Investors in the High Performance Manuka Plantations Primary Growth Partnership Programme

Progress Review of the High Performance Manuka Plantations Primary Growth Partnership Programme

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sapere research group

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Key Points

- The High Performance Mānuka Plantations PGP Programme ('the Programme') started in 2011 with the objective of developing techniques in mānuka plantation husbandry for honey production.
- Plantation mānuka for honey is in its early stages. This Programme is part of the journey of research and optimisation that is needed to generate proven results over the life-time of plantations. Now, 6 years into this Programme, material quantities of nectar are beginning to be produced.
- Given the challenges found in growing plantation mānuka, the Programme has made good progress. It has provided a foundation of good information on establishing plantations and produced nectar with significantly higher anti-bacterial activity potential - dihydroxyacetone (DHA) - than wild local mānuka. The work planned for the remainder of the Programme has the right priorities. Some additional work on viable plantation size, and extension activities are recommended.
- Governance and management of the Programme are effective and focused.
- External factors such as (i) the development and implementation of a scientific definition of mānuka honey when sold as a food, and (ii) grants for afforestation, are positive influences on the Programme and should assist with achieving the outcomes.
- The Programme's work has shown that finding the right combination of land, climate, scale and drive to establish successful plantations is likely to be demanding; hence, the volume of suitable land is lower than original estimates. Once suitable blocks of land are identified, carefully planned and executed establishment of mānuka plantations appears to be a very attractive and profitable option compared with continuing with sheep and beef in many cases, and even against *Pinus radiata* forestry in some cases.
- While plenty of high DHA nectar has been produced by mānuka plants in the Programme, it hasn't harvested this nectar into honey with high anti-bacterial properties at the plantation level as yet because of factors such as adverse weather, alternative nectar sources and other apicultural difficulties. More risk averse investors will likely need clearer proof of plantation harvested honey, with high levels of mānuka attributes distinct from wild stands before they would invest.
- Based on the Programme's findings to date, it seems very unlikely that the Programme's vision of a $1.2 billion New Zealand mānuka honey industry by 2028, will be achieved. Instead, there is likely to be an evolution towards the realisation of a lower level of benefits, rather than the revolution initially believed. This seems the most probable outcome of this Programme as the industry continues its research and learns more.

- The Programme is also providing benefits by making high quality information available helping guide more informed investment in plantation mānuka, and hopefully avoiding uneconomic investment.

Summary

This review is designed to provide the High Performance Mānuka Plantations PGP Programme's ('the Programme') co-investors with an independent assessment of how it is tracking towards its goals.

This Programme started in 2011 with the objective of developing techniques in mānuka plantation husbandry and predictive techniques to help manage mānuka honey supply. However, mānuka only begins to produce reasonable quantities of nectar from year 7 or 8 after planting and it is expected that it could take up to 13 years for mānuka plants to reach full production. So in 2017 the earliest plants in the Programme are just beginning to produce good quantities of nectar.

The Programme's research has highlighted some and discovered other important characteristics about growing successful mānuka plantations. Amongst others these include that:

- Genetics is the main driver of mānuka nectar quality and it also affects flowering period and flower numbers.
- Soil type affects plant growth, flowering time and duration, flower numbers and nectar yield but not nectar quality.
- Contrary to what was thought earlier, mānuka grows better on soils with more nutrients.
- Temperature doesn't seem to affect nectar quality, but does have a significant influence on nectar production (and therefore honey production). So warmer regions are likely to produce more honey than cooler areas.
- Despite some variation, Comvita Limited's seedlings are generally yielding higher anti-bacterial activity potential - dihydroxyacetone (DHA) - than wild local mānuka. Some have produced nectar with twice the DHA levels over four seasons.
- Mānuka cultivars are fussy about being shifted out of their local habitat so great care is needed to get the right cultivars for plantation sites and even parts of plantation sites. Eco-sourcing (sourcing locally) mānuka plants with the potential to produce high DHA nectar would increase the chances of matching cultivars to site whilst also aiming to achieve honey with high anti-bacterial activity.
- Bees prefer other sources of nectar e.g. clover compared to mānuka making it difficult to achieve monofloral or medical grade mānuka honey where significant alternative or preferred sources of nectar are available.
- It has proven difficult to establish successful mānuka plantations where there is high risk from browsers like goats, deer and hares or in drought prone or very wet areas.
- Losses of plants experienced in the trial plantations suggest that higher planting densities can be needed as well as astute plantation management.

The Programme has gathered its work on predictive techniques into a model designed to provide better knowledge of the key factors in establishing and managing successful

plantations. This may provide a useful tool as long as sufficient resources are allocated to improving, testing, maintaining and making it more user friendly over the last 17 months of the programme. The Programme's distilled research, in the form of the model, technical notes and business case, are likely to be an important point of difference for Manuka Farming New Zealand Limited (MFNZ) compared to other enterprises competing to develop mānuka plantations for honey in NZ. No other company currently appears to be offering the bundle of services that MFNZ is planning.

However, the value of this data has not been put to the test yet. Plantation consultants will need to see value in buying a licence to use it as part of their advisory businesses for landowners.

Successful management of bees on mānuka plantations has proved challenging. Finding the right combination of land, climate, scale and drive to establish successful plantations is likely to be demanding. The Programme's work has emphasised the need for plantations of sufficient scale, ideally within areas of regenerating mānuka, to allow for the bees to be profitably managed and mānuka honey dilution effects minimised. It may be possible to achieve profitable plantations with smaller land areas but currently the evidence suggests that this is likely to require very good plantation management and apiculture.

However, once suitable blocks of land are identified, carefully planned and executed establishment of mānuka plantations appears to be a very attractive and profitable land use option compared to continuing with sheep and beef in many cases and even against radiata forestry in some cases. This can be explored by making some assumptions based on the Programmes's findings to date and sensitivity testing these using NPV models.

As was the case at the beginning of the Programme, in general mānuka's expected returns appear lower than forestry with carbon pricing. However, mānuka has the advantage of a shorter wait for income from a similar level of upfront investment. Forestry investment is also likely to be a poor choice when the distance from ports is significant or there are high fixed costs of harvesting.

The indicative modelling shows that significant value could be earned from successful plantations. It may be helpful to hold a mānuka plantation and apiculture field day on a large plantation which has benefited from the findings of the Programme as a way of disseminating what can be made public at this time and providing insights into the plantation and apiculture management needed for success. This could steer the sector towards more informed investment and increase the recognition and profile of MFNZ.

The setting of a regulatory definition of mānuka honey should help MFNZ's business case as it seeks to launch its consulting services to landowners as it will highlight to potential investors the expertise needed to succeed with mānuka plantations and help to reduce uncertainty about returns. It may also drive up the premium for monofloral mānuka honey.

Overall, given the Programme's findings, it seems very unlikely that its long term outcomes will be met in the time period to 2028 as originally forecast. One key reason for this is that the Programme has been going for 6 years but it may take up to twice that time for the earliest planted mānuka to reach peak nectar production. The Programme has clearly produced nectar DHA in mānuka at significantly higher levels than is available on surrounding wild mānuka. This has encouraged some, particularly those skilled in beekeeping or with access to those skills, to invest. But the Programme hasn't harvested this

nectar into high anti-bacterial honey at the plantation level as yet because of factors such as adverse weather, alternative nectar sources and other apicultural difficulties. If over the next decade hard evidence emerges of plantation harvested honey, with high levels of mānuka attributes distinct from wild stands, the case for plantation mānuka as an attractive and profitable land use option will be proven. Given the issues the Programme has highlighted, there is likely to be an evolution towards the realisation of the benefits rather than the revolution initially believed. This seems the most probable outcome of this Programme as this industry continues its research and learns more. A focus of any further research on apicultural management would appear to be the most fertile ground over the next 17 months.

The Programme is also providing benefits by making quality information available to potential investors in mānuka plantations. Against the backdrop of the industry's current "gold rush", this could well help to avoid at least some uneconomic investment and influence other more informed investment towards better chances of success. If a worst case transpires and it proves much more difficult to optimise the many variables needed to establish and manage a successful plantation, then at a minimum the Programme could succeed in avoiding some wasted investment by swinging some investors towards more productive land uses or by them maintaining existing land uses.

Recommendations

Having reviewed the Programme's documentation and interviewed a range of Programme members it is recommended that the Programme:

- Continue to prioritise work on the gaps in apiary and honey data under milestone 2.1, work on the predictive model, technical notes and business case and consider reallocating resources to these areas or additional funding if necessary. Focus efforts particularly on strengthening data collection on apicultural management as far as possible before the end of the Programme.
- Continue the strong focus on getting the predictive model, technical notes and business case for mānuka plantations completed in a form that can be readily handed over to MFNZ at the end of the Programme (Objective 5, milestones 5.1 and 5.3). These need to be of sufficient quality to attract licencing by plantation consultants and help landowners make good decisions given the specific characteristics of their land. Continuing to improve them beyond the end of the Programme could be important and could provide a continued competitive edge for MFNZ. It is likely to be necessary to continue to improve the quality of the apicultural management data beyond the end of the Programme due to the difficulties in collecting adequate data to date and the time it takes for mānuka to reach full nectar production.
- Ensure that an agreed plan is in place covering new research and resources needed to continue to build and validate the data and the model beyond September 2018. This plan was to be completed by 30th of March, 2017.
- Continue investigating what might be sufficient scale for a successful mānuka plantation to allow for the bees to be profitably managed and mānuka honey dilution effects minimised. It may be possible to achieve profitable plantations with smaller land areas but currently the evidence suggests that this is likely to be challenging and require very good plantation management and apiculture.
- Consider whether a more realistic estimate of the total value of the Programme could be estimated. This could be achieved by using a revised volume of land that could be successfully developed into mānuka plantations. This could be scenario tested by breaking this land into differing NPVs to simulate different degrees of success in establishing plantations. These estimates could then be summed to give a range of estimates of the potential value of the Programme separate from the overall growth in plantation mānuka and in the mānuka honey sector.
- Consider holding a mānuka plantations/apiculture field day that could include scale plantations established with the benefit of the findings from the Programme as a way of disseminating those that can be made public at this time. This could steer the sector towards more informed investment as well as increasing the recognition and profile of MFNZ.
- Discuss whether testing is necessary to ensure there is an acceptable alignment between the Programme's focus on DHA levels for both medical and food use and the attributes of mānuka honey that has been proposed by MPI for honey as a food.

Progress Review of the High Performance Mānuka Plantations Primary Growth Partnership Programme

Introduction

1. The High Performance Mānuka Plantations PGP programme ('the Programme') is a partnership between Mānuka Research Partnership (NZ) Limited (MRPL), Comvita Limited and the Ministry for Primary Industries (MPI). The programme aims to increase the yield and reliability of supply of medical-grade mānuka honey by moving the industry from wild harvest to science-based farming of mānuka plantations. The programme started in April 2011 and is due to run for seven and a half years finishing in September 2018. It has planned total funding of $2.984 million, with MPI contributing up to $1.4 million over seven years.

The Progress Review

2. Sapere Research Group was engaged by MPI, on behalf of all the Programme's partners, on 3 March 2017 to provide an independent progress review of the Programme 17 months from the scheduled end of the Programme. The review was undertaken in March/April and a draft report prepared at the end of April 2017.

Objectives of the Review

3. The objective of this progress review is to provide the co-investors with an independent assessment of how the Programme is tracking towards its goals as set out in the original business plan (and updated by subsequent business and annual plans).

4. It includes a review of progress made in each of the projects that make up this Programme and will make recommendations as to their future direction and funding priorities. Specifically the objectives of the progress review are to:

   - Assess the Programme's progress to date as a whole and the likelihood of the Programme delivering the expected outcomes;
   - Review the likely benefits to New Zealand from the Programme including commercial, economic and spill over benefits and how to maximise these benefits. In doing so, review the methodology and assumptions being used by the Programme to assess benefits and provide practical recommendations for improvement;
   - Assess internal and external factors affecting the Programme including management and governance;

- Deliver recommendations on any adjustments to the Programme's activities, management and governance, taking into account the remaining time frame.

Scope of the Review

5. The scope of the review will include:

   - All 6 projects within the Programme;
   - The management, governance, budgeting and reporting of the Programme to date and going forward;
   - Appropriateness of Programme activities to achieve outputs and outcomes;
   - The Programme outcome logic model and evaluation framework;
   - An assessment of the value to landowners/farmers of the technical notes and the predictive tool(s), and the potential impact these will have on the sustainable growth of the industry;
   - An assessment of the commercialisation strategy and its likelihood of enabling the long term benefits, acknowledging that commercialisation per se is outside the scope of the programme;
   - Any changes in strategic direction of the projects and their likely future direction;
   - Other internal and external factors affecting the likelihood of success of the Programme.

6. The review will not involve an independent review of the programme management prior to April 2015 and the financial management of the Programme, as MPI conducted a financial management audit during the 2015/16 financial year. It also does not cover the rationale for PGP investment in the Programme.

Reviewer

7. Due to the small size of this Programme relative to the other PGP programmes, this review is being undertaken by Peter MacIntyre on his own. Peter is a Principal at Sapere Research Group.

Methodology

8. The reviewer appraised information about the Programme, including:

   - High Performance Mānuka Plantations Business Plans (2010 and 2014) and Annual Plans.
   - PGP Agreement and Variation Agreements.
   - The more recent quarterly Programme reports.
   - Recent Programme Steering Group (PSG) minutes.
   - Financial audit report.
   - Some science reports.

- Expert review reports, recommendations and resulting actions. An expert review of the functional description of the predictive tool was conducted between October and December 2016.
- Reports and presentations to the PGP Investment Advisory Panel.
- The Programme's outcome logic model, baseline data and evaluation indicators.
- Mānuka Farming New Zealand Limited's (MFNZ) commercialisation strategy. MFNZ is the commercial arm of MRPL.
- Additional recent MFNZ documents from MFNZ's Dropbox.

9. The reviewer interviewed the Programme Manager (Bronwyn Douglas), MRPL Board members (Neil Walker, Tony Wright, Don Tweeddale, Dan Riddiford, Campbell Leckie and Phil McKenzie) and most members of the Programme Steering Group (including Stephen Lee and Richard Archer) and Sir Maarten Wevers, a member of the PGP Investment Advisory Panel (IAP). The interviews were a range of face to face interviews and some done by telephone. Through this process the reviewer sought to understand the factors affecting the Programme, the efficacy of the Programme and identify possible opportunities for improvement.

10. This review focused primarily on the extent to which the programme's activities and outputs for 2011 to 2018 were likely to achieve the short term outcomes within the timeframe left in the Programme. Assessing the short term activities and outputs allowed the reviewer to comment on whether the medium and longer term outcomes were likely to be within reach as well as whether the forecasted extra benefits for the sector and country were achievable. The review assessed whether good progress had been made to achieve the short term outcomes across all the activities in the Programme so that an acceptable result can be achieved for industry co-investors and the Government.

11. The reviewer also checked on whether there were any problems with the original assumptions made about the enablers and inputs for the Programme and these foundations for the Programme were proving as useful as envisaged at the outset. External factors which could affect the Programme's last 17 months were also investigated to see if there could be factors that could materially affect it such as large upswings or down swings in markets driving alternative land uses in hill country areas.

12. The review also explored whether the metrics used to assess progress were suitable and whether the Programme had the resources it needed to achieve its outcomes and outputs in its final 17 months. The reviewer investigated whether the Programme's priorities should be changed and whether resources should be reallocated to more important outcomes and output targets.

13. Finally, this review evaluated the management and governance of the Programme to assess whether accountabilities and processes were clear and adhered too.

Business Plans

14. This section investigates the objectives of the original 2010 Business Plan, the 2014 Expansion and Extension Business Plan as well as the 2016 Annual Plan.

2010 Business Plan

Key Opportunities and Challenges

15. The original 2010 Business Plan identified that a lack of good information for interested landowners and beekeepers was a key challenge for the growth of the industry which the Programme sought to address. These people therefore risked investing in mānuka plantations without good knowledge of key information such as:

- Which cultivars would thrive in which areas of the country
- The effect of different locations for a cultivar on flowering period
- Optimum planting densities under different conditions
- Benefits or otherwise of spot fertilisation at planting
- The effect of soil biota on mānuka cultivar performance
- The effect of companion plants on mānuka cultivar performance
- The effect of scale insect infestation on mānuka cultivar performance

16. Concerns from consumers and overseas regulators about the lack of a regulatory definition of mānuka honey have presented a broader challenge for the NZ mānuka industry. This led MPI to set up the Mānuka Honey Science Programme in 2014, after the PGP Programme began, to work on a scientific definition of mānuka honey when sold as a food. MPI put out a proposed regulatory definition in April 2017 for consultation. This seeks to provide a robust and sophisticated scientific approach that can be used to authenticate New Zealand mānuka honey. This is seen as essential to maintain New Zealand's premium position in overseas markets and to ensure that consumers can be confident in the products they are purchasing.

Key Enablers

17. As identified in the Programme's Outcome Logic Model the inputs and enablers include:

- Support from MPI, MRPL and Comvita Limited;
- Historical investment in mānuka genetic improvement by Comvita Limited;
- Callaghan Innovation grants for PhD student stipends; and
- Research facilities and capability in multiple disciplines at Massey University.

18. MRPL currently includes the following shareholders Nukuhau Carbon Ltd, Landcorp Farming Ltd, Comvita Ltd, DR & CY Tweeddale Partnership, Maori Trustee, Arborex Industries Limited and the Hawke's Bay Regional Council. MRPL has three businesses under development by MFNZ as follows:

- One focused on a levy per stem for planting advice:
- A second charging for plantation consultancy; and
- A third which would provide a cultivar proving and testing service[1].

[1] Source : Page 17 of the Business Plan High Performance Mānuka Plantations [Expansion and Extension], 28 February 2014

Original Vision and Objectives

19. The original 2010 Business Plan summarised the purpose of the Programme was to:

- develop techniques in mānuka plantation husbandry
- develop predictive techniques to help manage mānuka honey supply[2].

20. This Programme was not intended to develop new mānuka honey products nor develop new mānuka cultivars. These activities were for others to pursue[3].

21. Information on mānuka husbandry was to belong to the co-investor group who would use it in their own operations and make it available in New Zealand via:

- information provided with every seedling sold in return for a small levy.
- a testing service whereby newly developed or discovered cultivars could be tested rapidly and optimal husbandry techniques identified.
- a commercial consultancy available to land owners wishing to plant mānuka.
- published theses, journal papers, reports and popular articles.

22. The husbandry information was to provide the ideal latitude, aspect, soil type, spacing, spray treatment, planting technique, releasing treatment, dressing etc for a particular cultivar. Two predictive tools were initially imagined; one predicting the lifetime yield and quality of mānuka honey from a potential plantation given knowledge of cultivar and soil and assumptions on husbandry, beekeeping and climate; while a second would predict for an existing plantation the likely yield and quality in the coming season given recent and forecast weather patterns that season. It was also thought that the Programme could isolate mycorrhiza beneficial to mānuka cultivars and that seedlings could be inoculated for a fee, or inoculum sold to nurseries.

23. The estimated net economic benefit to New Zealand from the Programme, as explained in the 2010 Business Plan[4], was to increase mānuka honey market returns 16-fold which would take the market value of this honey from around $75m in 2010 to over $1 billion. This was later set out in the Outcome Logic Model in the form of the Programme's long term objectives. It was also expected that there would be considerable potential multiplier effects. The 16 fold increase in market returns would occur through the simultaneous doubling of four key performance parameters.

- Doubling the average number of hives per hectare on mānuka

  (It noted an average hive density of 1.5 hives/ha but flagged that 4 hives/ha was achieved on some plots with yields on these hives still exceeding the industry average so it did not represent overstocking of bees).

- Doubling the yield of honey per hive per year

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2 Source : Page 16 of Business Plan High Performance Mānuka Plantations 29 June 2010

3 Source : Page 16 of Business Plan High Performance Mānuka Plantations 29 June 2010

4 Ibid Page 13 and 28

(In 2010 the average was circa 35 kg/hive/year. But some apiarists had achieved close to 100 kg/ hive in good years and 50 kg/hive on average).

- Double the unit value of mānuka honey.

  (Analysis of mānuka price against UMF score[5] showed that increasing the score by 6 or 7 points could double the unit value given the exponential relationship between price and UMF score apparent in 2010)

- Double the land area economically accessible to beekeepers.

  (The logic was that 1.14m ha of hill country pasture was classed as erosion-prone but it was assumed this land was accessible via farm tracks. Depending on achieving the goals above, this meant that if less than 5 percent of this land was put into mānuka plantation the overall production targets could be met. Land was therefore not thought to be a constraint. It was also noted at the time that there was some risk of an oversupply of lower UMF factor honey if the sector didn't focus on production of higher quality mānuka)

24. The original Business Plan recognised that some of the 16-fold gain could be achieved without the Programme. It did not try to apportion out what would come incrementally from the Programme and what would occur without it. However, the original Business Plan averred that the Programme was necessary if the targets of doubling hives/ha, yield/hive and unit value were to be achieved[6].

25. In February 2014 the 2010 Business Plan was expanded and extended by a new business plan.

2014 Expansion and Extension Business Plan

26. The 2014 plan noted that the original plan anticipated private landowners planting blocks of perhaps 20 to 100 hectares on steep marginal land being retired from pasture[7]. It anticipated that results obtained in glasshouses and corroborated by a limited range of field sites would give information adequate for extrapolating across New Zealand.

27. The 2014 plan retained the 2010 objectives but added two as follows:

- Expanding the existing programme to address issues revealed to date so that our original commercial aims can be met more quickly and robustly.
- Extending the programme into two new applications (riparian planting and low-profile shelter near irrigators) on intensively farmed flat pastoral lowlands.

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5 UMF® stands for Unique Manuka Factor and is a registered trademark of the Unique Manuka Factor Honey Association (UMFHA). The UMFHA operates the UMF grading system – an industry grading system.

6 Page 28 of Business Plan High Performance Mānuka Plantations 29 June 2010

7 Page 4 of Business Plan High Performance Mānuka Plantations [Expansion and Extension] Final 28 February 2014

28. This required an additional $1.2 million in funding[8]. At this time MPRL committed to ensuring that plantation honey mānuka be offered as a viable option for hill-country remediation, riparian planting and low-profile shelter. It was stated that this would have a significant bearing on economic, social and environmental welfare of the nation[9].

2016 Annual Plan Programme Objectives

29. Six years into the Programme the objectives have evolved so that it is now targeting the following activities and outputs by the end of the programme on 30th June 2018[10]:

- Best practice knowledge base for propagating, planting and managing mānuka plantations will be developed and the IP will be used in a commercial consultancy and mānuka cultivar testing business;
- Small scale research trials and large scale plantation trials are completed that identify environmental and site factors, and genetics that influence mānuka establishment and growth, and honey yield and quality;
- A predictive model tool is developed which uses the research data to identify mānuka honey yield and quality in different seasons and environments. It is used by MRPL consultants; and
- A proven production and financial business case for retiring marginal land to plantation mānuka is completed, with access to: (i) best practice plantation establishment and management; and (ii) the best available performing mānuka provenance and hybrids for specific sites and environments.

30. These 2016 Annual Plan objectives built on the research focused goals of the original 2010 Business Plan. The economic benefits as well as the 16 fold increase in mānuka production and growth in sector value to over $1 billion predicted in 2010 appear to have been very demanding targets. There was no analysis done in 2010 that explicitly connected how the Programme's activities and outputs to 2018 would link to achieving a specific portion of the over $1 billion increase foreseen in the market value of NZ mānuka honey. Since 2011 honey exports (all honey types) have increased significantly, without production from the Programme, from $102 million to $315 million[11] (June year-end). This would suggest that this target is a very mobile one so the Programme's long run target probably needs resetting and more directly linking to plantation produced honey perhaps when there are enough plantations beginning to produce. However, as discussed above in paragraph 24 , it was noted that the Programme work would be needed if hives/ha, yield/hive and unit value were to be doubled.

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8 Ibid

9 Ibid

10 Page 17 of High Performance Mānuka Plantations PGP Programme Annual Plan 2016/17 and 2017/18, 22 November 2016 and Outcome Logic Model October 2016

11 Page 2, Ministry for Primary Industries 2016 Apiculture Monitoring Report.

Spill over effects and net sustainability benefits

31. The 2010 Business Plan set out the spill over effects expected from the Programme as[12]:

- 3 new PhD research scientists would be trained in the cultivation of mānuka
- 4 significant players in the mānuka honey value chain would work together
- A de facto research consortium would be formed which could grow to become a major development engine for the industry
- The integration of honey, health foods, carbon farming, and native forestry would be tested and studied.

32. It also set out net sustainability benefits from mānuka farming on marginal land, as:

- speed up the rate of hill-country remediation
- reduce the direct and indirect costs of erosion
- provide savings for local and central governments

33. These sustainability benefits were targeted at an estimated 1.14 million hectares of hill country pasture which was classed as erosion-prone. Seventy percent of this vulnerable pasture land is in the North Island. Around 200,000 hectares of this pasture land in the North Island has a mapped erosion severity description of severe, very severe or extreme. Most of this land is located on the East Coast and in the Manawatu, with smaller areas in inland Taranaki, Coromandel and Northland.

PGP Programme Objectives

34. This section explores each of the Programme's objectives and their focus over the remaining life of the Programme as set out in the 2016 to 2018 Annual Plan[13] and the Outcome Logic Model.

Programme Objective 1 : Glasshouse

35. Objective 1 was focused on mānuka glass-house trials on sun light, soils and cultivars flowering, nectar yield and quality. The work in this objective has been completed.

Programme Objective 2 : Field Plantation Evaluation of Quality

36. Objective 2 has involved field trials to explore the best management approaches for managing mānuka plantations. The Programme had around 400 hectares of trial plantations on marginal and riparian land on 14 sites in the North and South

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12 Page 28 of Business Plan High Performance Mānuka Plantations 29 June 2010

13 Source for programme objectives from page 26 of High Performance Mānuka Plantations PGP Annual Plan 2016 to 2018, 22 November 2016

Islands[14]. Comvita's mānuka breeding programme varieties were planted on these sites. Currently Objective 2 has three milestones which are condensed as follows:

- Milestone 2.1 : Site, microsite and stocking rate plantation management

  This includes completing the collection of data from each site in the programme about:

  (i) mānuka seedling survival,

  (ii) plant growth rates,

  (iii) nectar yield,

  (iv) nectar quality,

  (v) apiary activity including hive management, bee activity, honey production and quality (in line with mānuka honey labelling guidelines),

  (vi) site identification and climate data (where possible).

- Milestone 2.2 : Effect of companion biota on mānuka honey yield and quality

  This research covers the relative attractiveness of cultivars and wild mānuka to honeybees and other insects, the effects of scale insect infestation on growth, flowering, nectar yield and nectar quality and the effects of mycorrhizal associations on growth, flowering, nectar yield and nectar quality.

- Milestone 2.3 : Implementation

  Collection of the data produced by Objective 2 into a single database for use in the predictive modelling tool under Objective 5.

37. The remaining 17 months of the Programme's work on Objective 2 will be focused on collecting more apiary and honey data from the older plantation trial sites as well as sampling wild stands that are older than the Programme's plantations. This extra data will be used to confirm flower-growth relationships, nectar production per flower data and other parameters.

Programme Objective 3 : Study of Temperature, Water Stress and Salinity on Mānuka

38. Objective 3 involves researching the effects of temperature, water stress and salinity on mānuka plant growth, flowering, nectar yield and quality (dihydroxyacetone (DHA) and sugar levels) through controlled environment trials. It has four milestones abridged as follows:

- Milestone 3.1 : Water deficit and salinity as environmental factors

  This milestone involves a glasshouse trial on (at least) two clones of mānuka grown under three different soil and/or foliar salinity treatments and/or two different soil water contents and capture of the trial's data.

- Milestone 3.2 : Temperature as an environmental factor

[14] A few sites have been damaged by goat grazing and slips so the total area has reduced.

This tests and records data for mānuka in different night/day temperature regimes as well as its growth in soil at two different temperatures simulating the annual mean temperature range across New Zealand.

- Milestone 3.3 : Secondary leaf metabolites in mānuka as indicators and predictors of nectar quality

  This covers further research to validate an earlier finding. If this finding is validated, an in-field tool for the rapid screening of mānuka plants for honey quality potential could be developed.

- Milestone 3.4 : Implementation

  This includes the collation of Objective 3's data for the predictive modelling tool as well as its inclusion in the technical notes. In addition, the technical protocol and supporting information is to be provided for development of a mānuka cultivar testing service.

39. These milestones are to be completed by 30 June 2017. The work on the milestones in Objective 3 will continue over the remaining 13 months of the Programme to finish on 30 June 2018.

Programme Objective 4 : Evaluation of Mānuka for Companion Riparian and Irrigation Shelter Plantings

40. Objective 4 is researching the factors for managing plantations in riparian strips and for shelter in irrigated pastures. It will also look into the viability and economic feasibility of such plantations. There are three milestones under this objective precised as follows:

- Milestone 4.1 : mānuka for riparian plantings

  This includes testing of seedling survival and growth rates of seedlings planted in the five riparian plantings.

- Milestone 4.2 : mānuka for planting under centre pivot irrigators

  This covers examining the comparative shelter effectiveness of different plantings, seedling survival and growth rates from these sites.

- Milestone 4.3 : Implementation

  This includes the collation of data for the predictive modelling tool as well as its inclusion in the technical notes.

41. This objective has been scaled back. It has become clear that beekeepers cannot in practice place hives or time that placement on these small blocks to achieve high grade monofloral honey. However, work will continue on the issues of planting in waterlogged and riparian zones as findings on this are believed to potentially be of use for establishing mānuka in other plantation sites.

Programme Objective 5 : Predictive Tools

42. Objective 5[15] covers the development of predictive modelling tools for investing in and managing mānuka plantations. This is designed to allow better risk management by providing better knowledge of the key factors in establishing and managing such plantations. It consists of 3 milestones which are summarised as follows:

- Milestone 5.1 : Development of predictive tools

  Late in 2016 a functional description of the predictive model was completed. The potential for other models to assist the Programme's modelling was assessed and found not to be of significant help. By March 2017 the full model code was to be set up, a NPV analysis included in the model and key variables included (such as establishment costs for plantations, honey production, honey price, management factors and costs). Where there was uncertainty over some factors best estimates were to be used based on discussions and similar data. All the model's assumptions were to be documented.

  By 30 April 2017, the model's priority research areas were to be recommended to the PSG as well as the work that might be needed following the end of the Programme. As at 30 June 2017 the model is to be populated with all data including best estimates where only that is available and NPV analysis done. Decisions are also to be made about which parameters are likely to have the most value for prediction versus what can be refined by further research over the final months of the Programme. From this choices will be made over where to direct the final year's research efforts. The objective is to ensure that at completion of the programme a final, partially validated predictive tool, annotated and made sufficiently robust for use by the co-investors is available.

- Milestone 5.2 : Influencing the volume and quality of NZ mānuka honey

  The plantation husbandry techniques are to be made available within the wider NZ industry through a commercial consultancy service for land owners wishing to plant mānuka plantations. This will provide information on the technical and economic feasibility of mānuka plantations, against other land uses. The technical notes are to include husbandry notes to be supplied with mānuka cultivars following the termination of the Programme for a small levy. The commercial consultancy may also look to develop data on eco-sourced material. In addition, if the work in Objective 3, Milestone 3.3 is successful, a testing service for newly developed or discovered cultivars may be developed. The Programme also intends to provide scenario reports, conference presentations, published theses, journal papers, and articles, subject to the IP management plan.

- Milestone 5.3 : Feasibility of productivity gains

  This involves Massey and MFNZ completing a framework for the PSG which assesses the technical and economic feasibility of productivity gains and quantifies the potential economic value of plantation mānuka to NZ by 31

[15] Ibid, Page 34

March 2017. By 30 June 2017 a first draft of this work is to be completed and by the end of the Programme it is to be finalised.

43. The 2016 Annual Plan noted that the modelling approach had changed due to gaps in the Programme's data. It explained that the model's empirical approach had had to change to something which was more mechanistic and would be based on existing plant physiology growth models. However, it explained that these needed to be altered for mānuka[16].

44. The predictive model was reviewed by Associate Professor David Horne and Professor John Bronlund of Massey University in November 2016. Associate Professor Horne believed it would facilitate very comprehensive simulations of mānuka honey production and its economic return. He explained that the model began with basic climate, resource and physiological data, and used this information to generate honey yield and quality which it then analysed using an economics model. He also pointed out that the model could discriminate between different areas (e.g. soil types) and took a long-term view from planting to production. He commented that the model would be extremely helpful for exploring the potential conversion of land to mānuka honey production.

45. Both reviewers thought the model could be made more user friendly and that some parameters and figures needed better labelling and explanation. Professor Bronlund believed that the model needed testing as it was being built and that a number of important variables needed separating out from each other, for example the nectar collection model from the tree growth model. In addition, a number of parameters needed further work, for example tree status (which had used a model designed for timber trees) and plant losses due to drought, etc.

Programme Objective 6 : Programme Management and Science Auditor

46. Objective 6[17] is focused on managing the Programme by providing high quality management. It is designed to ensure that the budget is delivered on time, that cost accounting and financial reporting is reliable and all contracted suppliers and services are effectively managed. This objective also seeks to ensure the Programme management is responsive and communicates appropriately with all stakeholders and with MPI.

Programme's Metrics

47. The activities and outputs to the Programme's end in September 2018 as set out in the 2016 to 2018 Annual Plan and the Outcome Logic Model, as discussed in paragraph 29, are suitable measures to judge progress in the Programme. The more detailed achievement measures of the various activities discussed above are also

16 Ibid pages 20, 21 and 23.

17 Ibid

appropriate given what the Programme is seeking to achieve. This is discussed in more detail in the next section.

Progress made by the Programme

Achieving Near Term 2018 Outputs

Scientific Research: Objectives 1, 2, 3 and 4

48. The key achievements of the Programme to date in Objective 1, 2, 3 and 4 were listed in the 2016 Annual Plan as follows[18]:

- Soil type affects plant growth, flowering time and duration, flower numbers and nectar yield but not nectar quality.
- Different cultivars respond differently on different soils.
- Contrary to the previously reported studies, mānuka has better growth and produces more flowers on soils with more nutrients.
- Light experiments mimicking NZ's latitude range did not affect plant growth, flowering time or nectar quality.
- Cultivars have differing drought tolerance.
- Water deficit did not alter DHA levels.
- Temperature doesn't seem to affect levels of higher or lower quality nectar, but temperature has a significant influence on nectar (and honey) production.
- Bees seem to prefer cultivars with higher sugar content in the nectar.
- A PhD thesis was completed and a science paper published.
- Data is being collected from the nearly 400 hectares of plantations on how plants perform in different environments at establishment, growth, nectar production and quality, floral traits and apiary performance for the predictive modelling tool and technical notes.
- The data has shown that despite some variations the Comvita seedlings are generally yielding higher DHA concentrations than wild mānuka.
- Glasshouse and field trials have generally given similar results, so cultivar proving may be able to be carried out in the nursery in the future.
- Some trial cultivars have consistently over four seasons produced nectar with two-times the level of DHA compared with wild local mānuka.
- Genetics are the main driver of mānuka nectar quality and it also influences flowering period and flower numbers.
- Around 21 hectares of riparian mānuka plantations were developed at 3 sites in the North Island and one in the South Island.

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[18] Page 17 to 19 of High Performance Mānuka Plantations PGP Annual Plan 2016 to 2018

49. While not much was spent on Objective 4 which was to evaluate mānuka for riparian and irrigation shelter, it did represent adding a new objective to the programme that had other aims of improving water quality and providing shelter. This was introduced by the 2014 Business Plan but was tangential to the key purpose of producing high performing mānuka plantations[19]. However, the work on this objective did provide some additional data on plantation establishment and underlined the importance of establishing plantations with sufficient scale to make achieving high grade monofloral mānuka honey possible.

Predictive Tools : Objective 5

50. Overall the predictive model looks to provide a useful tool as long as sufficient resources are allocated to implementing the reviewers' recommendations. Improving, testing, maintaining and making it more user friendly should be priorities over the last months of the Programme. Thought needs to be given to how this will continue following the end of the Programme on 30 June 2018 so that MFNZ's consultation service can continue to differentiate its services from the competition over coming years. The predictive model and the quality of its data is likely to be one of the more important points of difference for MFNZ compared to other enterprises competing to develop mānuka plantations for honey in NZ.

51. However, the value of this data has not been put to the test yet. Plantation consultants will need to see value in it.

Objective 6 : Programme Management and Science Auditor

52. Earlier in the Programme the partners were doing much of the management themselves. This was low cost but put pressure on people who had other priorities. Interviewees believed that programme management had improved since more resources were devoted to that purpose over the last few years, for example, the employment of a dedicated Programme Manager in March 2015.

53. The May 2016 Assurance and Evaluation Report undertaken by MPI found that MRPL had robust and effective systems in place for the financial management of the programme that are suitable given its size and complexity. It had systems for developing funding claims and financial reports and budgeting, forecasting and monitoring spending. The report did note that these financial management systems and processes had only been in place since July 2014. Before this there had been no programme manager. However, concerns about this had been resolved now. The report recommended that the Programme continue to employ dedicated programme management resources until the end of the Programme in September 2018. This review did not find any evidence to suggest that the findings of the May 2016 report on the Programme's management had changed.

Outcome Logic Model (OLM) Outputs for 2018

54. The OLM outputs for 2018 set out in paragraph 29 largely correspond to the objectives discussed above from the 2016 to 2018 Annual Plan. As discussed above

[19] From an apicultural point of view trying to harvest material quantities of nectar from under pivot irrigators would have been challenging given it would be washed away regularly when the irrigator was in use.

these have largely either been achieved or are to be achieved over the next 17 months. The only 2018 OLM output that is not yet achieved is that corresponding to Objective 5 : Predictive Tools and the output which states "*A proven production and financial business case for retiring marginal land to plantation mānuka, with access to (i) best practice plantation establishment and management; and (ii) the best available performing mānuka provenance and hybrids for specific sites and environments.*"

55. It is not possible at this point to confirm that this OLM output will be achieved by the end of the Programme. This is because achievement will depend on the results and quality of the research over the last 17 months and how those are incorporated into the predictive modelling and technical notes as well as the findings about the relative economics of mānuka plantations. This must all be completed and handed over in a form that is of value to MFNZ and more widely e.g. to plantation consultants and landowners, before this output can be said to have succeeded in providing "*A proven production and financial business case*".

56. By the end of the Programme it may be that a production and financial business case will be proven for some early adopter investors who have a greater appetite for risk and believe that they can master the plantation and apicultural management needed to succeed. However, there will still be important gaps in knowledge especially as there is no proven economic harvest of high anti-bacterial activity mānuka honey at the plantation level in the Programme yet. While plenty of high DHA nectar has been produced by plants within the Programme, more risk averse investors may need clearer proof of plantation harvested honey, with high levels of mānuka attributes distinct from wild stands, before they would invest.

Progress towards Medium and Long Term Economic Outcomes

57. The 2016 Annual Plan[20] set out where the Programme has got to in the 6 years since its inception in seeking to meet the original Business Plan's economic outcomes (the Outcome Logic Model's medium and long term outcomes). It recorded some positive points as well as some problems.

Doubling the average number of hives per hectare on mānuka

58. The Annual Plan stated that the Programme was making good progress on this. This is because more than double the amount of attractive nectar could be on offer on a flush day than was the case in a typical wild-harvest site. But it noted that plantations were still immature and not flowering fully nor producing nectar fully, nor shading out flowering pasture weeds which can dilute mānuka nectar.[21]

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[20] High Performance Mānuka Plantations PGP Programme Annual Plan 2016/17 and 2017/18, 22 November 2016

[21] Ibid Page 3

Doubling the yield of honey per hive per year

59. The 2016 Annual Plan noted that this had not occurred yet because no season had allowed all the varieties planted to flower at auspicious times. In no year had the spring been sufficiently warm and dry for bees to collect the volume of honey to double yield/hive. The Annual Plan explained that extending flowering times in a plantation (e.g. developing earlier flowering cultivars) had exposed them to more adverse weather events which could reduce yields.[22]

Double the unit value of mānuka honey

60. This target involves increasing the density of mānuka nectar offered in a given area and having high DHA levels in the nectar. It would appear that a number of challenging factors have not allowed this target to be achieved either. The Annual Plan stated that "*Our plantations have yielded nectar of double the DHA/sugar ratio of local indigenous plants*". Professor Archer's and Dr Millner's article "Plantation Mānuka - Gold Rush or Real?" shows this relationship. In Table 1 they show that standardised nectar DHA content of a single plantation variety and indigenous mānuka at different sites in Whanganui and Hawke's Bay in 2014. Table 1 shows that in Whanganui the difference between plantation nectar DHA and wild mānuka was more than double at 153 percent higher. While in Hawke's Bay it was 43 percent higher. However, to date the problems achieving this target overall have included: competing floral sources, hive placement, pests and the need for larger plantations, amongst others[23].

61. Professor Archer commented that the exponential increase in price against UMF shown in the 2010 Business Plan[24] has changed over the years as more, lower grade mānuka honey has been pushed into the market. However, the proposed scientific definition of New Zealand mānuka honey will likely cause a return of that exponential relationship between price and purity/quality, as the higher purity/quality mānuka honey will be better defined and likely flow through into market prices.

Double the land area economically accessible to beekeepers

62. The 2016 Annual Plan stated that this "*goal was flawed in logic when first set*"[25]. It explained that the key factors that would determine this were MRPL proving the business case for mānuka plantations on marginal pastoral land and cutover pine forest land. So achieving the 3 targets above would allow MRPL to prove the business case[26]. The business case could be assisted by the Afforestation Grant Scheme (AGS), regional council erosion control schemes and ETS carbon returns.

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22 Ibid Page 4

23 Ibid Page 4

24 Page 14, Business Plan High Performance Mānuka Plantations 29 June 2010

25 Page 5, High Performance Mānuka Plantations PGP Programme Annual Plan 2016/17 and 2017/18, 22 November 2016

26 Interview with Professor Richard Archer, 3 April 2017.

63. The 2016 Annual Plan pointed to the 2015/16 year expectation of selling 350,000 plants for honey plantation use, its sales growth forecasts and the interest shown in mānuka at meetings with landowners as evidence that this goal could be achieved.

Commentary on the Outcomes Achieved

64. The Programme has accumulated good measures of plantation nectar quality over multiple years and sites. There are also reasonable measures of nectar quantity and plant growth and factors that inhibit growth. There has been useful data collected on flowering times as well as plant survival and factors affecting that[27].

65. However, the Programme has not been able to get honey production for measurement at the plantation level due to factors such as adverse weather, alternative nectar sources and other apicultural difficulties.

66. At the same time the Programme has uncovered a variety of challenges to achieving consistently higher hives/ha, yield/hive/year and value/kg. Proving the business case for mānuka plantations and unlocking double the land availability for beekeepers has therefore not been possible. The challenges have included:

- Mānuka has proven to be fussy about where it will grow well. Local plants have proven to be better adapted to local conditions than plants from other localities[28].
- Bees prefer other sources of nectar. For example bees prefer clover compared to mānuka making it difficult to achieve high anti-bacterial activity honey where significant alternative sources of nectar such as clover are available.
- At the outset erosion prone high country was thought to be a good target for mānuka plantations but plant growth and nectar production appear to have been better with higher soil fertility based on a glasshouse trial. Erosion prone hill country still has potential but may not provide as much return on investment as more fertile areas.
- It has proven difficult to establish successful mānuka plantations where there is high risk from browsers like goats, deer and hares. Establishment is also challenging in drought prone and very wet areas although come cultivars are better adapted to these conditions than others.
- Losses experienced in the trial plantations suggest that higher planting densities are needed. That could be around 1,600 seedlings per hectare, rather than 1,100/hectare planting densities estimated at the outset. Or more replacements need to be factored in to plantation establishment[29].
- Initially it was suspected that peak floral density and nectar production would occur about year 8, which it has done under good conditions at Massey

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27 Email from Professor Richard Archer of 7th April 2017

28 Interview with Richard Archer, 3rd April 2017 and page 44 of Boffa Miskell "The Mānuka & Kānuka Plantation Guide", April 2017.

29 Interview with Richard Archer, 3rd April 2017.

University. But it is now believed that peak floral density and nectar production may not occur until as late as year 13 on more typical hill country sites because of the number of variables that can conspire to slow growth[30]. This is significantly longer than the Boffa Miskell estimate that maximum yields of honey occur at years 6 and 7 and, unless mānuka trees are specifically managed to maintain flowering vegetation, flowering naturally decreases from around year 9 or 10[31].

- Weed control needs to be effective at the outset to stop brush weeds such as gorse and blackberry overwhelming the mānuka. These weeds are difficult and expensive to manage once the seedlings are planted.

67. There are also factors that could benefit the business case for mānuka plantations such as the potential for the cost of seedlings to fall materially[32]. Other potential outside of honey production, for example, mānuka oil production also could provide upside value for investments in plantations although access and transport costs will have a strong bearing on this option for mānuka.

68. The finding that it may take between 8 and 13 years for plantations to reach peak floral density and nectar production underlines the time required before the business case for mānuka plantations could be proven in the field by the Programme's work. The Programme will have run for seven and a half years by the time it finishes in September 2018. This means that most of the Programme's earliest planted mānuka plantations will still be yet to reach full production, with some a few years from reaching it, when the Programme winds down.

69. The doubling of time needed to get to full production and the other challenges of establishing high performing mānuka plantations, such as weed and pest control, indicate that the business case set out in the 2010 Business Plan was very optimistic. The current expected timeline by MFNZ of production ramping up from first production in year 3 to full production in year 9 may need to be extended and greater costs of establishment and blanking factored in.

70. On a more positive note the Programme's research does suggest that if the plantation establishment issues are solved and a well-established plantation is achieved, perhaps as late as in year 13, then the first three of the 2010 targets could be achieved. The investor could expect to double hives/hectare by achieving significantly increased floral density compared to wild mānuka.

71. An investor could also double yield/hive in more benign locations by extending flowering time earlier into spring as well as by having later flowering, drought tolerant, cultivars. This elongated flowering period would act as both insurance against and increase exposure to bad weather. A longer flowering period would increase the risk that weather could affect the bees' ability to harvest the mānuka nectar but also increase the chances of getting some high anti-bacterial activity honey

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30 Interview with Richard Archer, 3rd April and email of 29 May 2017. However, if all variables are well managed it is possible to get peak nectar earlier at around 8 years. In addition, denser planting could result in earlier peak nectar flows.

31 Boffa Miskell "The Mānuka & Kānuka Plantation Guide", April 2017, page 21

32 Interview with Richard Archer, 3rd April 2017.

from at least part of the longer flowering plantation. Locations with higher probability of cool springs and/or droughts in summer would of course be exposed to elevated risk.

72. In addition, DHA could be doubled compared to local wild stands of mānuka as well but only in some locations. Currently this has only been measured in the Taranaki and Whanganui areas. However, in Northland and the East Coast of the North Island some wild stands have high levels of nectar DHA now so doubling would be more difficult. Getting high DHA honey also requires a large plantation so that DHA dilution by the bees harvesting alternative nectar sources can be effectively managed[33]. This suggests that achieving high DHA honey might be a lot more challenging in smaller plantations. The optimal plantation size is not clear yet. However, bees generally fly up to 4km from their hives. This means that, without any other flora based or geographic barriers, a plantation would need to be 5000 hectares with canopy closure and centrally placed hives to prevent competing clover etc. and ensure very minimal dilution of DHA. Naturally, bees will trade off energy expended getting to nectar sources with the quality of those sources. So it may be possible to effectively manage honey quality with smaller plantations.

73. MFNZ currently require 20 hectares or more to explore inquiries about plantation establishment. It may be difficult to ensure high mānuka attributes in the honey in small plantations. This problem will be made more hard-edged once the new definition of mānuka honey is finalised as proposed by MPI because the levels of dilution by other nectar sources could become more important. This may indicate that doubling the honey quality metric would not be achievable on smaller plantations.

74. The Programme's findings to date do suggest some considerable caution is required in forecasting the potential value of the plantations. Judging by the springs experienced over the last few years it could be prudent to assume that harvests would be poor perhaps 2 years in 5 rather than assume average yields or only the occasional harvest failure. Of course the predictive model should provide historic weather records that reasonably closely match a plantation site's actual weather. This can be used to simulate what might have been harvested under historic conditions to get a better view of this risk. It would appear that it is necessary to get the best cultivar for the micro-climate of a site as well as the best mix of management given the problems that the site might present to establishing a successful plantation. In some more challenging regions, for example, alpine areas, coastal Wairarapa and exposed ridges there may not be cultivars that can be planted to achieve profitable plantations[34].

75. As flagged in paragraph 30, there was no analysis done in 2010 showing what portion of the 2028 long term outcomes, - an estimated more than $1 billion increase in the market value of NZ mānuka honey, would derive from the Programme itself. Without that metric specified it is not possible to identify to what extent these net economic benefits might be attainable now. However, in its six years of research the Programme has exposed a number of factors that should materially reduce any

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33 Email from Professor Richard Archer of 7th April 2017

34 Email from Professor Richard Archer of 7th April 2017

reckoning of the long term outcomes that might be achievable. Even if the cash flows might still be possible, it is most unlikely to be achieved over the same timeframe meaning that discounting will appreciably reduce the long run contribution of the Programme to the $1 billion plus target. It should be noted that other factors may mean that this target is achieved anyway for example any extended increase in price. This could result from other initiatives such as MPI's proposed definition for mānuka honey which may protect and enhance the industry's global market position.

The Rest of the Programme

76. In this section we analyse and comment on the activities planned for the last 17 months of the Programme as well as the nascent commercialisation strategy of MFNZ.

Activities of the last 17 months of the Programme

77. As discussed above under the heading PGP Programme Objectives, the Programme is now focused on continuing to collect and analyse measurement data from its field trials and study of temperature, water stress and salinity. This data is being used to improve the technical notes and the value of the predictive model. These are important activities that need to be completed before the Programme ends in September 2018. The quality of the model and notes will determine the extent to which the Programme provides an on-going value to the sector.

78. The Programme has $129,000 allocated to Objectives 2, 3 and 4 in 2018. Most of this ($105,000) is focused on Objective 2[35]. This appears to be a sensible allocation of resources. Working to fill in the gaps in apiary and honey data is part of this work under milestone 2.1.

79. There is $65,500 dedicated to finalising the predictive model in Objective 5[36]. This represents an increase in the relative allocation of Programme resources towards Objective 5 compared to the 2017 budget.

Progress Towards Benefits

80. The original 2010 Business Plan did not see land as a constraint[37]. Part of the logic of the Programme rested on a calculation that if only around 5 percent of around 1.14m ha of hill country pasture, which was classed as erosion-prone, were developed into mānuka plantations then the long term outcomes for the Programme

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35 Page 48 of the High Performance Mānuka Plantations PGP Programme Annual Plan 2016/17 and 2017/18, 22 November 2016

36 Page 48, Ibid. We understand that the expansion of the Programme in 2014 meant that work in Objective 5 started sooner than was planned in the 2010 Business Plan intended. This allowed enough time for the modelling approach to be altered.

37 Page 14 of Business Plan High Performance Mānuka Plantations 29 June 2010

could be achieved[38]. However, this may not be the case and the amount of land suitable for achieving successful plantations may be limited.

81. It may be that quite large plantation areas are necessary to achieve material improvements in anti-bacterial activity scores, increases in hives/hectare and yield/hive because if a better alternative nectar source is available bees prefer to harvest that over mānuka nectar. If larger plantations are needed to achieve material increases in anti-bacterial activity and achieve the other two production metrics then the area available for potential successful mānuka plantations will be significantly less than originally believed.

82. The Programme has underlined the difficulties in managing bees to harvest plantations, particularly small plantations, of mānuka. On top of the need for plantations of scale, preferably where mānuka is regenerating, there are many other factors which could mean that suitable land is quite limited. These factors include:

- having suitable almost year around access tracks for the apiarist (all weather tracks allowing visits of up to 10 times per year if bees are on site year around),
- farm size and topography that prevents boundary harvesting by other beekeepers. (If a plantation owner's crop can be harvested by neighbouring beekeepers, thereby taking the benefits of another's efforts, investment will be suppressed)[39].
- lower natural levels of pests and weeds to make plantation establishment less costly (gorse, goats, hares, red deer and blackberry are all major barriers to establishing a successful plantation).
- better soil fertility to give better plant growth and nectar production (a finding of the Programme's research) with eroded land not ideal (plant growth will be less and the plants exposed to greater risk of erosion losses during establishment from extreme weather events).
- Alpine or drought prone land should probably be avoided due to the higher probability of failing to establish successful plantations (e.g. cultivars from Northland will die if exposed to Central North Island frosts).

83. Apiculture hive placement considerations will also trim potential areas if they are on exposed ridges or in cool shaded sites.

84. Events such as specialist field days involving the Programme's members may be useful ways of reaching some potential investors.

Price, Costs & Returns and Land Use Choices

85. For many potential MFNZ customers the expectations about the returns possible from mānuka compared to alternatives such as sheep and beef or forestry will be critical. Establishing a fuller picture of the economics of mānuka plantations and its

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38 As discussed in paragraph 23

39 This issue seems particularly difficult to resolve. It is possible that case based on tort law could offer a means to challenge an egregious example of this kind of stock trespass. If this were to happen it could set a useful precedent and offer an example that could be used should any policy development occur in this area.

relative value compared to other land uses is part of the current work of the Programme. The 2016 to 2018 Annual Plan's Objective 5, Milestone 5.1[40] included an achievement measure in which the full predictive model code was to be set up, an net present value (NPV) analysis done and key variables documented to the best level of accuracy available by March 2017.

86. Some analysis was done on the potential economics of mānuka plantations and other land use options in the Business Plan in June 2010. That analysis showed mānuka plantations as being a type of land use option that required a similar outlay to radiata forestry but not the regular outlays of continued sheep and beef farming. Including forecast earnings from the emission trading scheme (ETS), mānuka plantations stood to earn marginally less than the expected NPV for forestry but mānuka could provide a more regular cash flow than forestry. But mānuka plantations could earn over 50 percent more than continuing with sheep and beef farming without ETS credits. With ETS credits, a mānuka plantation could earn considerably more than an existing sheep and beef operation. However, these estimates incorporated higher estimates of ETS unit prices than currently estimates.

87. The key value drivers of these different land uses can be expected to vary significantly over the 20 year investment cycle of a mānuka plantation. So while this view of the relative values of these land uses may have provided reasonable point estimates in 2010 these could well have changed by 2017 and can be expected to change again by 2028 (The time horizon for the Programme's long term outcomes).

NPV of Mānuka Plantations

88. The Programme has simple NPV models which can be used to explore the value that could be achieved from mānuka plantations. At a basic level these can be used to test the economics of planting mānuka for honey given the findings of the Programme to date.

89. As discussed in paragraph 111, if an Afforestration Grant Scheme (AGS) grant is received to fund part of the establishment of the plantation then the NPV rises significantly. Other grant schemes such as those of regional councils are likely to have a similar effect if they provide around the same amount ($1,300/hectare) as an AGS grant.

90. The NPV analysis which is to be completed over coming months could be used to better specify the potential benefits of the Programme compared to the high level analysis done for this report. This could be done by using a new more realistic estimate of the volume of land that could be successfully developed as mānuka plantations, with assumptions for rates of uptake. The volume of land could be split up to simulate the NPVs of a mix of successful and less successful plantations. Summing this for all the land volume identified would give an estimate of the potential value of plantation mānuka the Programme specifically. This would be separate from the overall growth in the mānuka honey sector which was not

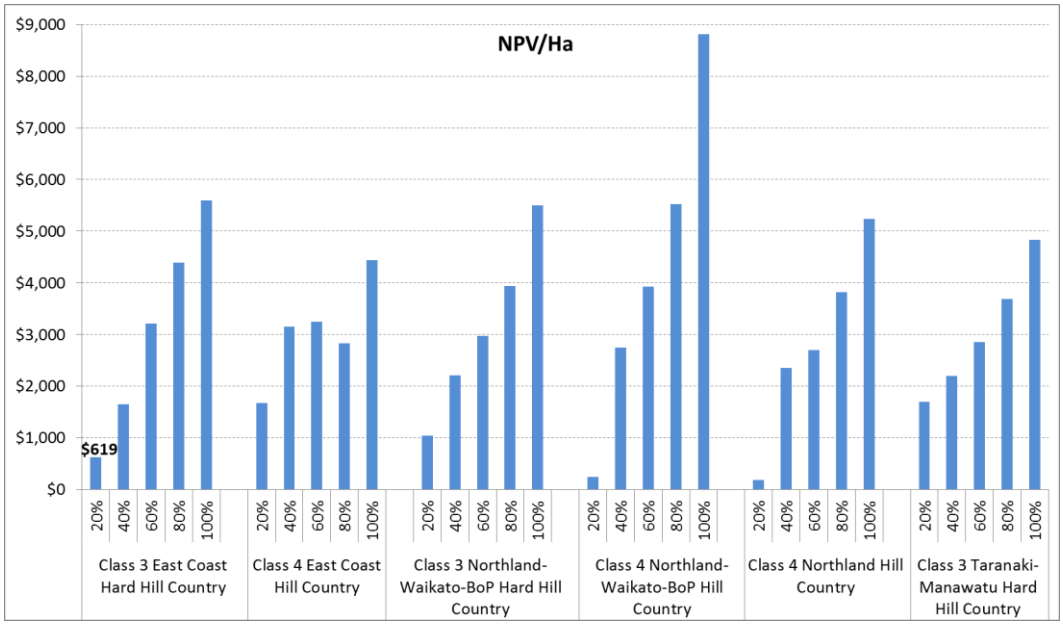
[40] Page 35, High Performance Mānuka Plantations PGP Programme Annual Plan 2016/17 and 2017/18, 22 November 2016.

separately identified in the original Business Plan[41]. Such an estimate would need to be sensitivity tested due to the large number of uncertain variables included but it could provide a useful range of possible values.

Sheep and Beef

91. Beef and Lamb New Zealand's Benchmarking Tool Analysis[42] provides a way of comparing mānuka plantations with a key alternative for landowners of continuing to farm the land for sheep and beef[43]. Figure 1 shows a NPV/hectare of Beef and Lamb's survey farms for actual performance in 2014/15 (data for Northland hill country farms was from the year before - 2013/14).

Figure 1 Beef and Lamb NZ Benchmarking Tool : Survey Farm Data 2014/15 year



Source: Beef and Lamb NZ benchmarking tool[44]

92. The Beef and Lamb NZ survey farms are broken into quintiles of weighted average performance based on Earnings before Interest, Tax and Rent (EBITR). Figure 1 shows that the estimated weighted average NPV of the worst performing 20 percent

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41 See paragraph 24 which discussed the point made in the 2010 Business Plan that some of the 16-fold gain could be achieved without the Programme and noted that the 2010 Business Plan did not try to apportion out what would come incrementally from the Programme and what would occur without it.

42 Available at http://portal.beeflambnz.com/tools/benchmarking-tool

43 Beef and Lamb NZ use 8 farm classes, 3 for the North Island (hard hill country, hill country, intensive finishing farms) and 5 for the South Island (high country, hill country, finishing breeding farms, intensive finishing farms and mixed finishing farms). Sapere focused on the more extensive farming categories. These do not match Land Use Capability (LUC) System for classifying land use based on its physical properties.

44 The data has been adjusted by taking farm profit before tax and adding back depreciation, interest and rent in an attempt to normalise to the NPV approach taken in 2010 Business Plan shown in Figure 1. The 2014/15 NPV estimate is rolled forward over 20 years to calculate the NPV.

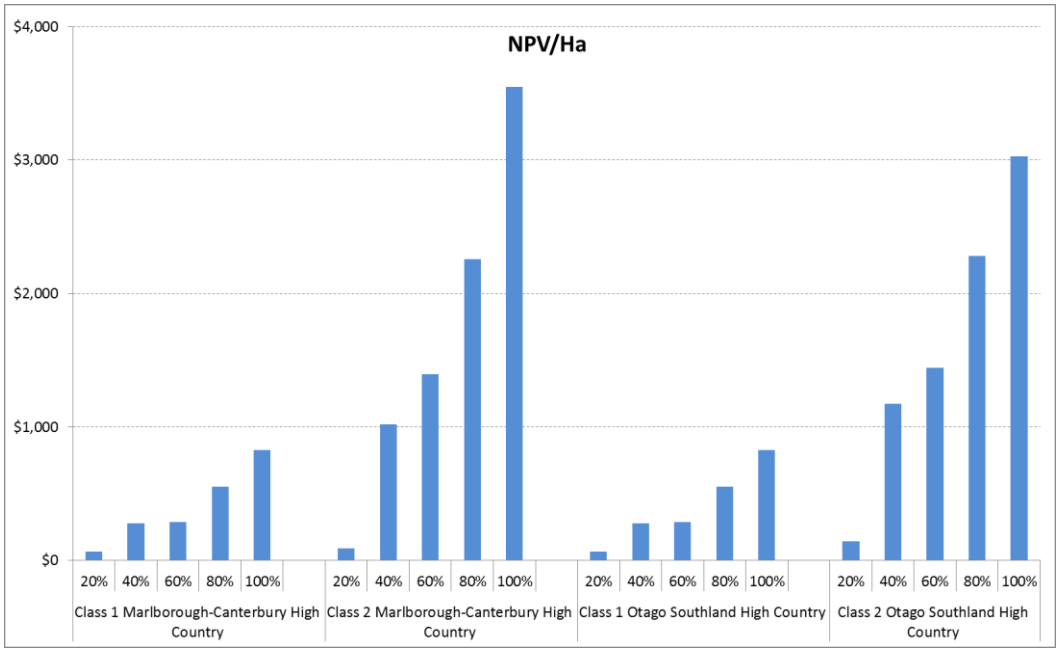
of surveyed farms on the Class 3 East Coast hard hill country was $619/hectare - the first value on the left hand side. In contrast, the top 20 percent of Class 4 Northland-Waikato-BoP hill country farms earned the highest average NPV of $8,818/hectare.

93. The base case NPV/hectare estimate for mānuka plantations is better than the poorer performing farms but not as good as the more profitable farms. This indicates that mānuka should be an attractive land use alternative for farms performing in the lower quintiles. Poorer parts of better performing farms could also potentially profitably switch from sheep and beef to mānuka plantations as this data averages performance at the farm level and doesn't break farms down into on farm soil types. It would also be necessary to distinguish between lower performing farms which were simply not being well managed and those that were being well managed. The former group of farms would be unlikely to manage an investment in mānuka well either. In contrast those that were being well managed, but who are unable to perform better due to their poorer physical resources or locations, could be expected to have better chances of managing a conversion to mānuka effectively.

94. It is noteworthy that if the average price of bulk mānuka honey is assumed to be $100/kg on average or full plantation and beekeeping management and ownership is assumed, mānuka plantations could be expected to return NPVs that would compete with the top performing 20 percent of farms in the regions shown in Figure 1.

95. The South Island presents more challenges both for farmers and mānuka plantations. The land is often less productive per hectare than the North Island counterparts. In addition, the South Island has many high country stations. Successfully establishing mānuka plantations there would also present challenges given the colder climate and northern provenance of mānuka with higher DHA potential. Figure 2 shows the quintile performance of Beef and Lamb NZ's South Island survey farms. If a similar mānuka plantation NPV could be achieved as in the North Island, then mānuka could provide a better expected economic return than sheep and beef on most of the surveyed South Island farms. However, this would require developing a more cold tolerant cultivar, either through breeding of existing cultivars or potentially through eco-sourcing.

Figure 2 Beef and Lamb NZ Benchmarking Tool : Survey Farm Data 2014/15 year



Source: Beef and Lamb NZ benchmarking tool[45]

Forestry

96. Forestry as an alternative land use option appears to have maintained its differential value over mānuka plantations and sheep and beef. Three studies of the value of forestry as a land use option indicate that forestry may still provide greater NPV over the long term[46]. However, the range of NPV outcomes is very broad reflecting factors such as location, climate, distance to ports, discount rates and carbon prices. Distance from ports can make forest harvesting uneconomic as shown in Dawoon Park's study and the Scion study.

97. If Scion's estimates of radiata small block NPV's are overlaid on Figure 1 the potential for forestry investments to provide greater NPVs than either mānuka or sheep and beef is apparent. The top values for mānuka may still be bettered by forestry NPVs.

98. These land use NPV comparisons vary widely within each land use. The results depend on many assumptions, prices in commodity markets and returns over long periods. The best use of a particular block of hill country land will depend on its specific characteristics and whether it offers particular advantages or disadvantages

45 Ibid

46 "An Update on Forestry Economics and Market Outlook to Support Land-Owner Decision Marking in Lower Nutrient Leaching Land Use Systems", John Moore, Graham West and Leslie Dowling SCION, November 2015, Page 3; "Economic Wood Availability and Profitability of Small-Scale Forests in Wanganui District", Dawoon Park, 2011, Page 68 and "Economics of Alternative Land Use on Crown Forest Licensed Land" Ian Dickson, Mike Hensen & Peter Madden, May 2009, Page 31

for these different land uses. However, the relativity between these land uses at a generic level remains roughly the same in 2017 as it was in 2010.

Mānuka Market

99. MPI's Provisional Estimates of Tree Stock Sales and Forest Planting in 2016 has for the first time attempted to gather information on mānuka seedling sales and make an estimate of the area planted. MPI has identified 12 nurseries as undertaking bulk sales of mānuka, including 8 of 28 commercial forestry nurseries. It has tentatively estimated that 9.8 million mānuka seedlings were sold and about 6,300 hectares planted in the 2016 calendar year, mostly for the honey industry, some for revegetation and a small area for investigating mānuka oil production[47].

Commentary

100. In summary, it appears that it will be a lot more challenging than believed at the outset in 2010 to successfully manage bees on mānuka plantations. Finding the right combination of land, climate, scale and drive to establish successful plantations is likely to be demanding. A good example of a material change in perspective resulting from the Programme's work is an emphasis now on needing plantations of sufficient scale, ideally within areas of regenerating mānuka, to allow for the bees to be profitably managed and mānuka honey dilution effects minimised. However, once suitable blocks of land are identified, carefully planned and executed establishment of mānuka plantations appears to be a very attractive and profitable land use option compared to continuing with sheep and beef in many cases. While mānuka's expected returns appear lower than forestry with carbon pricing, in general mānuka has the advantage of a shorter wait for income from a similar level of upfront investment. However, forestry investment is likely to be a poor choice when the distance from ports is significant, for example over 100km. Another important advantage of mānuka planted in suitable land areas is that it provides a different income stream, one that is not necessarily correlated to forestry or sheep and beef income cycles, so spreading a landowner's income risk across a wider portfolio of activities.

External Factors

101. Two external factors either have or are likely to have a material impact on the long run success of the Programme and MFNZ activities following the end of the Programme. These are the proposed definition for mānuka honey and grants for afforestation.

Definition of Mānuka Honey

102. In April 2017 MPI released a proposed regulatory definition of mānuka honey when sold as a food (not for honey used in medical applications). This seeks to provide a robust and sophisticated scientific approach that can be used to authenticate New Zealand mānuka honey. MPI's science programme:

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47 MPI Provisional estimates of tree stock sales and forest planting in 2016, Page 4

- established plant and honey reference collections;
- identified suitable attributes;
- tested plant and honey samples;
- developed and validated laboratory test methods; and
- analysed and interpreted the data that was collected.

103. The science programme sought to find nectar and honey attributes that were most useful and practical for distinguishing between plant species and honey types. A classification model was used to analyse these attributes, and the threshold levels that may be suitable to separate honey types. Threshold criteria have been proposed for different honey types, including monofloral and multifloral mānuka honey.

104. An important finding of the classification modelling approach was that no single attribute can be used alone to identify mānuka honey but a combination of attributes can be used. Five attributes were identified for defining honey mānuka types - four chemicals and a DNA marker[48].

105. In its announcement in April 2017, MPI noted that 74 percent of honey samples originally identified by the supplier as monofloral mānuka met the monofloral mānuka honey threshold criteria and a further 12 percent met the multifloral mānuka honey threshold criteria. In addition, over 56 percent of samples originally identified by the supplier as multifloral mānuka met the monofloral mānuka honey threshold criteria.

106. The MPI analysis found that 14 percent of honey sample thought to be monofloral mānuka was not. 21 percent of samples thought to be multifloral was found not to be mānuka honey of any sort while 40 percent of samples believed to be kānuka was actually monofloral or multifloral mānuka honey. The MPI research found that dihydroxyacetone and methylglyoxal are unsuitable for the identification of mānuka honey when sold as a food.

107. It also noted that bees may not always forage from the main flowering plant in the area. Therefore, the classification of some honey types initially identified by the supplier as monofloral or multifloral mānuka honey may change after being assessed under the classification criteria. MPI also pointed out that most samples came from single-source apiaries and did not reflect blending practices within the honey production supply chain. Therefore, similar correlations with the identification criteria mentioned above may not be evident for products in the market place currently identified as monofloral or multifloral mānuka honey.

108. Should the number of samples found not to be any sort of mānuka honey be indicative of quality and marketing of mānuka more widely, it could be expected that the MPI definition will see some fall in the quantities of honey that can be marketed as mānuka. This is likely to put upward pressure on the prices and potentially cause the relationship between UMF and price to become more exponential. In addition, the removal of uncertainty about the definition of mānuka honey should reduce the

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48 For more information see http://mpi.govt.nz/growing-and-producing/bees-and-other-insects/manuka-honey/

risks inherent in investing in mānuka plantations as investors are less likely to face reduced future returns from honey fraudulently passed off as mānuka. This should increase interest in mānuka plantations as a profitable land use option.

109. It may be necessary to do testing to ensure there is an acceptable alignment between the Programme's focus on DHA levels for both medical and food use and the attributes of mānuka honey that has been proposed by MPI for honey as a food.

Afforestation grants

110. There are a number of schemes that seek to encourage afforestation of erosion prone land. These include the Afforestation Grant Scheme (AGS), the Erosion Control Funding Programme [49]and other regional council grants. The AGS is designed to help establish 15,000 hectares of new forest between 2015 and 2020. Its purpose is to help reduce soil erosion with forest cover, improve land-use productivity and boost regional economic development as well as store carbon and improve water quality. It involves grants of $1,300 a hectare for growers to plant new forests from 5 hectares to 300 hectares with up to $19.5 million available in total for such grants in the period to 2020[50].

111. These schemes offer a way in which investors seeking to establish mānuka plantations can reduce the upfront cash costs of their investment and improve their economics. Factoring in the AGS scheme into the base case set out in paragraph 88 significantly improves the expected NPV from plantation mānuka. This takes the expected earnings above those from most sheep and beef farms in the Beef and Lamb NZ farm survey as shown in Figure 1.

112. The 2010 Business Plan[51] estimated that programmes at that time to treat erosion-prone land in the North Island, including those operated by regional and central government, covered 10,000 to 15,000 hectares per annum. It also noted that on average, the funding provided by local and regional governments for the treatment of marginal land (mainly by afforestation) was around $1,500 per hectare. Hence treating 10,000 to 15,000 hectares equated to an average spend of $15 to $25 million. These schemes remain a significant boost and encouragement to plant mānuka.

Management and Governance

113. Mānuka Research Partnership (NZ) Limited (MRPL) was formed in April 2011 and entered the PGP agreement, together with Comvita Limited, with MPI. The Programme Steering Group meets quarterly while the MRPL Board meets regularly. MRPL/MFNZ and the science group at Massey University meet fortnightly with

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49 The Erosion Control Funding Programme (ECFP) is a MPI programme that provides grants to Gisborne district landholders to help reduce wide-scale erosion problems in the Gisborne district. See http://www.mpi.govt.nz/funding-and-programmes/forestry/erosion-control-funding-programme/

50 For more information see http://www.mpi.govt.nz/funding-and-programmes/forestry/afforestation-grant-scheme/

51 Page 29, of Business Plan High Performance Mānuka Plantations 29 June 2010

monthly conference calls with Professor Richard Archer. The science audit ran at least twice annually until December 2016[52].

114. MRPL negotiated the replacement of the in-kind and some of the cash contributions of Arborex Industries Limited with a new shareholder in 2014 (the Hawke's Bay Regional Council, HBRC). HBRC took over the obligations to form and maintain a plantation and to provide cash and in-kind services. Landcorp Farming Limited also joined MRPL as a shareholder in 2014 and agreed to provide in-kind and cash support and also to establish plantations to support the Programme[53].

115. MRPL's commercial arm - Mānuka Farming New Zealand (MFNZ) has a separate brand, marketing and communications plan. It was launched in February 2016.

116. Interviews with those involved in the Programme including a member of the PGP IAP, six MRPL Board Members and five PSG members have shown a general level of satisfaction with the way the Programme has been governed. Given the number of partners involved and their differing motivations, there have of course been some divergent views about the direction and focus of the Programme. But overall many commented that it had been well governed.

117. There was a common perception by those interviewed that the management of the Programme had improved since the appointment of a dedicated programme manager in March 2015. Relying on people with other priorities to drive the Programme before this appointment had been a lower cost approach. However, as noted by MPI in its May 2016 report, there had been less focus on some aspects of financial management, such as reporting, monitoring and forecasting. The same report noted that since the appointment of a dedicated programme manager appropriate reporting and systems had been put in place. It also commented that the MRPL Company Secretary had ensured that the key day to day financial management processes such as processing and making payments, keeping the books of accounts and maintaining records to support funding claims had been done in the period between 2011 and 2014.

118. The current focus of the MRPL Board and MFNZ is on delivery of the Objectives and Milestones set out in the 2016 to 2018 Annual Plan as discussed in the sections headed PGP Programme Objectives and Progress made by the Programme. It is appropriate that given the importance of the predictive model, the technical notes and the business case showing the economic value of plantation mānuka to the Programme that significant resources are currently dedicated to delivering these.

Additional Benefits

119. The most tangible spill over benefit identified in the 2010 Business Plan[54] was that "*3 new PhD research scientists would be trained in the cultivation of mānuka*" This was achieved.

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52 Source Page 13 of the Business Plan High Performance Mānuka Plantations [Expansion and Extension], 28 February 2014 and MRPL/MFNZ

53 Ibid

54 Source : Page 28 of Business Plan High Performance Mānuka Plantations 29 June 2010

One new PhD research scientist finished and moved on to Fonterra. Two others are in the process of finishing, one a New Zealander and the other a Spaniard.

120. The other spill over benefits listed in the 2010 Business Plan were not too demanding as long as the Programme lasted for its expected 7 and a half years. They were that four significant players in the mānuka honey value chain would work together; forming a de facto research consortium which could grow to become a major development engine of this industry and the Programme would allow learning about the integration of different industries – honey, health foods, carbon farming, and native forestry. These have been achieved.

121. The 2010 Business Plan set out how the Programme could contribute environmental benefits. It proposed that net sustainability benefits from mānuka farming on marginal land such as more hill-country remediation would occur and this would reduce the direct and indirect costs of erosion and provide savings for local and central governments.

122. The 2014 Business Plan also had a focus on additional environmental benefits[55]. These could occur through encouraging riparian planting which would help to improve water quality through shading and interception of nutrients and micro-organisms and other mechanisms. It was also believed that biodiversity could be enhanced through the native corridors generated and native flora would naturally establish in the un-grazed strips. All this would help to improve the appearance of the land and assist in portraying a clean, green image for New Zealand's food marketing abroad.

123. An additional spill over benefit was seen in the re-introduction of shelter belts to irrigated land. It was believed that this would improve animal welfare as well as help to protect irrigators themselves against wind damage.

124. Unfortunately the Programme's research has found that benefits from riparian planting and shelterbelts under irrigation are unlikely to emerge from plantation mānuka for honey production. This is due to the difficulty in ensuring bees harvest mānuka nectar from smaller blocks of mānuka when there are an abundance of other nectar sources within their range, e.g. clover as discussed in paragraphs 66 and 67. Some really large riparian planting could have sufficient scale to allow successful harvesting of mānuka honey from it.

125. The wider environmental benefits that could derive from the Programme are very likely to be lower than originally hoped back in 2010. This is because, as discussed in the section titled Progress Towards Benefits, there seems to be much less land than originally thought that would be suitable for successful mānuka plantations for honey.

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55 Page 16 & 17 of Business Plan High Performance Mānuka Plantations [Expansion and Extension] Final 28 February 2014