Who will carry out this work and what is the per metre cost? If a fencing contractor will do the fencing, did they visit the plantation site before quoting? Does the price include gates and their installation?

Are pests present in high enough numbers to damage seedlings? If so, who will carry out pest control? If a contractor will do the work, what does their price include? Did they visit the plantation site before quoting?

BASED ON THE INFORMATION IN SECTION 9, SOME QUESTIONS TO ASK ABOUT PLANNING RULES:

Are there rules for vegetation disturbance and vegetation clearance?

Is mānuka or kānuka vegetation considered to be significant at any stage in its life?

If mānuka or kānuka is planted for production purposes, do the rules and/or ecological significance criteria still apply?

Are there any rules that might affect plantation management (thinning, pruning, replanting, weed control, removal), both at establishment and when mature?

Are there any rules for vegetation disturbance in erosion prone or riparian areas that might affect plantation management?

The answers to the questions above should help you to determine whether a plantation site is likely to achieve the objectives you have set. If plan rules allow long term productive use of the plantation and site conditions are appropriate for producing honey or oil, then the following simple questions will assist in establishing the basic business case for plantation establishment, i.e. will the expected revenue over the expected lifespan of the plantation exceed the expected costs to establish the plantation. These questions summarise the quotes provided by suppliers, contractors, beekeepers, distillers, and councils into costs and income, multiplied by the years over which they occur. If the business case is marginal, understanding the environmental and agricultural benefits more fully may provide additional financial justification for proceeding.

| | COST INFORMATION | INCOME INFORMATION |
|---|------------------|--------------------|
| PLANTATION ESTABLISHMENT | | |
| Establishment costs per plant or per hectare? | ● | |
| Plantation grants available? | | ● |
| Fencing grants available? | | ● |
| Annual weed maintenance costs? How many years? | ● | |
| Annual pest control costs? How many years? | ● | |
| Total Costs less Grants = Total Establishment Costs | | |
| HONEY INCOME | | |
| How many hives per hectare? How many hectares? | | ● |
| Start date for honey production? Likely number of productive years? | | ● |
| Minimum and Average yield per hive? | | ● |
| Minimum and Average price per kg yield of honey? | | ● |
| Annual plantation management & maintenance | ● | |
| Yield per hive x number of hives x number of years x price = Total Honey Income | | |
| Remember to account for lower yield in the early and later years of plantation lifespan. | | |
| OIL INCOME | | |
| Average foliage yield per hectare? How many accessible hectares? | | ● |
| Start date for foliage harvesting? Likely number of productive years? | | ● |
| Minimum and Average price per tonne of foliage? | | ● |
| Annual plantation management & maintenance | ● | |
| Yield per hectare x number of hectares x number of years x price = Total Oil Income | | |
| Remember to account for lower yield in the early and later years of plantation lifespan. | | |
| CARBON CREDITS | | |
| How many qualifying hectares? Start date for carbon credit eligibility? | | ● |
| Minimum and Average price per hectare? | | ● |
| Average/minimum annual revenue? | | ● |
| Total Carbon Credit Income | | |

