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Planting Manuka in the South Island of New Zealand to develop the economic value of manuka honey and the impact on the apiculture sector.

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Photo sourced from Taylor Pass Honey

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Executive summary

This paper is a literature review aiming to improve understanding of the potential of planting Manuka in the South Island to produce high value manuka honey, and what impact that will have on both the farming and apiculture sector.

It is obvious very early on in this process that while the Manuka honey boom seems to deserve the hype, the reality of delivering on this promise in the South Island, and particularly in areas where Manuka is not naturally occurring, isn't quite as straight forward as it seems.

In reviewing the history of manuka and the importance of manuka honey to the apiculture sector, I have been able to establish a very clear view of the position of this product in the market. This "excitement" is a double edged sword, products that have such a high profile and such high levels of interest quickly become the objects of strong worldwide competition and we are seeing this with Manuka honey at the moment.

The paper extends into the considerations for planting manuka in the South Island and whether in fact this is a viable option for most landowners and a review of available material, alongside my own commercial apiculture knowledge and that of others in my sector, would suggest that currently the unknowns outweigh the benefits and that it should be treated with caution.

This paper recommends farmers who are interested in profiting from manuka plantations should start with developing shelter belts, riparian margin and utilising the plant for erosion control. Farmers should harness the plants' natural ability to protect the land and still have full use of the land for farming, while claiming the carbon credits. Farmers should identify and partner with an apiculturist using the list of recommendations I have made in this paper to begin the process of capturing the nectar. Farmers can then be involved in the early establishment of new research and testing and have the opportunity to adapt and grow as key learnings are shared.

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Introduction

With world demand for more traditional health products increasing, one product that has soared onto the international market in the past decade is Manuka honey.

New Zealand is the only country in the world with the ability to produce the valued Manuka honey and work is currently being undertaken to trade mark the name (Manuka Ministry of Primary Industries, 2018, October 26). Recently the United Kingdom Trade Mark registry recognised Manuka honey as a certification mark. This is a large step towards protecting the integrity of Manuka on the international market.

The world demand for this high valued health product, Manuka honey, is far greater than what New Zealand can currently produce (Manuka Ministry of Primary Industries, 2018, October 26). This has created a hype around a plant that was once considered a weed. Planting programs are now emerging, the government is offering planting subsidies and the plant is on the “plants that count” for carbon credits list.

Once viewed as a nuisance product, Manuka honey has helped push hive numbers to almost one million domesticated hives. Most of the increased hive numbers occur in the North Island due to the Manuka there producing the highest value due to the dihydroxyacetone (DHA) content.

The Ministry for Primary Industries has introduced a new a scientific definition of Manuka honey to ensure the integrity of the product, which has thrown the industry into a tail spin.

With pressure on the North Island Manuka stocks, the South Island’s vast open, and retired farmland, a question that is currently being posed by local landowners is “should I plant Manuka?”

The aim of this paper is to give a better understanding of all the potential value to planting Manuka, including the impact on the apicultural sector, the benefits to farmers and bee keepers and the disconnect between the “hype” and the reality of what this transformational product can produce.

Methodology

The basis of the information in this report is a literature review of books, scientific research papers and consultancy websites. I have also included information based off 17 years of experience in the commercial apiculture sector.

I briefly discussed manuka plantation with a Plantation and Apiary Performance Manager from Manuka Farming New Zealand at the annual apiculture conference. I made contact through email and she recommended several research papers which gave me the starting point of my literature review. I selected and further researched the information I thought was relevant to the study’s aim.

The History of Manuka

Manuka has a long history in New Zealand and has been used in traditional Māori healing long before the healing properties of Manuka honey were discovered by European (Van Eaton, 2014).

Māori used all components of the Manuka plant. Manuka was placed on the bottom of canoes for the paddlers to sit or kneel on, and the long, stout trunks made good paddles. The strong and hard wood was used to make *korere,* sacred vessels and funnels, used to feed chiefs at times of high *tapu* (spiritual restriction), when they were not allowed to touch food and therefore had to be fed. Other implements included bowls, digging sticks, spears and various other domestic tools (Van Eaton, 2014).

Captain Cook brewed a beer from Manuka leaves in the confines of the Dusky Sound on the southwest coast of the South Island (Van Eaton, 2014). The crew boiled Manuka and Rimu leaves, strained the liquid and then added molasses. Once it had cooled, it was put into casks along with yeast. Captain Cook was so impressed that he later said, "Had I known better how this beer would have succeeded and the greater use it was to people, I would have come better provided" (Van Eaton, 2014).

Manuka was used regularly for the plant's healing properties (Van Eaton, 2014). A tea made from the plants leaves was a remedy for diarrhoea and dysentery and inhaling the steaming tea relieved the symptoms of a cold. The inner and outer bark of the tree was used to reduce fever and was helpful for mouth, throat and eye trouble. Seed pods were pounded into a poultice and applied to wounds and running sores (Van Eaton, 2014).

With society's shift from antibiotics and chemical drugs to natural health products, there is no wonder a plant with such a rich history for traditional healing has now come back into the spotlight.

While Māori found a multitude of uses for Manuka there was no honey in these early times. New Zealand hosts at least 28 different species of native bees, comprising of three genera, however none of these bees are honey producers (Van Eaton, 2014). It is important to note the arrival of honey bees in New Zealand was not until March 1839 when Mary Bumby, of England, arrived with two skeps of honey bees (Van Eaton, 2014).

Manuka and the early settlers

The spread of Manuka was influenced heavily by human interaction. Fires set by the early settlers to hunt the Moa encouraged the Manuka seed pods to burst and cleared the forests creating space for the Manuka plant to establish itself and grow abundantly (Van Eaton, 2014).

1840 saw a change in New Zealand with the Europeans turning the North and South Island into pasture-based farm land. The clearing of native forest continued with Europeans destroying the remaining native bush in half the time of the earlier settlers. Manuka and Kanuka took the place of the missing forest and its ability to regenerate in pastural areas made it a real nuisance to early food producers. This resulted in new and innovative ways to remove the plants, including chemical sprays, hard grazing of stock, and caterpillar tractors to roll and crush the plant (Van Eaton, 2014).

Manuka was subjected to early biological control. In 1937 dying Manuka trees were discovered in South Canterbury. The trees were being fed upon by a sap-feeding insect called Eriococcus (originating from Australia) that left the tree with blacken leaves and what appeared to be a sooty trunk, which eventual killed the tree. The infected trees were sold throughout New Zealand in an attempt to eradicate the Manuka species. But the Manuka plant recovered with the help of a fungus that attacked the scale insect (Van Eaton, 2014).

Workers were brought into New Zealand specifically for clearing of the plant. At one point it was believed that the removal of Manuka was critical to the survival of high-country food production (Van Eaton, 2014).

Manuka (*Leptospermum scoparium)*

Agriculturists who considered Manuka a weed and worked hard for decades to eradicate the plant are now considering its cropping potential. The question is "what is the best way to do this" and most importantly what are the implications of doing so.

Firstly, it is important to understand the Manuka species across New Zealand and the variation within the species. Initially, there was thought to be three species of Manuka native to New Zealand; *Leptospermum scoparium*, *L. ericoides*, and *L. sinclairii.* Later *L. ericoides* and *L. sinclairii* were reclassified as Kunzeas, commonly known as Kanuka. Consequently, *L. scoparium* is the only species of Manuka indigenous to New Zealand. Within this species there is genetic variation that results in different appearances in the plant such as growth habit, leaf size, leaf density, and stem and foliage colour. These differences are seen in different regions within New Zealand and may be due to varying environmental conditions (Stephens, Molan and Clarkson, 2005). For example, L. scoparium seedlings were transplanted from Central Otago to Dunedin and immediately grew larger leaves but the genotype remained the same (Burrell, 1965).

The nectar produced by *L. scoparium* is also subject to large variation within the species. The honey produced from Manuka commands a premium internationally because of the nonperoxide antibacterial activity (NPA). The activity has been linked to high levels of methylglyoxal found in mature honey. The methylglyoxal (MGO) comes from dihydroxyacetone (DHA) found in the nectar of Manuka. It is unclear why some species of Manuka produce dihydroxyacetone and why the variation exists. The variations of NPA in manuka honey harvested from different regions indicates indirectly the regional variation (Williams, et al., 2014).

Manuka is insect pollinated. *L. scoparium* has small white, open-access bowl shaped flowers which are visited by a range of insect pollinators. Several different species of flies, bees and moths have been recorded to visit the flowers at different periods of the day. This shows *L. scoparium* is a non-specific pollinated plant (Stephens, Molan and Clarkson, 2005).

Unfortunately, some insect pests are also attracted to Manuka. Scale insects*, Coelostomidia wairoensis*, *Eriococcus orariensis* and *E. leptospermi* produce a sooty mould on the stems of infested plants and on the resultant honey dew (Stephens, Molan and Clarkson, 2005). The scale insects remove the plants nutrients, weakening the plant, so they are unable to survive environmental stress and the sooty mould on the leaves reduces the efficiency of photosynthesis. Other pest insects include the Manuka beetle (*Pyronota* species) although they tend to prefer to eat grass root material than manuka and may help with pollination; the leaf feeding manuka moth (*Declana floccose*); webworm (*Heliostibes atychioides*); the wood-boring larvae of the longhorn beetle (*Ochrocudus huttoni*); and the gall-forming mite (*Aceria manukae*) (Stephens, Molan and Clarkson, 2005).

The value of Manuka as a protective scrub should not be overlooked. It provides excellent protection from shallow landslides. Mature stands help with soil erosion as the leaves can catch up to 40-50% of the rainfall in storm events. The roots bind together to help prevent soil erosion. Carbon accumulation is rapid and similar to plantation forest (Stephens, Molan and Clarkson, 2005).

Manuka has a life span of 30 to 60 years, it is usually succeeded by forest species. The seeds require high light for germination (the Manuka and Kanuka plantation guide 2017)

Products of Manuka

Currently, products harvested from the Manuka plant on a commercial scale are Manuka oil, Manuka Honey and more recently Manuka leaves, which are starting to be harvested for making tea.

Manuka Oil

Manuka oil is currently distilled in New Zealand from Manuka plantations. As with Manuka honey there are different types of oils produced from the plant. In the East Cape the oil has high levels of Triketones (a chemical compound containing three Ketonic Carbonyl groups), which has activity against pathological bacteria and some fungi. This is considered high value oil (New Zealand Institute for Crop & Food Research Ltd, 2000).

The oil is extracted by heating the oil sacs on the Manuka leaves so the oil evaporates and then is distilled off. The branches are cut and left to wilt before distillation which can occur at a lower moisture content for more efficient distillation. Manuka oil distillation takes between 2-6 hours (New Zealand Institute for Crop & Food Research Ltd, 2000).

Manuka oil is used topically as an external antiseptic (New Zealand Institute for Crop & Food Research Ltd, 2000).

Manuka Honey

Twenty years ago, Manuka was an undesirable honey and often fed back to hives as the value was so low. Nowadays, Honey is now the premium product produced from Manuka. Prices range from $16.00 per kilo to over a $100.00 per kilo for bulk trade. Apiculturists are currently offering landowners between 10-30% of the value of the honey produced from each hive site as payment for the land their hives are located on. The manuka honey crop variation from season to season can be up to 15-50kg of honey produced per hive. The national average yield (of all honey types) for a beehive is 36kg of honey per year. This is the main drive behind the planting programmes.

What makes Manuka honey so special?

Dihydroxyacetone (DHA) is found in the nectar of Manuka flowers. The DHA starts a chemical change when it is collected by the honey bee. The bees add a glucose oxidase enzyme to the nectar to ripen it, this in turns starts a chemical reaction that increases the methylglyoxal (MGO). MGO is directly responsible for 90-95% of Manuka honey's special antibacterial activity (Van Eaton, 2014).

The world hype for Manuka honey has created considerable changes in the Apiculture sector. The number of hives have increased, the price of manuka honey has increased and the Ministry of Primary Industries (MPI) has introduced the Manuka honey standard (Ministry for Primary Industries, 2018 February).

Registered hive numbers have soared from 2012 when there were 422,728 hives in New Zealand to 795,578 hives in 2017. In 2010, 18 operators running 3000 or more hives was considered a large operation. In comparison, in 2017 there were 43 operators running 3000 or more hives (Ministry for Primary Industries, 2018 February).

Honey prices have increased right up until 2017. In 2012 honey prices for bulk light coloured honey (for example clover) per kilo ranged between $4.40-$7.30 whereas in 2017 it ranged between $10.00-$14.00/kg. In 2012 honey prices for bulk Manuka ranged between $8.00-$50.00/kg and in 2017 they ranged between $10.80-$127.00. The average export price per kilo for New Zealand honey has reached $38.92 in 2017. That is an increase of $23.14 per kilo from 2012. The export trade value of honey has increased from $121 million in 2012 to $329 million in 2017. This data shows a significant increase in value of all honeys in particular manuka honey over the past 5 years (Ministry for Primary Industries, 2018 February).

In 2018 MPI introduced the new Manuka standard. This standard was introduced to protect the reputation of Manuka being produced in New Zealand and is to help keep the confidence of export countries that they are receiving genuine Manuka honey (Ministry for Primary Industries, 2018 July 16).

Figure 1 shows the manuka honey definition is made up of a combination of 5 attributes (4 chemicals from nectar and 1 DNA marker from Manuka pollen). This allows the industry to separate manuka honey from other honey types. It also identifies it as either monofloral or multifloral manuka flower. In response to industrys feedback MPI increased the required level of one of the chemicals (2'- methoxyacetophenone) that has only been found in Manuka plants to date. This has made it harder for anyone to attempt blending different types of honey with Manuka honey to meet the definition (Ministry for Primary Industries, 2018 July 16).

Figure 1: The Ministry for Primary Industries Science Definition of Manuka Honey
Source: (Ministry for Primary Industries, 2018 July 16).

Since the MPI manuka standard was introduced Manuka standard light honeys and other non-Manuka prices have dropped with some honeys currently trading at $6.50/kg.

Collaboration between the Apiculturist and the Food Producer

The improved price for Manuka honey has forced a shift in the dynamics of the apiculturist and food producer relationship. The high value Manuka honey created competition between apiculturists for sites situated near manuka stands. The once relaxed relationship that saw the beekeeper slip on and off the property with the odd pot of honey turning up on the door step is now a thing of the past.

The old spoken gentlemen's rule of keeping your hives' site 1.5 kilometres (distance varies dependant on which beekeeper you talk to) away from your neighbouring beekeeper is no longer abided. The hives are stacked against the land boundaries as apiculturists chase the Manuka.

Hives that were once placed on farmers properties for clover pollination are now being flown into the high country in search for Mono-Manuka.

Apiculturists are presenting food producers with contracts to get security for their investments in beehives. Planting programmes for Manuka are encouraged.

However, the question remains "how does a food producer make the correct decision to collaborate with an apiculturist?". The apiculture sector is unique due to the fact apiculturists are dependent on permission from food producers to access their properties. Apiculturists generally do not own the vast amount of land required to run a financially viable operation. MPI has reported that over the last few years many beekeepers have been asked to leave sites they have occupied for many years because the food producer has been offered a better deal by another competing apiculturist. Now reports are emerging of food producer dissatisfaction with beekeeper's management techniques on their properties, mainly around harvest time (Ministry for Primary Industries, 2018 February). With these types of reports emerging it may be prudent for food producers to consider other factors when partnering with an apiculturist.

What should a food producer look for when partnering with an apiculturist?

With the food producer and apiculturist relationship entering relatively uncharted territory, there is a new player in the game that has not been there before, that of the Manuka value. Normally when food producers planted crops which required pollinating, the beekeeper would be paid for their service of providing bees. For example, cherry orchards are reliant on bees for pollination requirements.

With the seasonal variations that apiculturists faced to produce an income, many saw pollination services of the clovers as a fair exchange for being on the property. At the time, paying for a site ten years ago seemed like a ludicrous idea due to the prices of honey. The change in the value of Manuka honey has moved the apiculturist to look to secure their food producer relationship. The value of Manuka and its scientific healing properties is constantly discussed. In turn food producers are looking to plant manuka with the intention of making a return from the apiculturist.

With the high value Manuka predominantly in the North Island, there has been a knock-on effect in the South Island of food producers questioning "should my apiarist pay to be on my property?".

The further south you head the harder it is to produce Manuka. The plant is there but it is always in competition with clover, making it difficult to produce a mono-manuka.

The food producer-apiculturist contract needs to be sustainable for both parties, with consideration of the value of the product produced. It is a good start to have a contract in place to outline expectations. Generally, if partnering with a new operator it will take a couple of years to truly understand how a property behaves with flowerings. If the operator has experience within their region this should not be an issue.

When a food producer partners with an apiculturist there are a few considerations (for wild stands of Manuka).

What is important to the food producer?

It is important to keep in mind with all the hype about Manuka that bees are still valuable pollinators, with an important role to play in a variety of crop pollination. Clover pollination is still very important. Often the two crops can flower at the same time. It is important to be clear what is important to the farm. It is suggested to have an agreement that hives remain in clover sites to ensure pollination occurs.

What type of contract is offered?

The apiculturist will offer a fixed hive rate, for example $40 per hive placed or a percentage of the honey yield, which can vary between 10-30% of the honey produced. It is sensible to have a scaling contract when manuka is involved. For example, UMF 5 at 10%, UMF 10 at 20%, UMF 15 at 30% of the honey yield and value. It is important to have a sustainable contract that represents the risk of seasonal variation for both parties.

Skill of the apiculturist

What knowledge of the area, flowering and weather patterns does the apiculturist have?

What ability does the apiculturist have to stock the property accordingly, covering both Manuka and pastural land? The food producer needs to know their requirements and density of manuka. The manuka wild stands stocking rates are 1-2 hives per ha.

What is the apiculturist's reputation as an operator?

What is the apiculturist's Health and Safety Plan?

What is the apiculturist ability to handle your product correctly? Is the apiculturist resourced to adequately handle a large honey crop if one was to occur? Hives can produce between 15-60kg per hive and on the rare occasion produce as much as 100kg per hive.

What is the apiculturist's disease management plan and what is the current American Foul Brood (AFB) level? AFB is a bacterial disease that attacks the larvae of the bee and spreads rapidly and easily when proper care is not taken. Eradication of the hive is the only treatment option when the disease occurs and this includes any honey produced if it is present on the hive at time of AFB detection.

What is the apiculturists traceability for honey boxes and how are they reporting accurate information on yields and honey quality per food producer?

Can the food producer source independent advice on honey price from a creditable source? How is the apiculturist going to source the best price?

What is the potential for long term jeopardy for the relationship?

The agreement should be viewed differently when the food producer is partnering with an apiculturist alongside manuka planting programmes aiming to produce high value Manuka with increased yield. All the above is still relevant. However, in the case of planting it would be fair to express expectation about the quality of hives that are coming into the plantation. Hive strength is extremely important to ensure the short window for nectar collection is achieved. For example the hive should have 7 frames of brood at all stages and have bees covering a minimum of 12 frames. The strength requirements are dependent on the time of year. An agreement should be made that is suitable for both parties.

The apiculturist will have expectations from the land owner. The track access must be safe. Location of hive sites are important. North facing, wind protected sites are always preferred for hive placement. The hives should be secure from intruders or thieves, especially when dealing with high value Manuka. The apiculturist will need access to good spring areas for building up hive strength. These are generally near the front of the farm and easily assessible as the apiculturist will need to visit them frequently. A bee safe spraying programme should be implemented.

Through all this it is important to remember the crop yield is still subject to weather and nectar availability. Not to mention that bees will always look for the best source of nectar and that may not be Manuka.

Manuka Planting Programmes

With interest growing in planting programmes for Manuka it has become increasingly important to know what is currently growing in your area/farm especially when Kanuka is present.

How to distinguish between Manuka and Kanuka

Manuka and Kanuka are two very similar species which are easily confused.

(Avoca Life, 2018)

- Young plants before flowering and seeding have a distinctly different feel to them. Manuka leaves are rough and sharp to the touch whereas Kanuka leaves are soft to the touch. As the leaves mature the sharper the difference. Māori have a simple way of remembering, Kanuka is “kind” (soft), Manuka you need to “mind” (prickly)
- Manuka seed capsules are larger, generally (5-10 mm) in diameter and generally don’t fall after flowering. Kanuka seed capsules are smaller (only 2-4 mm) in diameter and will fall after flowering
- Manuka flowers are 3 times the size of Kanuka flowers.
- Manuka is particularly susceptible to invasion by scale insect leaving the plant with a sooty mould growth. Kanuka is more resistant to the scale insect

- Manuka is smaller. It is usually 2-4 metres tall but known to grow up to 8 metres with multi stems diameters of 10-15 centimetres. Kanuka is larger and is more tree than shrub like with trunks up 30-60 centimetres and can grow upwards of 15 metres.
  (New Zealand Institute for Crop & Food Research Ltd, 2000).

The ability to tell the species apart will become an essential skill when identifying potential Manuka stands. The information collected from nectar, oil and honey samples will confirm existing Manuka plants and play a considerable role when planning a planting programme best suited to the area. Knowing the dominant species on the property will help food producers, apiculturists or any other interested parties to make informed decisions on harvest times and yield opportunities, which will help identify high value product. If there are high value manuka plants present on the property, they will be the plants to propagate from because they have adapted to the growing conditions.

Once wild manuka has been identified nectar sampling can be performed. The dihydroxyacetone (DHA) content in the nectar can be measured to determine the value of the plant (see *Appendix 1: Nectar Sampling Protocol*). The higher the DHA content, the higher the potential for a higher Unique Manuka Factor (UMF) honey to be produced. The UMF is a measurement of the ability of manuka honey to inhibit bacterial growth and greatly affects the value of honey (Van Eaton, 2014).

The age and sex of the flowers can affect the DHA value. In new flowers the hypanthium is green and as a rule of thumb the hypanthium turn red with age. DHA and Tsugar values are higher in the red hypanthium. The sex of *L.scoparium* flowers are andromonecious (a plant that has hermaphrodite and male-only flowers). Studies have found the male flowers have significantly higher DHA/Tsugars (Williams, et al., 2014).

Planting Manuka

If wild stands are present is there value in planting additional manuka plantations?

There is an opportunity to plant different plantations of Manuka to harness the different uses of the plant. It is important to note that all types of Manuka honeys have a strong value and are a sort after commodity by the apiculturist. Planting manuka also provides a viable option for diversification of income with carbon zero farming, shelter belts for erosion control and improving water quality.

Improved water quality, shelter belts and erosion control are valuable contributions of planting manuka but when planting for these options the income potential is considerably lower. The carbon credits are more valuable (Boffa Miskell Limited, 2017).

Carbon Storage

Carbon credits (NZUs) can be earned for any forest established after 31 December 1989. Carbon sequestrations is a technical term for carbon storage, where carbon is stored as organic material in the wood, foliage and roots of trees (Boffa Miskell Limited, 2017).

To be eligible the forest must be at least one hectare, at least 30 meters wide on average, have tree crown cover over at least 30% in each hectare, and have the potential to reach a minimum of 5 meters high at maturity. This includes Manuka. However, if the Manuka is manged in such a way that it will not reach the required 5 meters in height at maturity, that forest may then not be eligible for the ETS (Emissions Trading Schemes) or PFSI (Permanent Forest Sink Initiative). This is particularly important if planting for honey or oil production where the height is managed (Boffa Miskell Limited, 2017).

The market value of NZUs is generally $20/t of carbon sequester (Boffa Miskell Limited, 2017).

Water Quality and Shelter Belts and Erosion control

Manuka offers the potential for shelter belt planting for shading stock. When planted along streams (riparian margin) Manuka provides much needed organic debris and helps improve water quality. Their tight binding roots can help stabilise stream banks. Planting for erosion control is a sustainable option. Manuka is fast growing and the strong roots are flexible and elastic. The Manuka roots bind the soils at a depth of 0.5-1.0m preventing shallow landslides. Manuka, when closely spaced, can become an effective source of erosion control within 5-8 years (Boffa Miskell Limited, 2017).

The potential for Manuka honey production is possible but it will more than likely be a multiflora Manuka honey produced, which is a lower value honey, due to inability to prevent bees from foraging off other flower types. Manuka is typically not the first-choice nectar and pollen source for bees.

However, there are many benefits of bees to the food producer. Pollination of all flowering plant species is extremely important for pasture production. There are techniques apiculturists can attempt to produce mono-manuka. This can be difficult and will add cost to the apiculturist's operation if unsuccessful. It is important that when learning to crop any product there is some degree of trial and error. Record keeping by both parties, such as soil temperature and when the manuka and competing crops flower is invaluable information when attempting to produce a mono-flora Manuka honey (Boffa Miskell Limited, 2017).

Planting for Manuka Honey production

Manuka plantations are in their infancy. A lot of research is being conducted into understanding the most efficient way to crop manuka. It is generally agreed that the plant starts to yield nectar after 3-6 years. The high performance Manuka plantation PGP programme suggest reasonable quantities of nectar are produced from years 7-8 but that it could take up to 13 years for Manuka plants to reach full production (Mac Intyre, 2017).

The Primary Growth Programme (PGP) has been researching and developing techniques for manuka plantation husbandry for honey production. PGP has made their information available to help potential planters make more informed decisions. The high-Performance Manuka programme started in 2011 and is still currently running (Mac Intyre, 2017).

PGP suggest that it is difficult to ensure the quality of Manuka in small plantations as the bees are capable of foraging up to 4km from their hive. This would mean a plantation would need to be 5000 hectares with canopy enclosures and centrally placed hives to prevent competing nectar from outside sources (Mac Intyre, 2017).

South Island planting programmes for Manuka present more challenges as the bulk of the research has been completed in the North Island. The South Island's colder climate and the origin of the higher DHA content plants in the North Island present their own unique challenges. It would potentially require the development of a cold tolerant cultivar, which would be cultivated from existing plants (Mac Intyre, 2017).

It is suggested to contact planting consultants when considering planting Manuka. Understanding the best planting style for the desired outcome for the manuka plantation can be tricky. Planting costs between $2000 to $2500 a hectare depending on the control methods required before planting.

Manuka plantations will require constant maintenance to ensure the best growing conditions for the earliest possible nectar production if targeting honey production.

Afforestation Grant scheme is available offering $1300 a hectare to approved planting plans, in exchange for the first ten years of carbon credits produced. As mentioned earlier this would depend on what was the target production as cropped manuka may not make the requirements (P. F. Olsen, n.d.).

Viability of Manuka farming in the South Island

Manuka Farming New Zealand (2018) has researched and prepared models to illustrate the viability of establishing and managing manuka plantations. This research has concentrated on farms in the North Island with reference to North Island growing conditions and rainfall. To accurately compare these models to South Island conditions we need to take into consideration the shorter growing season, variable rainfall, harsher winter conditions and longer establishment times. The impact of pests and weeds will also have a bearing on establishment. Much of this land has been over-sown with exotic grasses including clover and had super phosphate and sulphur applied. Once grazing stops weeds take over as has been demonstrated when land has been retired and subsequently has been over-run with pines (Manuka Farming New Zealand, 2018).

The information from Manuka Farming New Zealand (2018) presentations demonstrate the comparison between existing land use and the viability of establishing and tending a manuka plantation.

Figure 2 contains the key assumptions for establishing a plantation (Manuka Farming New Zealand, 2018)

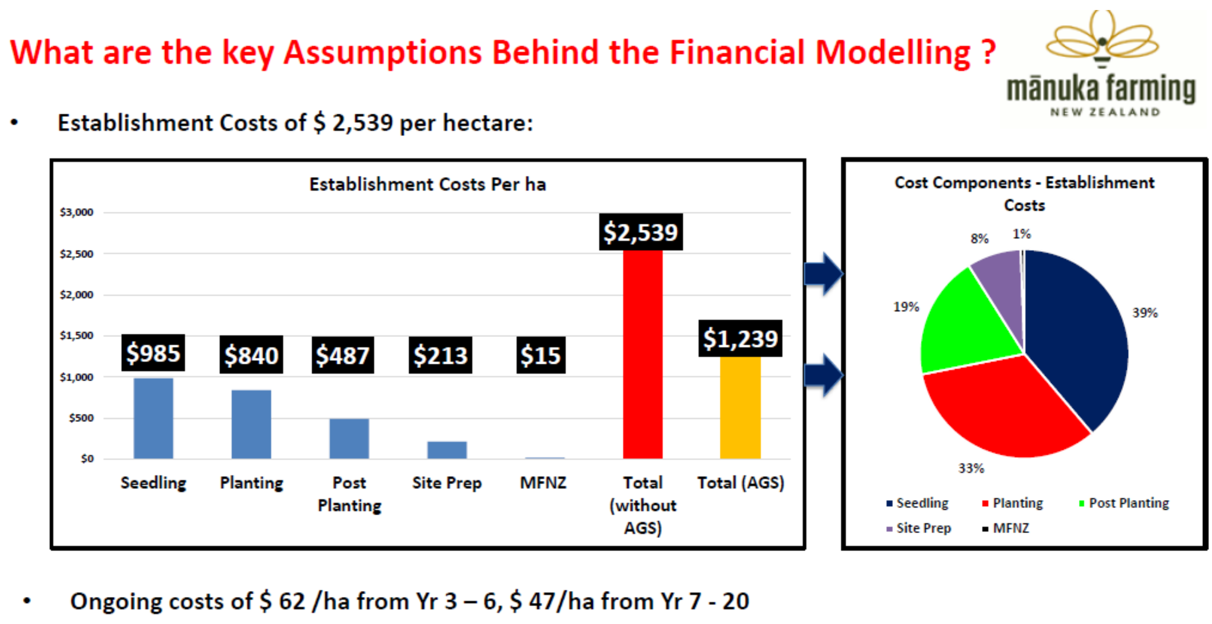

Figure 2: Cost analysis of establishing a manuka plantation
Source: (Manuka Farming New Zealand, 2018)

For the South Island with a reduced growing season and a history of dry summers I believe the establishment time could be up to eight years and the time to full production could be twelve years. I base these assumptions on fifteen years experience of harvesting honey in the South Island.

The longer establishment time and the increased time to full production will also impact on the return over time to the landowner.

Manuka Honey Income Assumptions

Manuka Farming New Zealand (2018) have based their manuka honey income assumption on beehives producing 40kgs of honey and a constant gate price. See *Table 1: Prediction of earnings from manuka honey from a manuka plantation site over 20 years*.

Table 1: Prediction of earnings from manuka honey from a manuka plantation site over 20 years

	Inputs for 20 Year Financial Projection	
	Key Variables	**Target**
1	Plantation Size (ha)	**100**
2	Hives per Ha (at peak)	**1.5**
3	Total Honey Production per Hive	40.00
4	Mānuka Honey as % of Total Honey	80%
4a	Mānuka Honey (kg)	4,800
5	UMF Value	15
6	Price for kg Mānuka Honey	$72.45
7	% Share of Returns to Landowner	30%
8	% of Plantation Size in receipt of AGS Funding	90%

Honey	**Gate Price**
Amber Clover	$10
Mānuka UMF 5	$21
Mānuka UMF 10	$37
Mānuka UMF 15	$72
Mānuka UMF 20	$130

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Source: Manuka Farming New Zealand, 2018

Table 2: Current gate prices sourced from Taylor Pass Honey

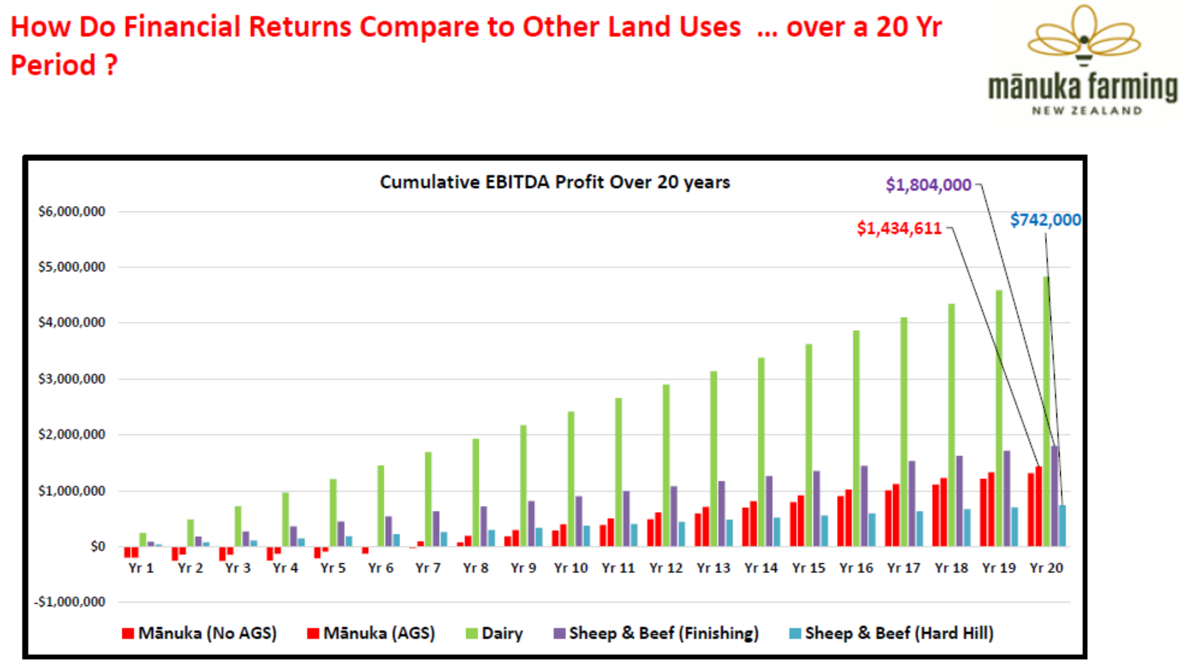
Honey Type	Price per Kg $	% Return to Land owner	Income per Hectare landowner (1.5 hives 40Kg per hive)
Mono-floral Manuka non-active	18.00	10%	$108
Mono floral Manuka +5 @	22.00	10%	$132
Mono floral Manuka +10	48.00	20%	$576
Mono floral Manuka +15	80.00	30%	$1440
Multi Floral Manuka	14.00	10%	$84
Multi Floral Manuka +5	16.00	10%	$134

Source: Kelvin Deaker, 2018 October 23

The price of manuka honey per kilo in *Table 1* and *Table 2* are comparable. They show the wide variation between the various types of honey and the impact this has on the income of the land owner. All factors must be in perfect alignment for the landowner to receive the top return.

Table 3 from Manuka Farming New Zealand (2018) demonstrates a 20 year income comparison between current farming types and a manuka plantation.

Table 3: A comparison of income from manuka plantations to other farming possibilities



Source: Manuka Farming New Zealand, 2018

Table 3 highlights the long lead in period before any revenue is generated from a manuka plantation. When this is overlaid with fluctuating world markets and the reliance on exporting to receive the maximum price it is easy to see why landowners are reluctant to invest. The table does not take into consideration the South Island where inputs and stocking rates much lower. Further analysis of South Island pastoral practices would need to be undertaken before any definitive conclusion could be made on changing from Merino farming to establishing manuka plantations.

Conclusions

Planting Manuka to take advantage of the potential income of producing high value Manuka honey continues to be a topic of interest for most land owners. Farmers are not immune to the hype of the manuka honey market as it is a product that seems to have a large return on investment.

I began this project with what I thought was a clear understanding of the response I would make to the question, “should I plant Manuka on my farm?”, and having begun the process of researching this more thoroughly I feel I am unable to provide a categorical answer.

Manuka will certainly have its place in the agriculture sector in the future. The natural characteristics of manuka plants will benefit landowners through shelter belts, riparian margin, erosion control and carbon omission. Although, the plantations success of producing high value manuka honey is still relatively unknown. Manuka’s ability to adapt to almost any environmental challenge makes it worth planting but unfortunately understanding the plant’s honey producing potential is proving to be the difficulty.

Manuka plantations for cropping are still in the early stages of development. With plantations starting to reach maturity in the next ten years, it will be imperative that we continue to research outcomes to see if the predicted numbers currently circulating are vindicated.

It is clear that planting Manuka is a long term investment with no returns for the first three years.

Manuka honey is the true driving force for plantations with the future for Manuka honey looking strong on the world stage. However, with the attention the honey receives overseas pushing other large honey producing countries to take a closer look at establishing a competitive product, New Zealand must be prepared to be out matched by a larger more agile, less constrained competitor. Food and health product trends can come and go very quickly and therefore the planting of Manuka should be approached with caution as the returns are strongly based on current reputation.

Though plantations look to be successful in the North Island where growing time is longer and there appears to be less competing pasture, there has been no work done to date on whether a high DHA producing cultivar would even survive in the South Island.

Recommendations

My recommendations at this early stage of my ongoing research and that of others are:

- Land owners should consider planting a manuka plantation in the South Island as a long-term investment.
- Farmers should start planting manuka in areas that still allows full use of the land for farming.
- Farmers should plant manuka when they require shelter belts, riparian margin and erosion control to harness the natural ability of the plant.
- Farmers should plant manuka to offset carbon omissions.
- Farmers should partner with an apiculturist using the list of recommendations made earlier in this paper and begin the process of capturing the nectar and potential income.
- Farmers should be involved in the early establishment of new research and testing to have the opportunity to adapt and grow as key learnings are shared.
- Ongoing research on the performance of manuka plantations should continue.

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Appendix

<u>Nectar Sampling Protocol</u> by Georgie Hamilton, June 2016. Sourced from Maggie Olsen, maggie@manukafarming.co.nz 2018

Nectar sampling is important to get an understanding of the DHA content of the nectar within a stand of manuka. This is because DHA is the precursor to MGO in the honey, so the higher the DHA in the nectar the better potential for high UMF honey to be produced.

<u>Preparation: weigh and label sample tubes before use. This will help in volume and sugar measurements.</u>

Step 1: The first step involved in sampling is determining which trees to sample in order to get a representative idea of the potential at a site. There is a lot of variation in the quality and quantity of nectar between trees within a stand so a minimum of ten different trees for each site/stand of manuka should be sampled to get a representative sample.

The sampler will have to use some common sense to pick a representative selection of trees when choosing what to sample, however when choosing which trees to sample there are a few things to consider:

Accessibility; generally for a site it is good to cover a range of trees across a reasonable area, however this needs to be within reason so that the sampling can be done in a reasonable time frame.
Choose the trees so all trees are within 20 minutes walking time from each other is reasonable, i.e.: don't just sample 10 trees all next to each other. For large stands of manuka, multiple sampling areas may be chosen to account for natural variation.

Ability to reach flowers; some larger/older trees will only produce flowers on new growth and so it may be hard to reach the flowers especially when there is canopy closure. Our research so far shows that there is no significant difference between old and young manuka trees in the same stand, so it may be better to sample some younger trees if this is the case.

Noticeable differences in the tree phenology; some sites may have more than one variety of manuka growing naturally. If there are any obvious differences in leaf colour or form/shape, or flower colour or size, this may be indicative of different genotypes. In this case it is recommended that representative samples are taken from each of these.

If a site has particularly rough, exposed or extreme conditions and there is manuka growing there, this may mean that this manuka is relatively hardy. Testing some of these plants may be useful as they already are displaying good survivability characteristics.

Step 2:

Look for a fine gap in the weather of at least 24-48 hours without rain (if it rains it will wash out or dilute nectar).

Step 3:

Place a mesh bag on trees to be sampled [see Figure 1]. The bags are necessary to stop the insects from taking the nectar so that it can pool in the flower. Each bag needs to cover at least 15 flowers that are at stage 4 [see Figure 2]. Each tree should be tagged with a metal coding tag and a GPS mark. of the tree position should be taken. This is so that trees can be identified for future sampling or to return to in the autumn to collect seed.

<u>Figure 1: Mesh bag on tree</u>

Stages 1-3 Flower begins to open and produce nectar.

Stage 4 – petals and anthers open, nectar production fully, time for nectar sampling.

Stage 5 – petals and anthers begin to fall off, nectar production begins to stop.

<u>Figure 2: Stages of a flowers development; stage 4 is the stage at which to collect nectar.</u>

Step 4:

The mesh bags need to remain on the flowers for 24-48hours.

Step 5:

Fill the chilly bin with ice and head to the first tree to be sampled with the nectar sampling equipment [see Figure 3].

Figure 3: Nectar sampling equipment.

Step 6:

Remove the mesh bag carefully from the tree and using the forceps, pick 15 flowers that are at stage 4. Place these flowers into the flower holder. Note: When picking the flowers it is helpful to leave a bit of stem attached as it makes them easier to hold when collecting the nectar.

Step 7:

Place the flower holder with the flowers inside onto the ice in the box.

Step 8:

Fill the cap with deionized water using the squeezy bottle, sit this cap on the ice too.

Step 9:

Pick a sample tube from the bag and place upright on the ice – ensuring no melted ice will get inside. Write down this sample tube's number and the code given to the tree being sampled in a notebook. One sample tube is used per tree.

Step 10:

Place a clean pipette tip onto the pipette and set the pipette to 5µl. Appendix 1 shows how to use a pipette correctly if you are unsure.

You are now ready to sample the flowers.

Step 11:

Pick up the first flower out from the flower holder and using the pipette carefully suck 5µl of deionized water from the cap. Squirt this water onto the hypanthium (base of the flower where nectar is located), now using the pipette carefully suck up the nectar/water solution into the pipette tip. The goal is to "wash" the nectar from the flower, dissolving it with the added water. Squirt this solution into the sample tube; it may take several pipette transfers to get all of the nectar/water solution off the flower and into the sample tube. When you cannot suck up any more liquid, discard the flower.

Step 12:

Repeat Steps 10-11 for the remaining 14 flowers. Note: Nectar/water solution from all 15 flowers from a tree is put into the **same sample tube** to create a pooled sample for each tree. Each sample tube should have at least 75µl of the nectar/water combination.

Step 13:

Close the lid of the sample tube (label if necessary) and leave in ice box.

Step 14:

Tip out the remaining deionized water in the cap and remove the used tip from the pipette. A new pipette tip is used for each tree to prevent contamination.

Now move to the next tree to be sampled and repeat steps 5 to 13.

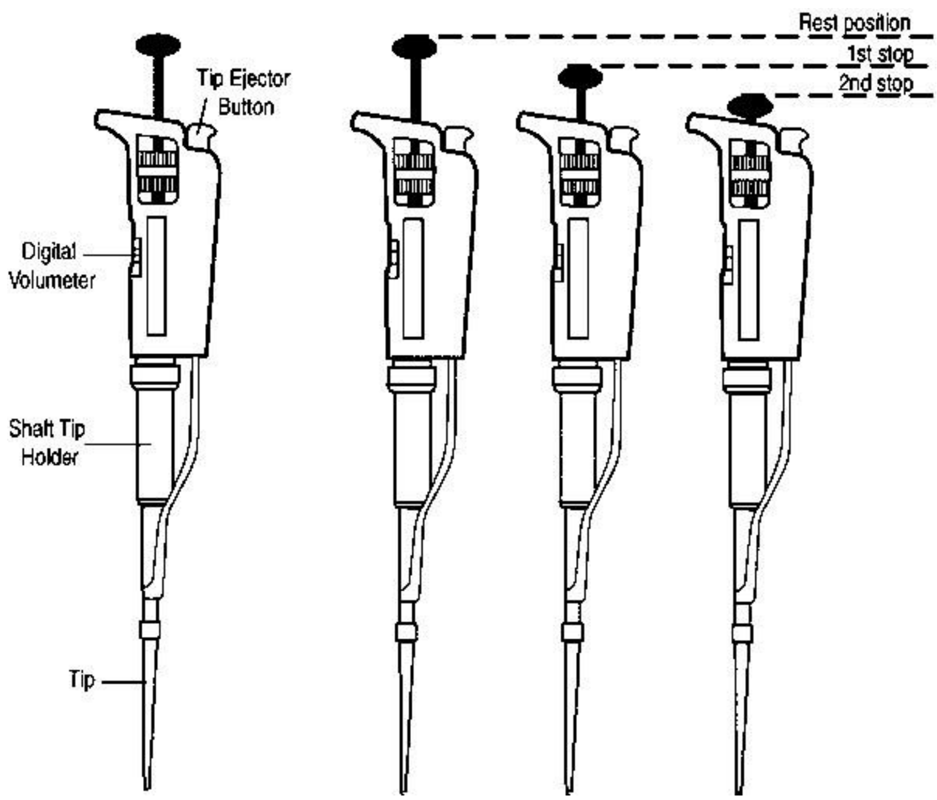
Step 15:

Once all trees are sampled, the sample tubes should remain in the ice until you return to a location with a freezer. The samples should remain frozen until they are ready for analysis as fermentation will affect the nectar analysis. Samples should be stored for no longer than 1 week at -20˚C, after that they should be stored at -80 ˚C until analysis can take place.

Note: If going to be in an area away from a freezer for more than a day then normal ice will melt quickly. Dry ice should be used in this situation. If samples are to be couriered for analysis they should be sent on dry ice, they cannot be sent by NZ post due to dry ice restrictions.

BOC gas has stores in main centres throughout NZ and can provide dry ice ($7.40/kg). Logical Freight Solutions can provide dry ice and courier for samples on dry ice.

Appendix 1: How to use a pipette correctly (Maggie Olsen from Manuka Farming New Zealand, 2018)



Instructions for pipetting liquids using a micropipette

1. Micropipettes have 3 positions:

1. Rest position
2. First stop
3. Second stop

2. Fit the tip to the end of the shaft. Press down and twist slightly to ensure an airtight seal.

3. Hold the pipette in a vertical position. Depress the plunger to the first stop. Air equal to the volume of the setting (e.g. 5 uL) is displaced.

4. Immerse the tip into the liquid. Release the plunger back to the rest position. Wait a second for liquid to be sucked up into the tip. The volume of liquid in the tip will equal the volume of the setting of the micropipette.

5. Place the tip at an angle (10° to 45°) against the wall of the vessel receiving the liquid, for example a well of a microwell plate or sampling tube. Depress the plunger to the first stop, wait one second, press the plunger to the second stop to expel all the liquid

6. Move the end of the tip away from the liquid. Release the plunger to the rest position.