Rotorua Land Use Directory

Tahuri Whenua

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

Ministry for the Environment
Manatū Mō Te Taiao

Rotorua Land Use Directory

Tahuri Whenua

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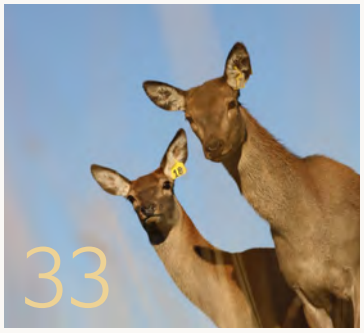

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ROTORUA LAND USE DIRECTORY – TAHURI WHENUA

MIHI

E tū ana au ki ngā pae maunga o te tawhā o Rotorua, ka hīkoi au i ōna taumata, whai ake i ngā tapuae o ngā tūpuna,

I stand upon ridges of the Rotorua caldera, I walk her ridges, tracing the steps of our ancestors,

Kia tau au ki tōku maunga a Ngongotahā, ka titiro whakararo ki tōku tūpuna a Te Rotorua-nui-a-Kahumatamomoe,

I settle on my maunga Ngongotaha, looking down upon my ancestor, the second great lake that honours our ancestor Kahumatamomoe,

He tūpuna, he waiora, he wairua, he wai mauri, e karanga ake nei ki a tātau

My lake is an ancestor, it is life giving, it is spirit, it is the essence of life,

Kia hono ai tātau ki a ia, kia rongo ai i ōna mamae, kia rongo ai i tōna mauri e kōhukihuki mai nei,

Our lake calls to all of us that we may connect with this essence, acknowledging her pain, acknowledging her distress,

Ka katakina ki runga,

Let us call to Ranginui above,

Ka katakina ki raro,

Let us call to Papatūānuku below,

Kia ueuenuku, Kia ueuerangi,

That they may strengthen us,

Kia homai i te oranga e,

Kia whakatā hoki au i ahau

Kia toro atu aku ringa, tōku manawa ki te awhi, ki te utaina i te aroha ki tō tātau tūpuna a Te Rotorua-nui-a-Kahumatamomoe,

So we may reach out with our hands and hearts to offer our love and assistance to our ancestor Rotorua-nui-a-Kahumatamomoe

Tūturu whakamaua kia tina, tina!

Let us grasp this!

Haumi ē, hui ē, tāiki ē!

Let us bind together and move forward as one!

Kei te iti me te rahi, tēnā rā koutou. Tēnā rā koutou i runga i te āhua o tēnei rauemi, me kī, he rauemi hei tautoko i a tātau. Kia ahu whenua tātau i runga i te whakaaro manaaki, te whakaaro tiaki i a Papatūānuku, me ōna rotomoana, ōna wai e whakaora i a tātau. Kia kaha rā te pānui mai, kia mau ki ngā mātauranga, kia puta tātau ki te whaiao, ki te ao mārama. Tēnā rā koutou, tēnā rā koutou, ka mihi, ka mihi, mauriora ki a tātau katoa.

We extend our greetings to all those who have picked up this resource. It is a resource to support us in managing our land in the spirit of caring and protection for earth mother and the many lakes and waters that adorn her. May we heed the knowledge within, so that we may be enlightened. We acknowledge you and call for wellbeing to us all.

ACKNOWLEDGEMENTS

The writers would like to thank the many people from land use and research organisations around New Zealand who kindly offered their knowledge, feedback and opinions to help us produce this *Rotorua Land Use Directory – Tahuri Whenua.* We'd also like to thank our technical advisory group members – Sandy Scarrow (Fruition), Simon Park (Landconnect), Phil Journeaux (AgFirst), Brent Clothier (Plant and Food) and Tim Payn (SCION) – for their feedback and guidance.

Much of the information in this directory is publicly available and has been gathered from a wide variety of organisations, websites and written resources. One of the aims of this project was to bring together this information from disparate sources into one easily accessible location. References for the information are provided in the directory, for those who wish to explore the land uses in more depth.

The land use field is a dynamic environment with developments occurring constantly in technology, the environment, markets, production systems and the political arena. Although we have tried to ensure the information in this directory is as accurate as possible, any errors, either through omission or commission, are our own.

Finally, we'd like to thank and acknowledge the support of the Bay of Plenty Regional Council and the Ministry for the Environment, who provided funding for the Low-Nitrogen Land Use Fund and this project.

Ngā mihi
Bill Young
Tatiana Kiwi-Knight
Te Arawa Primary Sector, Inc.

INTRODUCTION

Over the past 20 years, land users and the general public throughout New Zealand have become increasingly aware of the sensitive and complex nature of the environment in which we live. The issue of maintaining and improving water quality is becoming a key issue which many organisations and individuals are working on.

Within the Bay of Plenty, maintaining water quality of the lakes is a prime concern and has given rise to the Bay of Plenty Regional Council's (BOPRC) Plan Change 10[1], which focuses on improving water quality in the Lake Rotorua catchment. During the next decade, land users in the catchment will face a number of challenges, which will involve having to balance initiatives to help improve water quality with the need to produce an income from the land.

The *Rotorua Land Use Directory – Tahuri Whenua* is a guide to help land users in the Lake Rotorua catchment evaluate other land use options that may be available to them. The *Rotorua Land Use Directory – Tahuri Whenua* has been published in both this hardcopy format and on a public website at www.landusenz.org.nz.

The website contains all the information that is in this hardcopy directory, along with access to the sources of information and other resources.

HOW TO USE THIS DIRECTORY

This directory is divided into three main sections:

1. An introductory section, which includes environmental information about the Lake Rotorua catchment including climate, soil and topography data and BOPRC regulatory information;
2. The land use section, which consists of existing and potential land uses that are considered to be suitable for the Lake Rotorua catchment; and
3. An appendix with additional information on crop protection and greenhouses.

HOW WERE THE LAND USES SELECTED?

There were a number of criteria that influenced which land uses could be selected for this directory.

Firstly, land uses could not be included in the directory if they leach a high level of nutrients, especially nitrogen, and require regular soil disturbances, e.g., cultivating. These factors eliminated many crops from the directory. Reduction of the nitrogen load entering Lake Rotorua is a key objective of BOPRC's Plan Change 10 (see Plan Change 10 section).

Secondly, the climate will always play a crucial part in determining which land uses are possible. In the Lake Rotorua catchment, high rainfall, low temperatures, relatively high humidity and the occasional presence of early and late frosts were key constraints that excluded[2] many horticultural land uses.

Thirdly, land uses were not included if they required an artificial environment, such as a greenhouse, for growing. It was felt that a Rotorua Land Use Directory should reflect Rotorua environmental characteristics.

Lastly, industry factors, such as the presence or lack of a supplier, processing infrastructure and well-developed market channels, were also factors that determined if a land use could be made viable or not.

It should be noted that the absence of industry factors does not necessarily mean some land uses are not viable. There are entrepreneurial land users around the country who, despite a lack of processing infrastructure or market channels, have endeavoured to work around these issues and set up their own solutions.

This directory does identify agricultural land uses that are traditional to the Lake Rotorua catchment. It also highlights some potential land uses that, although they each may face some hurdles, could offer the prospect of a worthwhile endeavour if the challenges are resolved.

Importantly, any land use change planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching, either in Overseer or an alternative nutrient budgeting model approved by the Regional Council, and a Nutrient Management

1 'Plan Change 10' is shorthand for 'Lake Rotorua Nutrient Management – Proposed Plan Change 10 to the Regional Policy Water and Land Plan'. At the time of writing, Plan Change 10 is subject to appeals and may be amended by the Courts. Despite this uncertainty, alternative land uses will remain an option for landowners.

2 This includes crops like kiwifruit, which have been grown around Rotorua but are well outside the crop's optimum growing conditions, such as frost risk and growing degree days.

Plan developed to ensure that nutrient limits for a property could be met.

LAND USE SECTIONS

Each land use section is divided into seven categories:

1. Overview
2. Products and markets
3. Production requirements
4. Infrastructure requirements
5. Environmental issues
6. Investment and return
7. Useful links containing information on contacts, resources and references.

NITROGEN LEACHING INDICATOR

Within the environmental issues section of each land use, there is a nitrogen leaching indicator that gives a visual indication of the nitrogen leaching potential of the land use. There are four levels:

- Low (green) indicates a low nitrogen leaching land use of <18 kg/ha/year;
- Medium (orange) indicates a medium range of nitrogen leaching from 19–54 kg/ha/year;
- High (black) indicates a high nitrogen leaching land use of >55 kg/ha/year;
- Unknown indicates there is no nitrogen leaching information currently available for this land use.

An indication of Low–Medium means the nitrogen leaching rate is at the lower end of the medium range.

Land uses with Medium or High nitrogen leaching rates will require intervention to reduce their nitrogen leaching levels.

DISCLAIMER

The information in this Rotorua Land Use Directory is a guide only to potential land use options in the Rotorua catchment and is intended to provide general information to the public.

While every effort has been made to ensure the accuracy of the information contained in this directory, Te Arawa Primary Sector, Inc. and the Bay of Plenty Regional Council make no warranty, express or implied, nor assume any legal liability or responsibility for the accuracy, any error of fact, omission, interpretation or opinion which may be present, nor for the consequences of any financial decision based on the information contained in this directory.

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The information in this directory should not be relied upon as a substitute for professional services and should not be construed as advice, whether legal, financial, technical or otherwise in any given situation. In such cases, it is recommended that services of a competent professional adviser be sought.

BAY OF PLENTY REGIONAL COUNCIL

PLAN CHANGE 10

Lake Rotorua Nutrient Management – Plan Change 10 has been developed to manage nutrient loss in the Lake Rotorua groundwater catchment.

This plan change is part of a wider programme committed to protecting water quality in the Lake Rotorua catchment. Input from public meetings, hui, information sessions, conversations and numerous research reports has been used to inform the policies, methods and rules being proposed in Plan Change 10.

Under Plan Change 10, the establishment of crops in the Lake Rotorua catchment is problematic.

Crops have the potential to leach large quantities of nutrients, including nitrogen. Crops should only be considered as a possible land use in the Lake Rotorua catchment where there is the capacity of land size to allow other land use changes to offset the large losses likely from the crop area. Please seek expert advice before progressing with any form of land use change involving crops.

Commercial cropping in the Lake Rotorua catchment, regardless of property size, will require a resource consent.

For controlled activities such as rural properties over 40 hectares in the catchment, they will now require a resource consent.

Properties/farming enterprises that are considered controlled activities will be given a Nitrogen Discharge Allowance that they will need to meet by 2032 and will require a Nitrogen Management Plan that shows actions that manage the reductions.

More information on Plan Change 10 – Lake Rotorua Nutrient Management can be viewed on the Bay of Plenty Regional Council's website.[3]

3 https://www.boprc.govt.nz/lake-rotorua-nutrient-management

PLANNING – RESOURCE CONSENTS

When making a land use change, it's important to consider whether or not this change will require a resource consent.

Resource consents are vital to ensuring our natural and physical resources are allocated and used efficiently and sustainably, and are required under the Resource Management Act (1991).

WHAT IS A RESOURCE CONSENT?

A resource consent is an approval to undertake certain activities identified in rules. They are generally required for activities that have a greater impact on the environment due to the significance of the activity either in the short or long term. Resource consents specify:

1. The length of time an activity can be carried out; and
2. Any specific conditions that need to be met.

WHAT IS THE PROPOSED CONSENTING SYSTEM?

Proposed Plan Change 10 provides for three types of consent classes:

Permitted activity
No consent needed as long as rule conditions are met

Controlled activity
Consent needed and will be granted as long as rule conditions are met

Non-complying
Consent needed and may be declined

Whether a landowner will need a resource consent under Proposed Plan Change 10 depends on:

- Property size;
- Rate of nitrogen loss from activities on the property;
- If managed nitrogen reductions are planned for;

- If there is commercial cropping, horticulture or dairy farming on the property.

Before applying for a resource consent, it is recommended that landowners talk or meet with a land management officer from the Rotorua Office. The land management officer may also be able to undertake a site visit to provide further advice on development of a Nitrogen Management Plan to support an application for Land Use Activities in the Catchment of Lake Rotorua (PC10).

To arrange this, please phone 07 921 3377.

More information on the resource consent process can be found on the regional council webpage: https://www.boprc.govt.nz/environment/resource-consents/.

THE LAKE ROTORUA CATCHMENT

The Lake Rotorua catchment is approximately 30 km across from the Mamaku Plateau in the west to the Whakapoungakau range in the east, and around 22 km from the northern to the southern boundary.

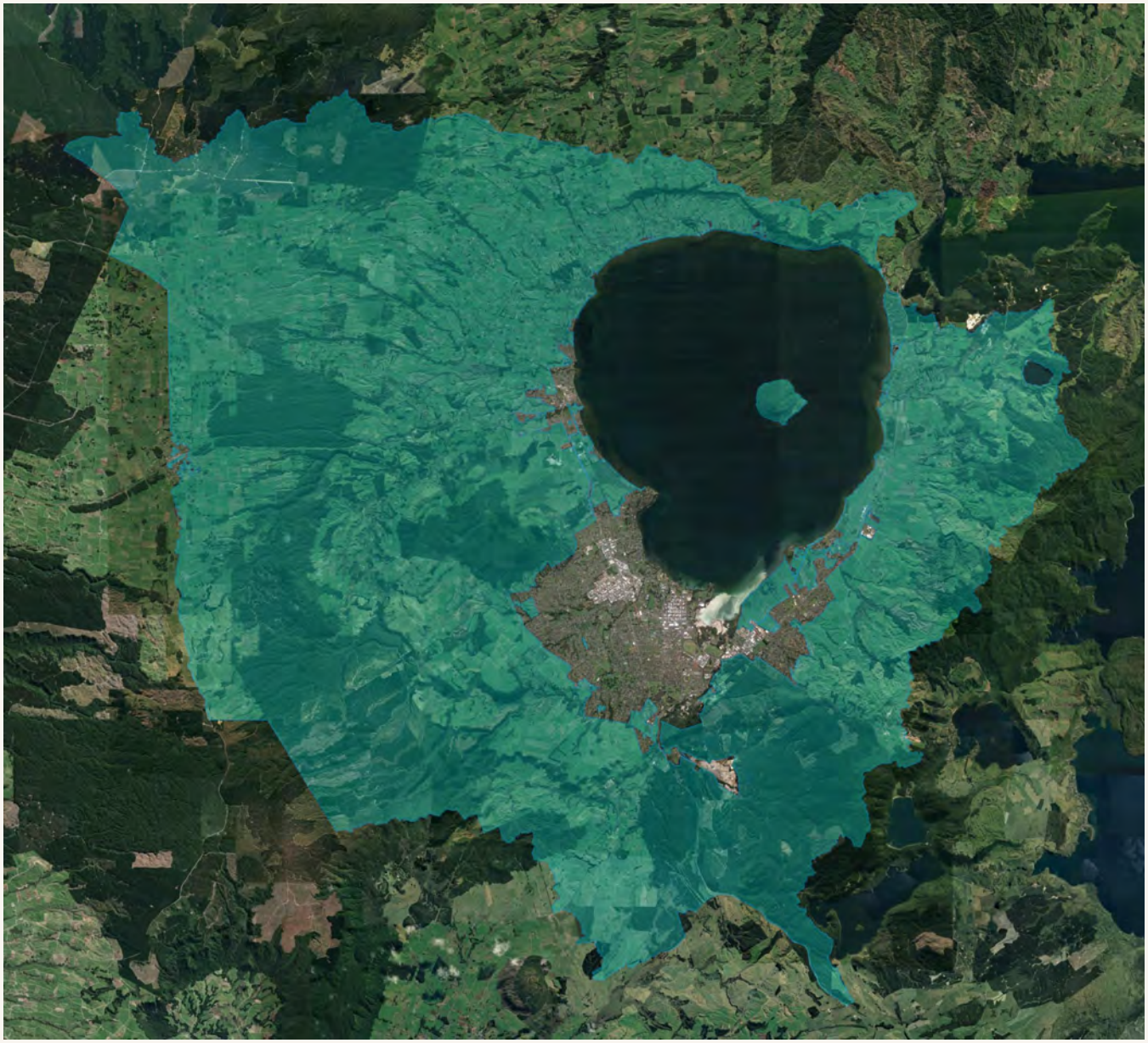


Figure 1: Lake Rotorua catchment rainfall map

ROTORUA CLIMATE, SOIL AND TOPOGRAPHY

The existing climate, soils and topography are key elements in the biophysical environment that provide a framework of environmental limits that can either promote or restrict different land uses to varying degrees.

This section examines these elements in relation to the Lake Rotorua catchment.

ROTORUA CLIMATE

The table below shows average monthly figures for a range of climatic factors over the 30-year period 1981–2010.[4] These figures are measured at the weather station at Rotorua Airport.

4 Cliflo Database, NIWA

SUMMARY ROTORUA CLIMATE 1981–2010

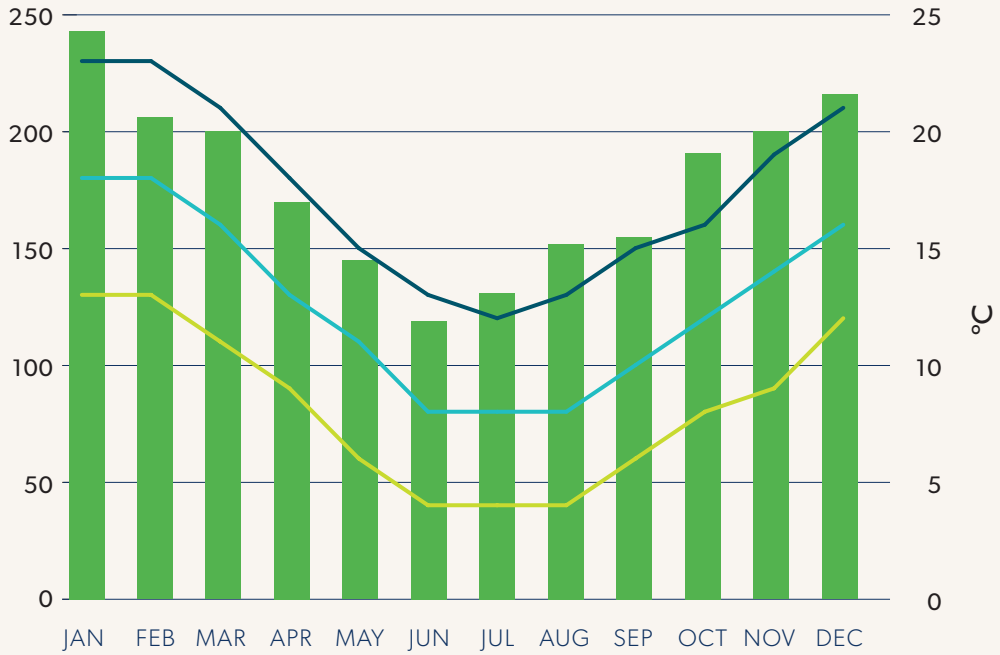
Climate factor	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Sunshine hours	243	206	200	170	145	119	131	152	155	191	200	216	2128
Mean daily maximum temperature (°C)	23	23	21	18	15	13	12	13	15	16	19	21	17
Mean temperature (°C)	18	18	16	13	11	8	8	8	10	12	14	16	13
Mean daily minimum temperature (°C)	13	13	11	9	6	4	4	4	6	8	9	12	8
Growing degree days (hours)	234	224	181	102	48	15	8	8	30	65	109	189	1214
Humidity (%)	79	81	81	83	87	88	87	86	82	80	77	79	83
Rainfall (mm)	93	94	99	107	117	136	135	131	109	112	94	114	1342
Wet days (1mm or more of rain)	8	7	9	8	9	11	11	12	11	11	9	10	117
Ground frost days	0	0	0	2	5	9	12	10	5	2	1	0	46
Winter chill hours	-	-	-	55	119	177	214	190	115	-	-	-	870

Some key points arising from this table:

- Sunshine hours are at their maximum in January, at 243 hours, and typically reach their lowest in June, with 119 hours.
- Temperature: the annual average temperature ranges from 8–18°C with the average maximum temperature being 23°C and the average minimum being 4°C.
- Growing degree days (above a 10 degree baseline) vary during individual years from under 1000 hours up to about 1400 hours, with an average across the 30-year time period of 1214 hours.
- Humidity ranges from 79 percent in summer up to 88 percent in June, with an annual average of 83 percent.
- Rainfall is measured at Rotorua Airport but varies significantly across the catchment from 1342 mm at Rotorua Airport to around 2400 mm on the Mamaku Plateau. (See Figure 1 – Lake Rotorua catchment rainfall map.)
- Frost: Rotorua (airport) has about 46 ground frosts and 20 air frosts per year on average. Importantly, there is also a risk of early-season ground frosts in October, November and December, and late-season ground frosts in March and April, which can adversely affect many crops.
- Winter chill hours: Rotorua receives an annual average of 870 hours of winter chilling below 7°C.

The following graphs show temperature and rainfall figures in the Lake Rotorua catchment.

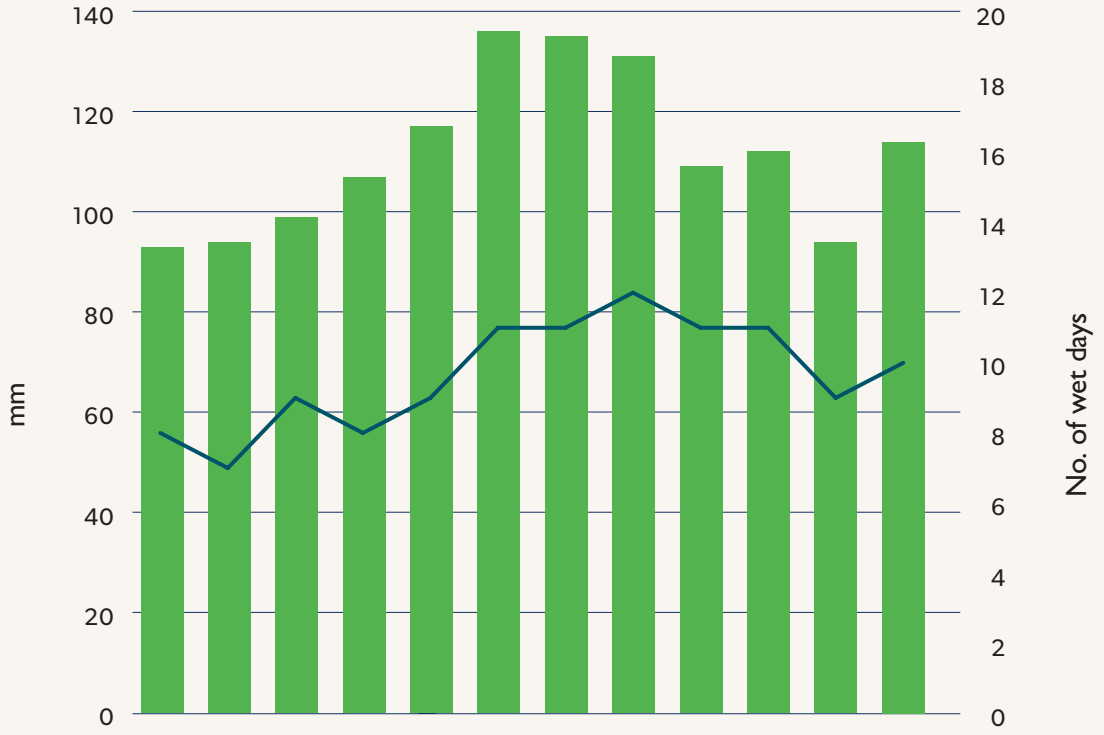
ROTORUA SUNSHINE HOURS VS TEMPERATURE 1981–2010



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Sunshine Hours	243	206	200	170	145	119	131	152	155	191	200	216
Daily Max Temp	23	23	21	18	15	13	12	13	15	16	19	21
Mean Temp	18	18	16	13	11	8	8	8	10	12	14	16
Daily Min Temp	13	13	11	9	6	4	4	4	6	8	9	12

Figure 2: Rotorua sunshine hours vs temperature

ROTORUA RAINFALL VS WET DAYS 1981–2010



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall (mm)	93	94	99	107	117	136	135	131	109	112	94	114
Wet days	8	7	9	8	9	11	11	12	11	11	9	10

Figure 3: Rotorua rainfall vs wet days

ROTORUA COMPARED TO OTHER GROWING AREAS

To provide context of how Rotorua compares with other growing areas in New Zealand, below is a table comparing select climate variables in these areas averaged over the years 1981–2010[5]:

5 Cliflo Database, NIWA

Location	Rainfall (mm)	Sunshine (hours)	Mean temperature (°C)	Growing degree days (10°C)	Humidity % (Min–Max)
Hamilton	1108	2020	14	1500	79–91
Tauranga	1181	2346	15	1856	73–85
Rotorua	**1342**	**2128**	**13**	**1230**	**77–87**
Napier	785	2259	15	1575	67–79
Nelson	960	2472	13	1264	73–90
Christchurch	618	2142	12	1055	78–92
Alexandra	359	2006	11	1122	68–89

Rotorua's rainfall of 1342 mm is the highest of the locations listed, but this does not represent the entire catchment well as the Rotorua Airport location receives the lowest rainfall in the Lake Rotorua catchment. Rainfall levels increase moving westward to the Mamaku Plateau, which can receive up to 2400 mm per year.

While sunshine hours at 2128 hours annually is in the midrange of the other regions reported, the lower mean temperature of 13°C results in lower growing degree days, essentially a shorter growing season. This shorter growing season coupled with higher rainfall and hence humidity creates a limiting environment for many horticultural crops.

WIND

Although the prevailing windflow over northern New Zealand is west to southwest, winds over the Bay of Plenty region are modified by the local topography.[6]

Wind roses (showing mean annual frequency of surface wind speed and direction based on hourly observations) for four sites in Bay of Plenty are shown in Figure 4. Winds from the west and southwest prevail at Mt Te Aroha (elevation 951 m) and at Tauranga, while at Whakatane, north-westerly and south-westerly winds are the most frequent.

At Rotorua, the prevailing wind is north-easterly, but winds from between south and west are also common.

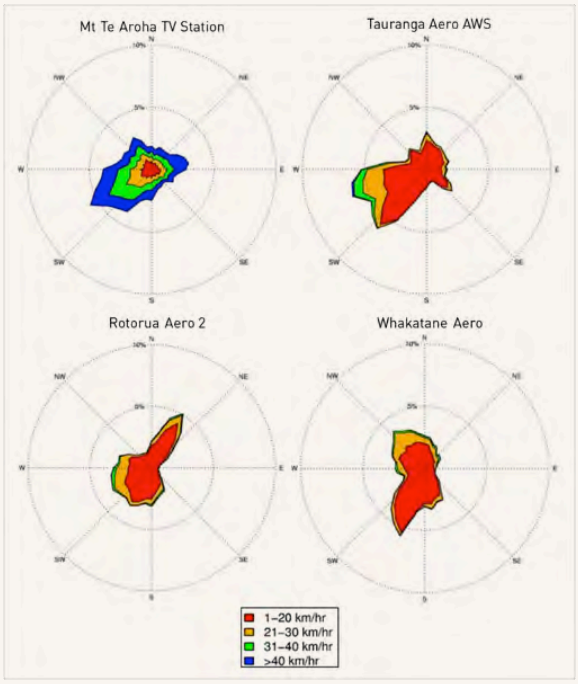


Figure 4: Windroses showing the frequency of wind direction for four sites in the Bay of Plenty

WIND SPEED

The average daily wind speed in Rotorua varies little throughout the year, averaging around 12 km/hr with a slight increase during spring to 13–15 km/hr.

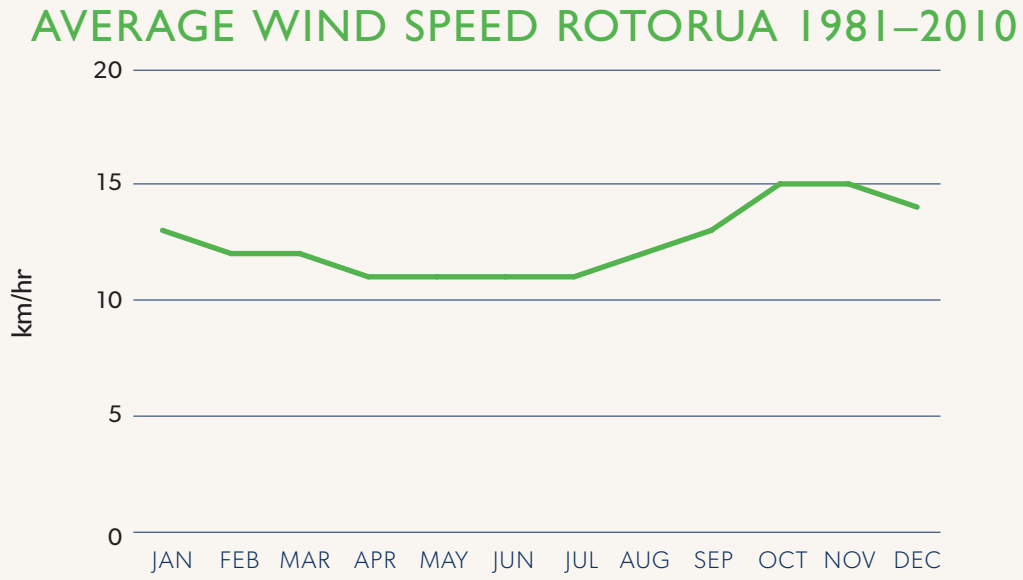


Figure 5: Average wind speed

6 *The Climate and Weather of the Bay of Plenty*, 3rd ed., NIWA 2013

CLIMATE CHANGE

With the impact of global warming, temperatures across the country appear to be rising.

The warmest year since the start of the NIWA 'seven-station' record in 1909 is the year 2016, with an annual mean temperature of 13.44°C, or +0.83°C above the 1981–2010 average (see Figure 6).

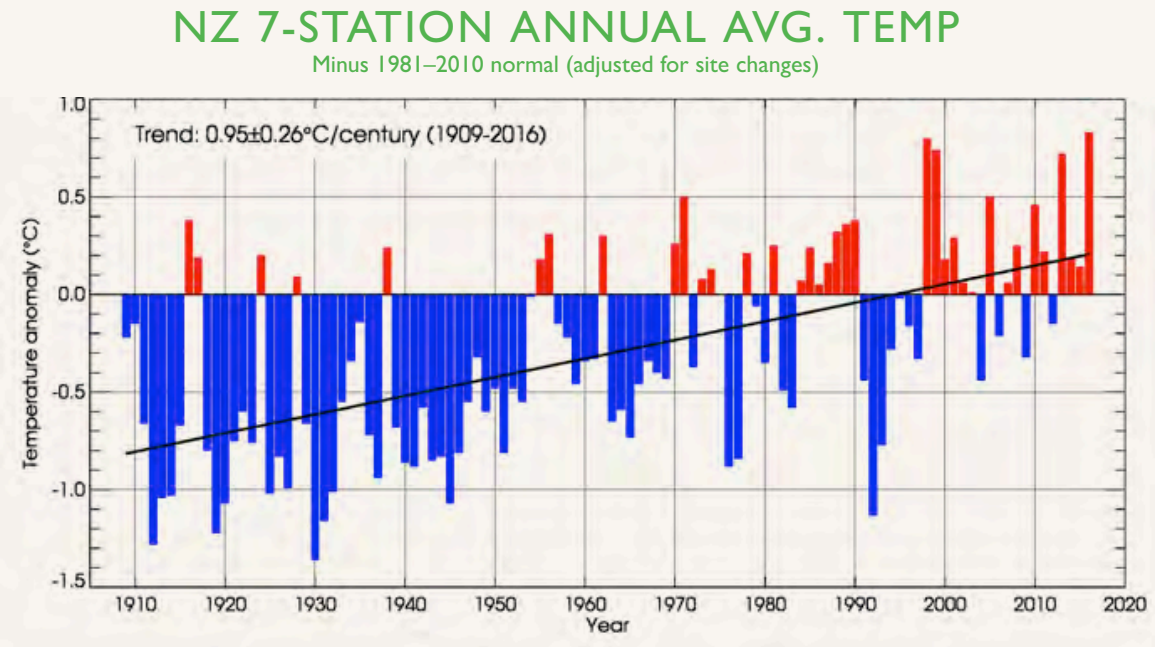


Figure 6: NZ 7-station annual average temperature

The warmest years on the basis of monthly mean temperatures are: 2016 (+0.83°C), 1998 (+0.80°C), 1999 (+0.74°C), 2013 (+0.72°C), with 2005 and 1971 tied at +0.50°C.[7]

The black trendline indicates an increase in temperature from 1909–2016 of 0.95°C over a 100-year period (+/- 0.25°C).

Rising temperatures will have a significant impact for the rural economy and land uses across the country.

CLIMATE CHANGE IN THE BAY OF PLENTY

In 2011, Bay of Plenty Regional Council asked the National Institute of Water and Atmospheric Research (NIWA) to update a 2003 climate change report for the region with new information from more accurate climate models and projections. A summary of the information[8] is as follows:

TEMPERATURE

- Bay of Plenty temperatures will rise over the rest of this century. By 2040, the region's annual mean temperature is expected to be around 1.2°C warmer than it was in 1990. By 2090, it is expected to warm by between 2.7°C under a mid-emissions scenario and 3.6°C under a high-emissions scenario. (See Emissions Scenarios below)
- Hot days, i.e., 25°C or more, are tipped to become the summer norm by the end of the century. Whakatāne, for instance, currently gets about 22 hot days a year; by 2090, it may experience between 80 and 100. Rotorua currently gets about 12 hot days a year; under a high emissions scenario, it could expect to get between 50 and 60.

7 https://www.niwa.co.nz/our-science/climate/information-and-resources/nz-temp-record/seven-station-series-temperature-data - Excerpt from NIWA 7-station series

8 For more information, visit https://www.boprc.govt.nz/media/276278/climate-change-factsheet.pdf

- Tauranga currently gets around 22 hot days annually. By 2040, under a mid-range emissions scenario, it could see twice that number, and more than 70 a year by the century's end.
- Warming will be fairly uniform across the region; Tauranga, for instance, will warm at much the same rate as Whakatāne.
- Not all seasons will warm at the same rate. Autumn and winter are projected to warm slightly more than summer and spring.

RAINFALL

- The warmer air gets, the more moisture it can hold – about seven or eight percent more for each degree of warming – so rain is likely to fall more heavily in future.
- The region will get roughly the same average annual rainfall in 2090 as it does now, but rain may fall at different times. For instance, winters are expected to become drier as the century unfolds; by 2090, coastal and south-eastern areas may receive 10 percent less rain than they do now. On the other hand, summer rainfall is projected to increase – particularly inland – and to become more variable. We may see a sharp year-to-year contrast of either very dry summers, or very wet ones.

WIND

- The Bay of Plenty will get more easterly winds during summer, and more westerlies during winter.
- By analysing historical weather maps that have produced extreme winds in the past, and comparing them against the sort of maps we might expect in a warmer climate, scientists calculate that extreme winds may be less frequent during future summers, but more common during winters.

FROSTS

- By 2090, frosts will be a rare thing in the Bay of Plenty. At present, Ōpōtiki gets around five frosts a year, while Rotorua may get 20. By the end of the century, Rotorua is projected to experience frost just once or twice a year – none at all in some years. Other locations may get perhaps one frost every three years. There will be fewer cold nights.

Therefore, the future climate for Rotorua may mean warmer temperatures and more hot days in summer along with an increased risk of droughts, heavier summer rainfall and fewer frosts.

Warmer temperatures, a longer growing season and fewer frosts would provide opportunities for new crops and land uses in the catchment. Farmers might also benefit from faster growth of pasture and better crop-growing conditions. However, these benefits may be limited by negative effects of climate change such as prolonged drought and greater frequency and intensity of storms.[9]

Also, even decades into the future, the nitrogen-leaching capacity of new crops in the catchment would need to be analysed to ensure they still fell within low nitrogen leaching guidelines.

EMISSIONS SCENARIOS

The mid-range scenario describes a future world of very rapid economic growth. It assumes that the global population will peak mid-century, then decline, and that we will rapidly adopt new, more efficient technologies. It also assumes that our future energy will come more or less equally from fossil and non-fossil sources. In this scenario, carbon dioxide concentration doubles from pre-industrial levels by the 2060s, and is about 140 percent higher than pre-industrial (17th century) levels by 2100.

The high-range emissions scenario describes a more piecemeal response to climate change. Regions and nations adopt their own strategies and technologies, and their economies develop at differing rates. This slows the uptake of new technologies, while the global population goes on increasing. In this scenario, carbon dioxide concentration doubles from pre-industrial (17th century) levels by the 2060s and is almost 200 percent higher than pre-industrial by 2100.

9 http://www.mfe.govt.nz/climate-change/how-climate-change-affects-nz/how-might-climate-change-affect-my-region/bay-plenty

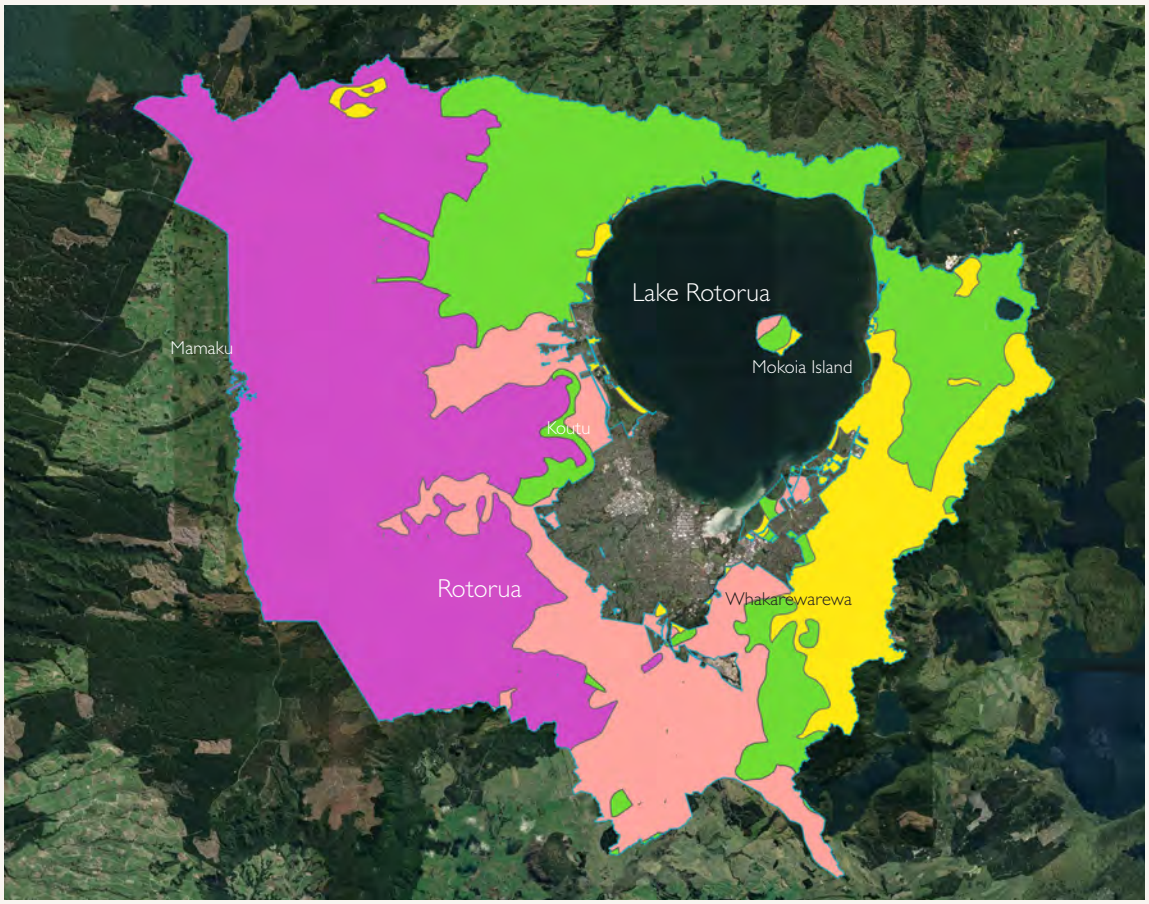


Figure 7: Soil order classification areas

SOIL

In the Bay of Plenty, nine soil orders are present.[10] Four of these are predominant in the Lake Rotorua catchment. Most catchment soils are derived from pumice and have low bulk density, are well-drained with moderate to high water-holding capacity and low natural fertility. Pumices that have been subject to high rainfall and historical native forest cover have developed into podzols. The allophanic soils to the south-west are formed on a mix of ash and Taupō pumice.

A brief outline of the four predominant soil orders[11] is below (see Figure 7):

Podzols (purple area). Podzols are strongly leached acid soils. The soils occur under high rainfall (generally exceeding 1800–2000 mm annually), mostly at higher elevations and have low natural nutrient levels. In the Bay of Plenty they are used for dry stock grazing and some dairying, forestry, and some cropping on the Mamaku Plateau. Podzols are predominant from lands south-west of Rotorua through to the Mamaku Plateau in the north-west.

Pumice soils (green). Pumice soils are soils that are dominated by pumice or pumice sand high in volcanic glass. Clay contents are generally less than 10 percent and soil strength is weak or very weak. The soils are resistant to pugging and, like the allophanic soils, have low to very low nutrient levels. The potential for erosion by water is high, especially when the surface vegetation and thin topsoil are removed. Summer droughts occur. These soils occur through Kaharoa to the north of Lake Rotorua to the lands around Okahu Bay at Lake Rotoiti and up around the hills to the east and north-east of Lake Rotorua.

Recent soils (yellow). The main properties of recent soils include weak soil development, generally high

10 *Soils of the Bay of Plenty vol. 2* Central, Bay of Plenty Regional Council

11 NZSC Soil Order Classification, SMAP, Landcare Research

base saturation, gravel or rock not strongly altered, high potential rooting depth, good drainage, low phosphate retention, high fertility, and susceptibility to erosion and/or sedimentation. Recent soils also occur on hilly or steep slopes where surfaces are renewed after erosion. Land use on such slopes is mostly dry stock or forestry, the latter restricted because of shallow profiles overlying parent rock. Many areas are in indigenous forest. These are among the most versatile soils in the Lake Rotorua catchment and are found primarily in the hills to the south-east of Lake Rotorua and around Lake Tarawera.

Allophanic soils (pink). These soils have properties strongly influenced by clay minerals that are poorly crystallised or amorphous. They have weak soil strength and are sensitive with low bulk density. The soils are formed from layers of volcanic ash that are visible near the source (Rotorua area) and telescope together further away (East Coast area). They were called yellow-brown loams in previous soil classifications. The soils typically have dark yellowish-brown grading to yellowish-brown sandy loam to silt loam subsoils with high levels of phosphate-fixing allophane in the clay fraction. Topsoils tend to be 18 cm or more deep with weakly developed structure and black to dark brown colours. The soils have a typically greasy feel when moistened and rubbed firmly between the fingers. Allophanic soils are generally moderately to strongly leached with low levels of exchangeable calcium, potassium, magnesium and sodium. Reserves of magnesium and potassium are low to very low. Available phosphorus is naturally low with high phosphate retention. Allophanic soils are friable to a great depth and do not have root-restricting layers. Along coastal Bay of Plenty, these are ideal soils for deep-rooting subtropical plants such as kiwifruit, provided they are sheltered from salt-laden winds. Other uses are pasture (dairying, dry stock), or forestry on steeper slopes. Cropping, such as maize, needs careful management to preserve topsoil structure. These soils make up a large proportion of the soils around Rotorua city centre, from Western Heights through to Tihiotonga and south towards Horohoro and Tumunui.

SOIL TEXTURE

Texture is a basic property of the soil that is not easily changed. It affects other soil properties, such as water availability, permeability, drainage, and aeration. It also influences nutrient retention, the development of soil structure and the ease of soil cultivation.

Texture is the relative proportions of the primary particles in the soil, namely sand (2.00–0.06 mm), silt (0.06–0.002 mm) and clay (<0.002 mm). Every soil contains a mixture of sand, silt and clay, and this is expressed as a textural class name such as sandy loam, silt loam, clay, etc. A soil that contains a balanced mixture of sand, silt and clay is called a loam. In general, soils of the Bay of Plenty do not contain appreciable amounts of clay.

The soil textural triangle shows all the textural class names that result in various combinations of sand, silt and clay. A more generalised, or simplified, textural triangle is used to group the textural classes into sandy, silty, loamy and clayey (see Figure 8).

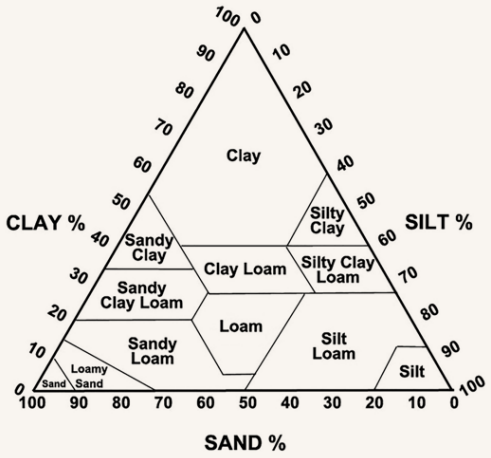


Figure 8: Soil texture triangle

Sandy soils have more large pores and fewer small pores. They have good aeration, but store much less water for plant use, and are considered droughty soils. In heavily-fertilised sandy soils, rapid water movement increases the risk of groundwater pollution through leaching of excess nutrients such as nitrate.

Leaching is the process of removal of soluble materials (nutrients, metals and pesticides) in solution by water draining through the soil. Strongly leached soils may occur anywhere, but are most common under high annual rainfall at higher elevations, as in the case of podzols.

Nutrient leaching is very relevant to the Bay of Plenty because many of the soils have sandy textures. Nutrients in sandy soils with low organic matter content are easily leached because the soils are freely draining and have low nutrient retention capacities. On the other hand, soils containing appreciable clay and organic matter do not leach as much because a greater proportion of inorganic nutrients is absorbed on the (mostly) negatively-charged exchange complex. Since texture is a basic soil property that is not easily changed, the addition of organic matter to sandy topsoils to increase their nutrient-holding capacity is very important.

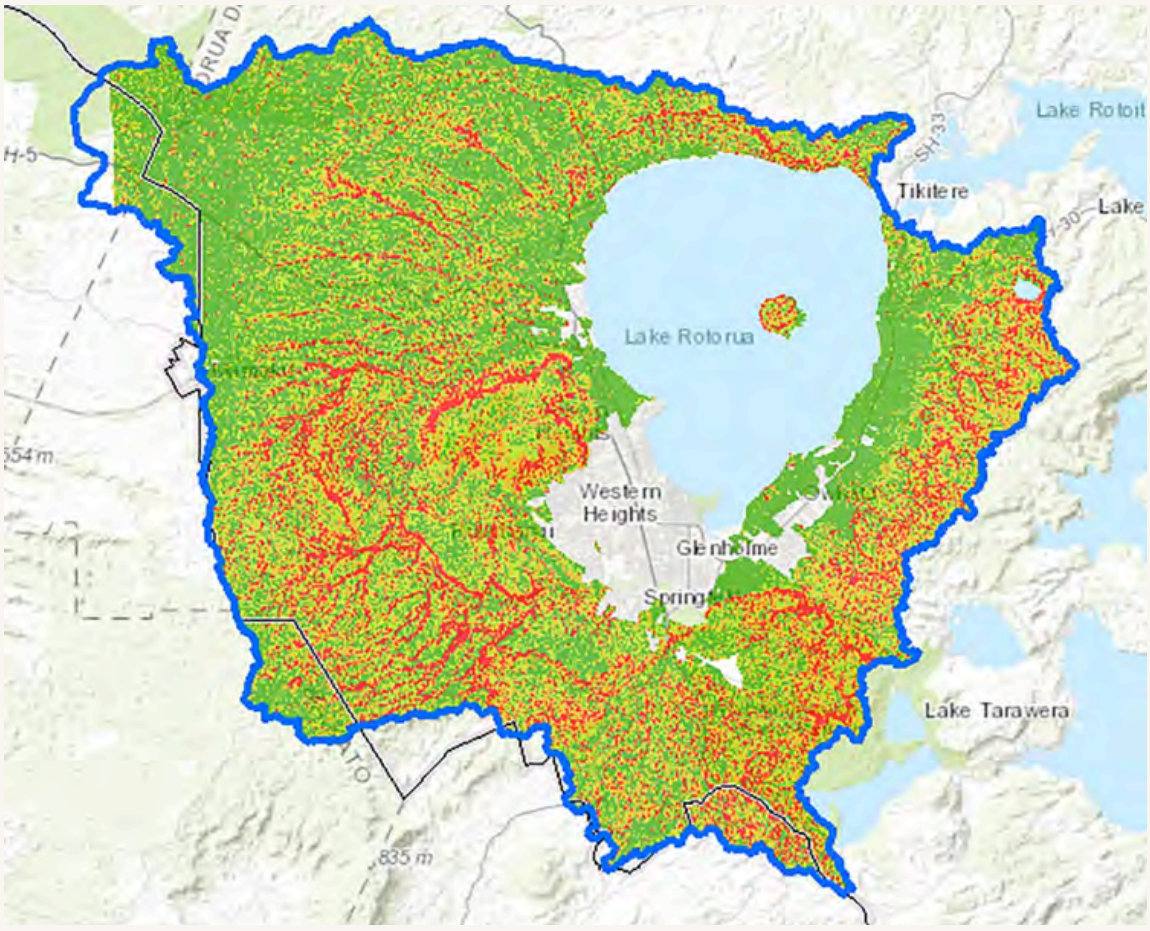
To avoid under- and over-irrigation, it is important to properly monitor soil moisture in the farm. Tensiometers, gypsum blocks, neutron probes, time domain reflectometry (TDR) and frequency domain reflectometry (FDR) sensors are the main instruments that can be used for monitoring soil moisture.

More detail on soil is available from Landcare Research, Bay of Plenty Regional Council and Rotorua Lakes Council.

TOPOGRAPHY

Of the catchment's approximately 20,000 ha pastoral land, 75 percent is flat to rolling (0–16°), 16 percent is hill (16–26°) and 9 percent is steep (>26°). The map below illustrates the variations in slope within the Lake Rotorua catchment.[12]

12 BOPRC Rotorua Lakes Catchment Characteristics And Nutrient Management Map Viewer



Slope class (degrees):

- 0–7.9
- 8–15.9
- 16–25.9
- 26+

Figure 9: Lake Rotorua catchment map showing slope classes

A more detailed view is available on the website www.landusenz.org.nz


329
329
47
48

LAND USES – AGRICULTURE

DAIRY GOATS

1. LAND USE OVERVIEW INFORMATION

In New Zealand, there are estimated to be 92 farms running 66,100 dairy goats, which are predominantly Saanen (85 percent) or cross-bred, with 72 percent of the dairy goat population located in the Waikato region.[13]

Dairy goat farming in New Zealand has become established, due in large part to the work of the Dairy Goat Cooperative (DGC), the largest dairy goat milk processor in New Zealand. Over the last 25 years, the company has completed significant research and development into dairy goat milk products and building market channels and partners, which enables DGC to provide high milk payouts to its suppliers of over $17 per kilogram of milk solids.

DGC has around 70 supplier shareholders, most based in Waikato with some in Taranaki and Northland. The number of suppliers is managed carefully to match the level of demand for the DGC product range. All export product is made, blended and packed at its three plants in Hamilton.

NIG Nutritionals, which is a subsidiary of New Image Group, has developed a goat milk-based product range and is supplied by two dairy goat farms near Auckland, one of which is one of the largest in the country, milking in excess of 3000 does.

Currently neither DGC or NIG are looking for new suppliers.

Fresco Nutrition is a New Zealand processing company collecting goat milk from farms in Manawatu and Hawke's Bay and processing the milk using the open access spray dryer at the Waikato Innovation Park. Fresco sells in New Zealand and overseas and has plans to build its own processing plant in Hawke's Bay.

NZ Dairy Collaborative Group is a newly formed company based in Ashburton. The company is largely funded by Fineboon, the largest goat milk infant formula brand in China. Initially the company was provided with goat milk from Manawatu and Hawke's Bay farms, which was shipped to the Waikato Innovation Park for processing and freighted to Ashburton. Recently, the company has built a $40 million processor at the Ashburton Business Park and aims to set up a supplier network of local Canterbury farms. The goat milk will be processed in Ashburton for export to China.

A smaller operation, Wairere Goat Creamery, has established a boutique goat milk business that supplies fresh goat milk direct to supermarkets and retail outlets predominantly in the Waikato area.

Setting up a new dairy goat farm in the Lake Rotorua catchment would be dependent on developing market channels, either locally for direct supply, contracting with a distributor independently or working cooperatively with other farms and potentially an international distributor to build a global marketing and supply network.

There are currently plans to build a dairy cow milk processing plant in the Bay of Plenty at Kawerau. They have plans to introduce dairy goat and dairy sheep milk processing, if warranted, in the second stage of their development, i.e., after 2020.

2. PRODUCTS AND MARKETS

Goat milk has traditionally been made into a range of products including cheeses, yoghurt and soap, as well as being available as milk. Goats' milk is seen as a healthy alternative to cows' milk, due to the different protein makeup, and is suitable for those who are unable to drink cows' milk, as well as being considered more easily digested and less allergenic.

DGC has broadened the product range further by developing the world's first commercialised infant formula from goat milk, as well as a range of consumer packaged nutritional powders based on goat milk. They market the products with joint venture partner Orient Europharma Co Ltd into Taiwan, Singapore, Malaysia, Hong Kong and China. Most milk is supplied to the DGC in Hamilton where it is converted to milk powder, UHT milk and specialised goat milk infant formula (powder).

More recently, NIG Nutritionals, based in Auckland, has also developed a range of goat milk formula products with markets in mainland China, South East Asia and the Middle East.

Fresco Nutrition supplies a range of powdered goat milk for infants, children and adults in New Zealand and overseas.

13 *New Zealand Goat Industry Report to Federated Farmers of NZ Inc.*, March 2017

Nitrogen leaching: low–medium

Wairere Creamery supplies fresh goats' milk in 1- or 2-litre containers, and goat feta cheese.

The industry is concentrated in the Waikato but is growing in Manawatu, Hawke's Bay, Canterbury, Northland and Taranaki.

3. PRODUCTION REQUIREMENTS

Approximately 85 percent of dairy goats milked in New Zealand are the Saanen breed, due to its greater milk production capacity, while the Toggenburg, British Alpine and Nubian type crosses comprise the remaining 15 percent.[14]

Dairy goats are housed in barns 24 hours per day, 7 days per week, for warmth and protection and to avoid picking up worms and parasites in paddocks. They are fed largely on grass, which is cut and carried to them, and a combination of silage and/or maize silage along with dry grain while milking. Goats walk to and from the milking parlour twice daily for milking.

Milk production for dairy goats starts at around 75 kg/MS/yr and rises to around 100 kg/MS/yr or more around year three or four, before dropping off as they get older. The season is similar to dairy cows running from approximately July to May.

Kids are reared for one month before going out into the paddock. Those not being kept for milking are sold to other farmers or reared for meat production.

4. INFRASTRUCTURE REQUIREMENTS

Infrastructure for a dairy goat farm depends on existing facilities, but would comprise a goat shelter, dairy goat milking parlour (either rotary or herringbone), tractor, mower, assorted implements, feed storage, etc.

The costs of establishing a dairy goat farm from scratch are significant. Costs can be less if converting from dairy cows to dairy goats, as some infrastructure can be re-used.

Dairy goat farms are much smaller than dairy cow farms. In terms of farm size, 1000 goats can be milked on an effective farm area of 50–60 hectares. Feed can be a mixture of pasture and/or supplements. Anecdotal evidence suggests allowing 1 tonne of grass per 100 goats to be cut and carried each day to the goat shelter.

5. ENVIRONMENTAL ISSUES

The impact of dairy goats on the environment is less than dairy cows for effluent, and housing dairy goats 24/7 reduces this further. However, it is assumed fertiliser would still be spread on the paddocks, so the amount of nitrogen used on paddocks would still need to be minimised. The application of effluent to paddocks would also need to be managed carefully.

Farmed goats are vulnerable to parasites, which can impact their growth, health and productivity. Housing goats and the cut-and-carry method of bringing grass to them is intended to minimise parasite infections. AgResearch is undertaking research that may help goat breeders select animals with naturally higher levels of immunity to parasites, through testing goat saliva.[15]

6. INVESTMENT AND RETURN

Gross annual returns for 1000 does producing 80 kg/MS per year at $17.00/kgMS would be $1.36M.

This would need to be weighed up against capital and operating costs. Capital costs would be in the region of $1–2 million for 1000 goats depending on existing infrastructure. This would include a goat shelter (allow $300–500 per goat or $300,000–500,000) and a milking parlour (allow around $10,000 per bail or $540,000 for a 54-bail rotary).

While there would be other costs involved in setting up a dairy goat farm in the Lake Rotorua catchment, the priority would be establishing market channels.

7. SOURCES/USEFUL LINKS

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14 *Dairy goat production systems in Waikato, New Zealand*, Solis-Ramirez et al., 2011

15 *CARLA could soon help combat goat parasites*, AgResearch

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DAIRY SHEEP

1. LAND USE OVERVIEW INFORMATION

Although dairy sheep farming has been underway for some years in New Zealand, it has only recently started attracting a higher profile, principally through the efforts of Landcorp with their Spring Sheep brand, and Waituhi Kuratau Trust, the Tūrangi-based Māori land trust and their Maui Milk brand.

The dairy sheep industry in New Zealand is a relatively recent phenomenon. The five main producers of sheep milk are:

- Blue River Dairy, in Southland;
- Kingsmeade, in Wairarapa;
- Thorvald, in Nelson;
- Maui Milk, near Tūrangi; and
- Spring Sheep, near Reporoa.

Interestingly, although the industry is in its infancy in New Zealand, Blue River Dairy, which milks over 10,000 sheep, is one of the largest sheep dairies in the world. However, the industry has some way to go to build national infrastructure, develop quality standards, establish national industry bodies and support organisations, and importantly, improve genetics to increase productivity. New Zealand's depth of experience in sheep farming and dairy farming should help hasten this process.

Dairy sheep organisations Maui Milk and Spring Sheep will be looking for dairy sheep suppliers, but are both working through a development period over the next two years to increase milk yield through improving genetics and management to create a high-performance New Zealand dairy sheep breed.

2. PRODUCTS AND MARKETS

Sheep milk is highly nutritious and is richer in vitamins A, B and E, calcium, phosphorus, potassium and magnesium than cows' milk. Sheep milk has a higher solids content than goat or cow milk. As a result, more cheese can be produced from a litre of sheep milk than a litre of goat or cow milk. Sheep milk yields 18 to 25 percent cheese, whereas goat and cow milk only yield 9 to 10 percent.[16]

Sheep milk products include cheeses, yoghurt, ice cream, milk powder and fresh milk. Other income, from milk-fed lambs, meat, wool and leather, is also possible.[17] Small-scale dairy sheep milking is also an option to produce milk, cheeses, and yoghurt for local markets.

Worldwide production of sheep milk in 2014 was approximately 10.5 million tonnes[18] and is growing at around 2.5 percent per year. The largest producers of sheep milk globally in 2014 were China with 1.5 million tonnes (14.7 percent), Turkey (10.7 percent), Greece (7.4 percent), Syria (6.6 percent) and Romania (6.5 percent).

Key markets are China, Taiwan and other Asian countries, although the world's biggest market for sheep cheese is the United States.

3. PRODUCTION REQUIREMENTS

Dairy sheep farming would be similar to a dairy cow farming regime, with sheep being milked twice daily.

Grass-feeding sheep is considered not only a sales benefit for customers, but also maintains a highly cost-efficient industry. However, developing a high-performance dairy sheep breed using European genetics may necessitate a need for indoor housing in the future.

There is some evidence that housing sheep closer to the dairy shed increases productivity compared to sheep walking long distances.

Dairy sheep yield is currently around 150–200 litres per ewe per season. The aim is to increase this to at least 300 litres per ewe and more to become internationally competitive. Lactation is currently 180–200 days, compared to cows at 280–300 days.

4. INFRASTRUCTURE REQUIREMENTS

Infrastructure required will be influenced by whether the farm's existing assets can be used or modified for use, and will depend on the expected value of returns over subsequent years balanced with the necessity for specific asset/s.

Typical infrastructure would include sheep dairy shed (herringbone or rotary), related dairy shed and farm equipment, yards, shearing shed and sheep housing if required.

16 NZ Sheepmilk website - http://nzsheepmilk.co.nz/nutritional-faqs

17 Business Plan for the NZ Sheep Dairy Industry – Lucy Griffiths (2014)

18 FAOSTAT – Food and Agriculture Organisation of the United Nations

No published information is available for the cost of a dairy sheep milking parlour. However, they are similar in size to a dairy goat parlour and therefore a nominal cost of $10,000 per bail would be appropriate for the installation of a rotary dairy sheep parlour.

5. ENVIRONMENTAL ISSUES

Nitrogen leaching: low–medium

The impact of a dairy sheep farm on the environment is considered to be similar to a drystock sheep farm, with N-leaching of around 15–20kg/N/ha, however, more research is required to confirm this.

Most of the Lake Rotorua catchment is ideal for drystock farming and therefore would be ideal for dairy sheep farming.

Developing a Farm Environment Plan from Beef & Lamb NZ[19] would be a good first step in understanding a farm's unique resources and how to remain productive while mitigating any environmental and water-quality issues.

19 http://www.beeflambnz.com/farm/environment/farm-environment-plans/

6. INVESTMENT AND RETURN

Estimated costs and return are speculative at this stage, although costs to the landowner will be reduced if some existing infrastructure can be re-used.

Lucy Griffiths, as part of her 2015 Nuffield New Zealand scholarship, put together a *Business Plan for the New Zealand Sheep Dairy Industry*. As part of that project she assembled a financial forecast for a dairy sheep farm based on 2015 figures below. This has been included as a hypothetical example only.

The capital costs, variable costs and gross margin calculations for a flock of 300 East Friesian ewes in the New Zealand market currently are estimated below. Based on the assumptions outlined, Lucy believes a mid- to high-lactating flock could produce a return on investment within 3–6 years (excluding land costs). A low-lactating flock would lose money.

PROPOSED FINANCIAL BUDGET[20]

Performance levels (per ewe basis)	Low	Average	High
Milk yield (litres) per ewe per year	200	400	600
Sales ($)			
Milk value	400.00	800.00	1,200.00
Lambs	129.00	129.00	129.00
Wool	13.20	13.20	13.20
Cull ewes and lambs	13.50	13.50	13.50
Output per ewe	**555.70**	**955.70**	**1355.70**
Variable costs			
Concentrates	216.00	306.00	396.00
Miscellaneous (incl vet, med and shearing)	45.00	45.00	45.00
Total variable costs (excluding forage)	261.00	351.00	441.00
Gross margin per ewe	294.70	604.70	914.70
Deducting foliage costs	20.00	20.00	20.00
Gross margin per ewe	**274.70**	**584.70**	**894.70**
Stocking rate (ewes with lambs per forage hectare)	12.50	12.50	12.50
Gross margin per hectare (ex GST)	**$3434.00**	**$7309.00**	**$11,184.00**

Notes:

1. Price: $2 per litre at farm gate.
2. Lambing %: 175 percent. Assume a 300-ewe flock (525 lambs). Retain 60 ewe lambs for flock replacements. Sell 386 cow milk-fed lambs at $100 (inc 15 percent mortality). If ewe lambs for selling to other sheep milk producers, lamb value increases to $250. Milk-fed lambs 6–8 weeks sold direct to restaurants.
3. Wool: current season this is worth $3.30/kg and each ewe has approximately 4 kg.
4. Cull ewes: assumed 18 percent culled at $75 per head (average, including mortality) 6 years old+.
5. Concentrates: milking ewes: 200 days at 0.5–1.5 kg/head/day; cost $900/tonne. Ewe lamb replacements and artificially reared finished lambs at $85/head x 446.
6. Forage costs: additional silage or hay for feeding.

Fixed costs per ewe: labour (paid) $170; power and machinery $52; property costs $30; other $30;

Total excluding finance and rent: $282

20 Griffiths, L. *Business Plan for the NZ Sheep Dairy Industry*, Nuffield New Zealand (2014), http://nzaginvest.co.nz/wp-content/uploads/2015/10/2014_BUSINESS-PLAN-FOR-THE-NZ-SHEEP-DAIRY-INDUSTRY_Lucy_Griffiths.pdf

CAPITAL COSTS

Hoggets (300 @ $350)	$105,000
Rams (3 @ $1000)	$3,000
Sheds x 2 for housing stock, milking parlour (24), tanks, 3 automatic feeders and electronic measuring equipment	$500,000
Capital costs total	$608,000
Land (good land) 12.5 sheep/hectare @ $20,000/hectare = 24 hectares	$480,000

Assumptions:

- 200-day lactation
- Friesian-cross with standard New Zealand meat breed (low lactation)
- Pure Friesian (average lactation)
- Friesian/Awassi cross (Assaf) (high lactation)
- All ewes close to parlour (24 hectares); ewes housed in evening
- Maintaining flock (20 percent) versus growing flock
- Lambs removed from mother at 24 hours and raised on cow milk powder – $85/10 kg
- Lambs sold as milk-fed lamb direct to restaurants for $100/lamb; 6–8 wk
- Low-lactating ewes fed high-protein TMR mix averaging 500g/day
- Medium-lactating ewes fed high-protein TMR mix averaging 1000g/day
- High-lactating ewes fed high-protein TMR mix averaging 1000g/day
- Demand outstrips supply for breeding stock so ewe lamb prices high at $250 each
- Hogget lambs high cost to purchase at $350 each due to current demand
- Larger farms may have to feed more to compensate for ewes walking further to parlour
- Currently East Friesian lambs – $250
- Hogget (have had 1 lamb) – $350.

7. SOURCES/USEFUL LINKS

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DEER FARMING

VENISON, VELVET AND CO-PRODUCTS

1. LAND USE OVERVIEW INFORMATION

The first licence to farm deer in New Zealand was issued in 1970, so the deer industry is relatively young compared to the rest of New Zealand agriculture. However, New Zealand has taken a lead in farming venison and is the number one source for farm-raised venison worldwide, with around 1800 farmers farming approximately 870,000 deer.

The deer industry has been declining in size over the last decade, from farming 1,396,023 deer in 2007 to 852,919 deer in 2016, a drop of around 40 percent. The main reasons have been due to a reduction in herd numbers when returns for venison and velvet were relatively poor, the impact of the global financial crisis, and very strong competition for land use from dairy cows and dairy support.

However, the industry is confident that it has turned a corner with the deer industry's Passion to Profit (P2P) strategy – a seven-year programme from 2015, supported by the Primary Growth Partnership fund, to improve the profitability of the deer industry. This appears to be having an effect with a reduction in the hind slaughter, a pick-up in the 2016–17 season of the venison price to $8.50/kg and an increase in processing plant carcase weights, which in part can be attributed to on-farm productivity gains.

Another positive sign was the reduction in the gap between off-season and peak pre-Christmas chilled prices, showing that, along with the shortfall in supply to growing new markets and the traditional markets, overseas marketing programmes were starting to have an influence.

FARMING AND EXPORT FIGURES AS AT SEPTEMBER 2016

Deer industry statistics[21]	y/e Sep 2015	y/e Sep 2016
Total deer farmed	900,100	834,608
Total FOB revenue (NZ$ million)	$255	$246
Venison exported (tonnes)	14,869	12,911
Venison export value (NZ$ million, FOB)	$174	$164
Velvet exported (tonnes)	572	603
Velvet export value (NZ$ million, FOB)	$39.1	$42.5
Co-products (tonnes)	4152	3947
Co-products export value (NZ$ million, FOB)	$27.7	$24.2
Hides and leather export value (NZ$ million, FOB)	$14.0	$14.5

(FOB – Free On Board)

21 Infoshare, Statistics NZ and Deer NZ website – www.deernz.org

2. PRODUCTS AND MARKETS

New Zealand exports a range of products derived from farmed deer:

- Venison is the main export for the industry, earning around 70–80 percent of the industry revenues;
- Hides and deer leather are exported to manufacturers of high-quality leather goods;
- Deer co-products include items for medicinal use in oriental medicine, as well as the bones and fat from deer;
- Deer velvet is a valuable export, with many farmers specialising in this product. Volumes produced have increased in recent years with the additional production finding growing demand in the healthy foods sector in Korea, and also beginning in China. YE Sept 2016 indicates export revenues in excess of $43M.

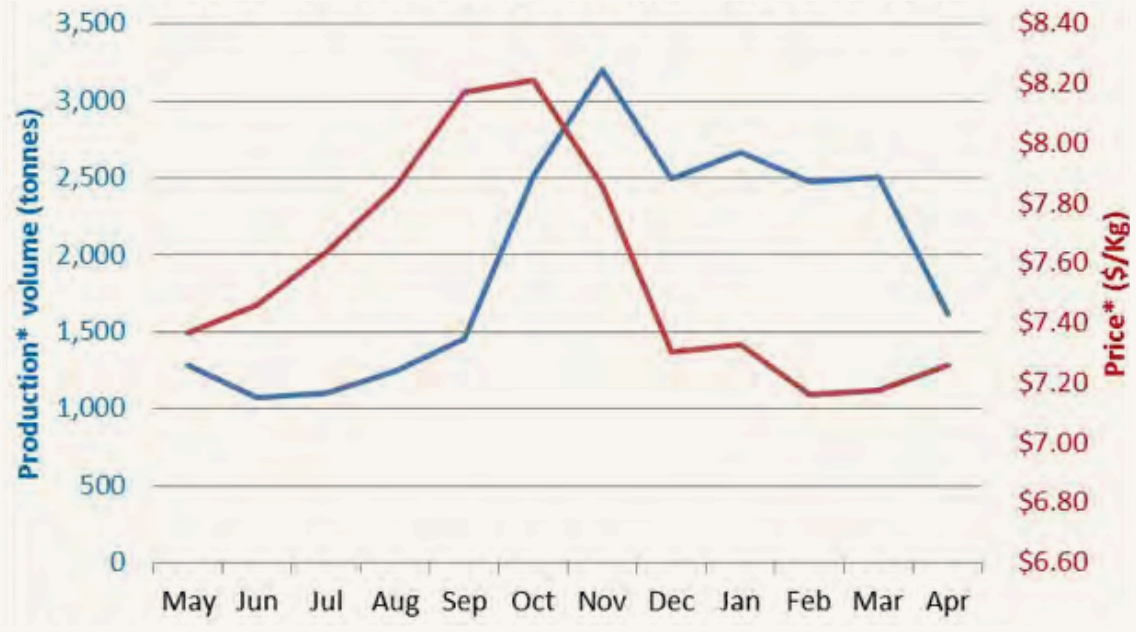
Deer produced for the spring chilled venison market traditionally earn farmers a premium of up to $1.50/kg from the end of August to early November.

22 Statistics NZ

TOTAL DEER INDUSTRY EXPORT REVENUE (Y/E Sept, NZD millions[22])

	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Co-products	$17.7	$19.6	$21.5	$28.1	$27.7	$24.4
Hides and leather	$23.8	$22.9	$24.5	$16.7	$14.1	$14.5
Velvet	$25.5	$28.0	$23.8	$27.9	$39.1	$42.5
Venison	$210.5	$198.1	$183.3	$180.9	$174.4	$164.3
Total	$277.5	$268.5	$253.0	$253.6	$255.2	$245.5

SEASONAL VENISON PRICING AND PRODUCTION



*5-year average monthly production and AP Stag schedule price – whole of New Zealand

Figure 10: This graph shows the mismatch between demand (pricing) for venison from traditional markets and production, with most production occurring after the price and demand has dropped[23]

23 DeerNZ website www.deernz.org.nz

Most of this venison is shipped by sea to continental Europe for the traditional game season, which starts in September and ends at Christmas. Traditionally the schedule starts falling in November, reaching a low in March, with most venison bought at this time needing to be frozen and stored until the next game season. A new pricing pattern has recently become evident as supplies reduce and the industry begins its rebuild, with extended high prices in the mid-high $8.20–8.70/kg range reaching right though summer and into autumn. This is less than a $0.80/kg difference between the end of the chilled season and the traditional frozen market.

The current higher-than-usual prices are a result of a combination of factors: product shortages in the market, the reduced kill (production is down 17 percent year on year) and firm demand out of North American and European markets driven by exporters' focus on market diversification and continued demand for premium grass-fed meat.

More than 90 percent of the New Zealand deer industry's products are exported, so the value of the New Zealand dollar and exchange rates also have an impact on pricing.

Exporters and Deer Industry NZ are working to develop year-round markets for chilled Cervena™ venison as part of the P2P strategy, by correcting the mismatch between venison production and demand in traditional markets, while progressively developing new markets that demand quality venison at chilled prices all year round.

In 2017, the United States has overtaken Germany as the single largest market for venison by volume and is the largest market for New Zealand chilled venison and the best-paying market for New Zealand chilled venison (mainly Cervena™). The United States is also proving to be an important and growing market for New Zealand venison used in processed meat products (burgers, sausages and high-end pet food), for which it pays an appropriate premium.

VENISON EXPORTS BY DESTINATION (Y/E March 2017)

	Chilled and frozen venison (tonnes[24])		
Country	2015	2016	2017
USA	2,126,259	2,446,035	3,114,841
Germany	4,858,761	4,730,084	2,808,312
United Kingdom	1,489,387	1,180,115	1,155,954
Belgium	1,504,879	1,252,048	1,077,118
Finland	1,133,889	987,627	787,037
Switzerland	991,420	1,017,968	724,485
Netherlands	1,259,352	1,121,085	643,647
Sweden	390,396	553,628	422,466
Canada	279,458	371,119	418,862
China, PRC	103,338	576,611	323,198

24 Infoshare, Statistics NZ

25 http://deernz.org

3. PRODUCTION REQUIREMENTS

Of all the commercially farmed species, deer are the most recently domesticated and as such can sometimes be problematic when mustering, although this is not always the case.

Deer are very different to sheep and cattle when it comes to temperament and behaviour. Deer farmers need to understand deer behaviour and reactions and how to minimise stress on the farm and in the yards.

The main aim of efficient deer handling and management is to handle deer without causing undue stress to the animals. Great stockmanship of deer is the most important aspect of good deer management. A capable stockperson will be able to muster and yard deer without causing stress at any time (within reason). A good understanding of the distinctive behaviours and traits of deer when designing, planning or managing a deer farm will also optimise deer movement, and minimise deer stress.

The predominant feed source for deer is permanent pasture (ryegrass/white clover). Winter or summer crops (swedes, rape, turnips and fodder beet), lucerne, silage, grain or palm kernel expeller (PKE) are used to improve the performance at different times of the year. Seasonal pasture curves and pasture quality vary widely throughout New Zealand.

Apart from farm systems, which are discussed in the next section, other issues to be aware of when handling deer are related to:

- Age – young deer that have been freshly weaned are to be handled with care. Health-related issues associated with stress can be common in weaner deer, so it is vital for weaners to be handled with minimum stress.
- Species – red deer are the predominant species in New Zealand. Wapiti deer are fewer but much larger than red deer, and have some behavioural idiosyncrasies that differ to red deer.
- Various stages within a deer farm's management calendar of operations, such as preparing deer for transport. In recent times the transport requirements from many of our importing countries have become increasingly complex and are highly likely to impact on the way we go about transporting deer in the future.

The Deer Industry New Zealand (DINZ) website[25] has a wide range of useful information and resources for the farming of deer.

4. INFRASTRUCTURE REQUIREMENTS

Infrastructure costs will be influenced by whether existing assets that are already on the farm can be used or modified for use. Things to think about when designing a deer farm so as to minimise stress include:

- Well-constructed fences designed specifically for deer;
- Good paddock layout and well-positioned races to facilitate movement of deer, and maximise feed utilisation;
- Well-designed sheds and yards that allow movement and handling of deer to occur efficiently and with minimum stress to handler and animals;
- Restraint systems that control animals safely to facilitate various deer treatments.

Fencing

Well-planned and properly constructed deer fencing has a large impact on the efficiency of deer handling. The long-term benefits of ease of management from good fencing is realised with a reduction in time taken on fence maintenance, as well as reduced personnel time chasing deer around due to inadequate fencing. Deer fencing is inherently expensive to construct due to the quantity of materials used. Poorly managed or handled deer can be extremely hard on fences, and often cause damage to posts, gates and netting.

Property layout

It is important to consider the layout of a property carefully, making sure that paddocks and races are suitably set up to facilitate deer mob movements and handling between paddocks and into the deer shed. The key to a well set up deer property is a well-positioned central race.

Paddocks should be laid out to take advantage of natural shelter, or topography, e.g., paddocks that are to be used for velveting stags should be located in an area where there is no visual or downwind contact from females.

Fencing off the corners of the paddocks and narrowing down the entrance to gateways can

improve stock movements and make mustering easier. The fenced-off corners are also an ideal site to plant a few shelter or shade trees, and assist in funnelling deer to the entrance of the gate.

Gates out of the paddock and into the race should be positioned so they are obvious to the mob of deer trotting down the fence-line. The best position for the gate is usually where the deer naturally gather when mustered.

Shed design

The shed and yarding system on a deer farm must be designed and constructed to provide a safe and practical work environment for both animals and the operator. Many deer are inherently flighty animals, especially when stressed, and can become unpredictable when handled. It is therefore important that sheds, yards and races are designed to eliminate the chance of injuries.

Shelter is important for deer, especially young stock. Planted shelter between paddocks also provides a visual barrier between adjoining paddocks of animals.

An excellent handling guide for deer farmers has been produced by Worksafe in consultation with the industry body, DINZ. A summary is on the Safer Farms website: visit http://saferfarms.org.nz/guides/safe-deer-handling/.

The full document, which essentially describes the basics of good deer farming practices with animal handling in mind, can be downloaded at: http://saferfarms.org.nz/assets/guides/WSNZ-1201-Safe-Deer-Handling-GPG-v9-0-FA2-LR.pdf.

5. ENVIRONMENTAL ISSUES

Deer have specific natural needs and behaviours, and if incorrectly managed, can threaten the quality of water and soil. Undesirable behaviour includes excessive pacing, wallowing, and digging in soils. These can cause erosion, compaction and pugging of soils, and the consequent runoff of nutrient, sediment and coliforms can result in contamination of waterways.

Applying good deer farm management with the Land and Environment Plan (LEP) template enables the following factors to be fully integrated with the profitable deer farming business:

- assessment of risks;
- evaluation of land capability;
- paddock conditions;
- riparian management;
- use of prudent wintering feed systems;
- scheduling of environmental protections and mitigations.

Undertaking LEP therefore provides confidence that the deer farming operation is sustainably using its water and soil resources, and can also be used to provide assurance of sustainable practice to consumers.

The *NZ Deer Farmers' Landcare Manual* is a practical guide to best landcare practice for deer farmers and can be found on the Deer NZ website.[26]

6. INVESTMENT AND RETURN

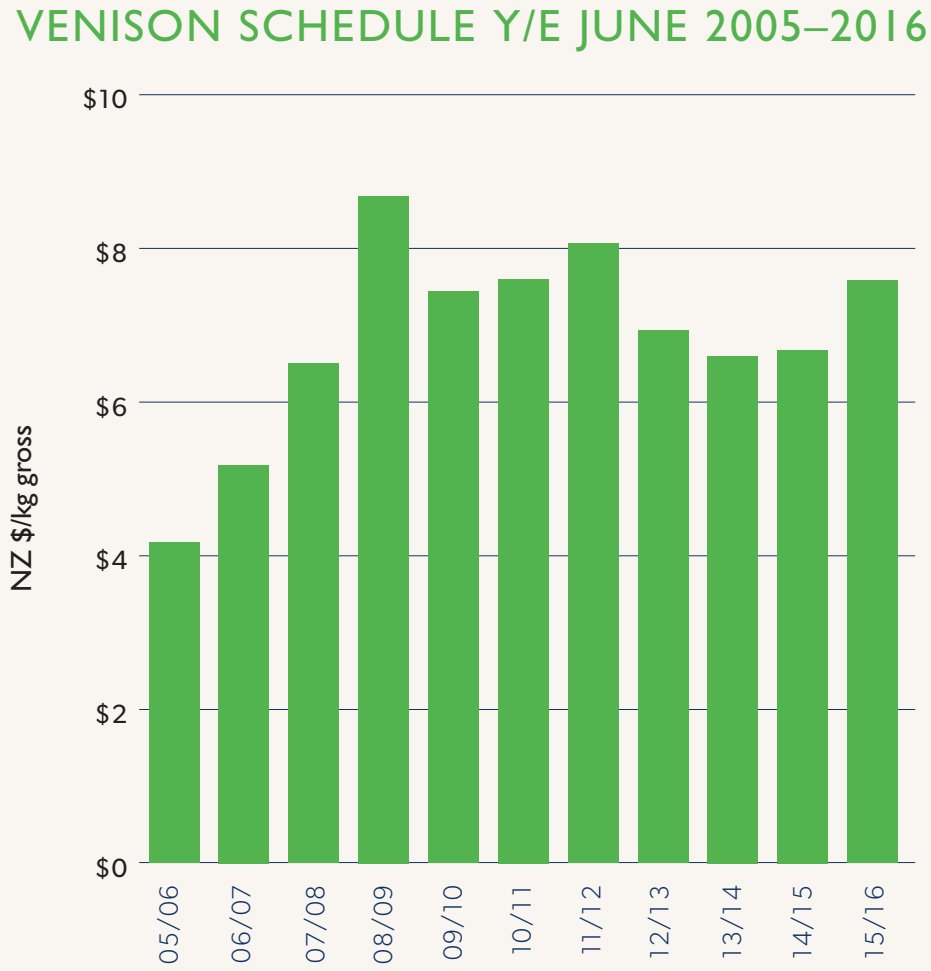
The profitability of deer farming varies greatly from farm to farm, and even between farms operating similar stocking policies in the same district. Lower profitability is usually the end result of lower productivity.

The P2P strategy aims to help farmers improve their farming systems so they become more profitable, enabling the deer industry as a whole to be more competitive with alternative land uses.

Over the past two years, significant work has been done internationally, marketing Cervena™ and New Zealand-farmed venison to differentiate it from non-farmed venison. Work has also commenced introducing chilled Cervena™ to the off-peak European market to broaden returns across the full year, rather than solely peaking during the traditional European game season.

26 http://deernz.org /sites/dinz/files/NZ%20Deer%20Farmers%20Landcare%20manual%202012%20for%20web.pdf

Nitrogen leaching: low–medium



Source: *Lincoln University Financial Budget Manual 2016*
Figure 11: Venison schedule 2016

Despite the drop in New Zealand deer numbers, returns for venison have remained relatively strong over the last ten years, ranging around the $7.00/kg mark. With less reliance on the traditional European game season and increasing growth in the United States and non-European markets, the future of the venison market is looking positive.

7. SOURCES/USEFUL LINKS

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Deer Industry New Zealand (www.deernz.org)

Deer Facts – Deer Industry New Zealand (http://deernz.org/deer-facts#.WZp3MCgjFpg)

The key elements of success and failure in the NZ Venison Industry 2008, Lincoln University (http://deernz.org/about-deer-industry/nz-deer-industry/deer-industry-statistics/external-resources-nz-deer-industry#.WZp3figjFpg)


18

GOAT FARMING

FIBRE

1. LAND USE OVERVIEW INFORMATION

The goat fibre industry in New Zealand predominantly produces mohair from angora goats.

The other main goat fibre is cashmere, which is the soft undercoat of some breeds of goat. Despite cashmere being of greater value, it is laborious to harvest and very little is harvested in New Zealand.

South Africa is the global hub for the angora market and the main market to which New Zealand mohair is sold.

At its peak in the 1980s, worldwide mohair production reached 24 million kg per year. Today it is less than 3 million kg, which to many farmers indicates a large unfulfilled demand.

2. PRODUCTS AND MARKETS

Currently, New Zealand mohair is grown for the global knitting market, where prices can range from $1 to $5/kg for low-quality, contaminated or stained fibre, to over $30/kg for high-quality fine micron mohair from kids, with an average of around $16/kg.

Mohair fleece in New Zealand is sold to brokers in the North or South Island who on-sell to customers overseas, principally the South African market. From there, the mohair is processed and used in many applications, notably knitwear, blankets, furnishings, upholstery, curtains, carpets and lightweight suits. Its resilience and durability make it particularly suitable for household textiles, such as upholstery fabrics, curtains and carpets.[27]

There has been recent interest in New Zealand in growing 'premium' mohair for the weaving industry, which buys for luxury apparel and textiles. Weaving prioritises fibre length over the fineness of the fibre. This new approach is being used in Australia, where returns have risen from NZ$14/kg to NZ$62/kg in less than five years,[28] and is starting to be used in New Zealand. Since 2016 there has already been a 10 percent increase in prices.

In 2016, New Zealand exported a total of 17.6 tonnes of mohair with a Free on Board value of $341,770.[29]

3. PRODUCTION REQUIREMENTS

Although in New Zealand goats are often farmed on small lifestyle blocks, goat farming can often be more effective for a farmer when incorporated into existing livestock farming systems with sheep, beef, dairy cattle or deer, where they can provide a number of benefits to the overall farm system including:

- increased revenue and profitability from the sale of goat meat and fibre;
- improved productivity from the livestock presently farmed;
- improved pasture quality and lower-cost weed control;
- a non-chemical alternative to weed control.[30]

Fibre goats suit a property of easier contour with some weeds, compared with meat goats, which can handle hillier farms and steeper terrain.

Animal selection and breeding has a significant influence on fleece weight, yield and quality, so it is important to know the product and focus on those traits that will improve income from mohair. It is also important to select/breed a goat that is physically sound, robust and fertile.

In terms of farming, firstly ensure boundary fences are secure, then the property can be broken into 'blocks'. Each block can contain several paddocks, with these blocks being goat proof to enable some rotation through the farm, enabling some control and management.

Goats have high mineral requirements and therefore need a varied diet. A diet that contains hay, tree fodder, grass, mineral blocks, straw and pellets, as well as chaff, will help to meet these needs. Trees like willow[31], tree lucerne and poplar, as well as pine needles, will help with overall digestive health. Herbs like fat hen and chicory aide digestion and provide vitamins.

Be aware of the plants on the property that may be poisonous to goats, and know how to recognise them visually. Plants include rhododendron, yew, azaleas, hydrangeas, bay trees, any wilted leaves and all flowers and bulbs, as well as anything that is sprayed.

27 Mohair Technical Information, Mohair South Africa

28 http://www.stuff.co.nz/business/farming/agribusiness/76309922/a-new-road-opens-for-mohair-producers-but-will-they-take-it, 27 Jan 2016

29 Stats NZ – Infoshare

30 Goats and Pastoral Farming, Goat Industry – An Overview, Meat NZ (http://www.mohairproducers.co.nz/wp-content/uploads/2015/06/Goat-industry-overview.pdf)

31 NB. Some species of willow are pests. To find out more, visit www.weedbusters.org.nz.

Shearing

As shearing approaches, every effort should be made to protect the long mohair from the possibility of contamination from vegetable matter, dust and pigmented fibres. Such contamination will depreciate the value of the mohair. Fineness of the fibre, to a large extent, is determined by the age of the animals, and therefore it is advisable to draft the herd into age groups, e.g., kids; 2–4 tooths; and mature aged goats, prior to shearing. The various age groups should then be shorn separately.

4. INFRASTRUCTURE REQUIREMENTS

The overriding message on infrastructure is that it needs to be secure and practical. The main infrastructure associated with a goat enterprise is:

- fencing;
- water;
- yards;
- handling equipment;
- shelter.

Nitrogen leaching: low–medium

Fencing

Secure fencing is a must, as goats are one of nature's great escape artists. Fences are generally 7–8 wire (9 wire for boundary fences). Best practice is a bulldozed line with a post and batten fence and a bottom wire no higher than 75 mm from the ground. Barbed wire on the bottom can be used if erosion is a problem. An electric wire on an outrigger is useful but optional. Netting should be avoided.

Shelter

Shelter is crucial for goats at kidding and in cold, wet environments as, unlike sheep, they do not have an oil or fat layer to protect them from the extreme elements. Therefore goats should have access to some form of draught- and leak-free shelter year-round.

Shelter doesn't need to be expensive or elaborate. A-frame shelters or similar can be made from bits and pieces lying around the farm. Small shelters made from corrugated iron and plywood will suffice. Shelter made from pallets and plywood can be added on to make the shelter accommodate more goats as required. Untreated materials should be used in construction as the goats may try to eat them. Portable shelters can also be purchased from rural supply stores if the budget allows.

Access to a shearing shed is a bonus for both shelter and shearing. If there is no shearing shed, portable shearing units are available.

Yards

Handling facilities are always good to have for shearing and routine animal health jobs. For an existing farming operation, there may be existing stock yards or something similar already available. Yards can be as simple as a race leading to a small pen, which will make animal handling safer and easier.

Water

Access to sufficient quantities of high-quality fresh water is critical. Goats drink 4–10 litres per day. Ideally water should be supplied through a reticulated water system.

5. ENVIRONMENTAL ISSUES

Angora goats tend to thrive in areas of low rainfall and humidity, and can survive extreme temperatures, but are sensitive to cold after shearing, particularly a combination of cold, wind and/or rain.

Goats are browsers, which means they eat a variety of plants and weeds including broom and gorse. Angoras will improve pasture by eating the weeds, which allows clover and desired pasture to grow. There is less need for herbicide use, so this makes for sustainable farming.

However, angora goats need to avoid contamination of their fleeces, so it is best not to graze them on weeds with small seed heads, like thistles, in the six weeks prior to shearing. This will maintain the quality of the fleece and avoid downgrades of their mohair.

The internal parasites that infect goats are the same as for sheep. However, they are different for cattle, so farming goats with complementary stock such as cattle helps reduce the parasite problem for goats.

Foot infections for goats, such as scald and footrot, can be a problem when pastures are continually wet and when hooves become overgrown. Trimming hooves and foot baths/spray can help overcome these

FLEECE PRICING JULY 2016

Fleece	Weaving $/kg	Knitting $/kg
Superfine kid fleece (SFK)	$34.00	$31.00
Fine kid fleece (FK)	$30.50	$28.00
Kid fleece (K)	$29.50	$27.00
Fine young goat (FYG)	$25.50	$22.50
Young goat (YG)	$21.50	$21.50
Adult hair (FH)	–	$17.50
Strong adult hair (SH)	–	$14.00

problems, although many farmers over the years have culled animals with recurring foot problems from their herds.

Good grazing management is about having enough of the right quality feed to allow stock to achieve their target performance, doing it in a way that enhances the natural ability of pasture to grow, and at the same time, minimising feed wastage.

6. INVESTMENT AND RETURN

Infrastructure costs will be influenced by whether the farm's existing assets can be used or modified for use. By farming fibre goats alongside existing farming systems, e.g., cattle, the investment can be held to relatively low levels with perhaps improvements to fencing being the most significant factor.

In terms of returns, a kid yields 3–4 kg per year from two shearings, while older goats yield 4–6 kg per year. A good fleece has plenty of lustre and good body. July 2016 fleece pricing was as shown above.

This could provide a gross return of, on average, $100 per animal per year. Cull goats can fetch on average $40 per carcass.

The related benefits that goats can provide to the farming system, i.e., improved pasture quality, reduced weed costs and additional income, help bolster the case for fibre goat farming.

7. SOURCES/USEFUL LINKS

Mohair producers
Website: www.mohairproducers.co.nz
Mohair Producers North Island
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E: mohair_pacific@farmside.co.nz

Farming Goats for Fibre, Meat and Wool NZ, May 2008 (http://maxa.mpi.govt.nz/sff/about-projects/search/04-059/farming-goats-for-fibre.pdf)

Lifestyle Block NZ website: https://www.lifestyleblock.co.nz/lifestyle-file/livestock-a-pets/goats/angora-goats

Meat and Livestock Australia website: https://www.mla.com.au/extension-training-and-tools/going-into-goats/

GOAT FARMING

MEAT

1. LAND USE OVERVIEW INFORMATION

Farming pastoral goats for meat production is an increasingly profitable enterprise that can add value to pastoral farming. The main meat goat breed in New Zealand is the Boer goat, although the New Zealand breed Kikonui™ is becoming important.

Boer goats were first imported into New Zealand by Landcorp, in 1987. The Boer goat is a larger goat, suitable for a wide range of pastoral conditions. It is the main meat breed, with a national estimate of 7175 Boer goats on 29 farms.[32] Boers under good management will reach carcass weights of 14–18 kg at eight months of age, and are also in demand for breeding stock, both within New Zealand and overseas.

Farming of Kikonui™ pastoral goats began in New Zealand in 2003, from a base of Kiko, which was purpose-bred in New Zealand specifically for hill country pastoral purposes. There are much smaller numbers of this breed; bucks are supplied to cross with feral origin and other goats, and have been developed through a policy of continually adding the best genetics for demanding New Zealand hill country conditions, using population genetics to increase survivability and reduce foot and parasite problems.

Although there is large international demand for goat meat, New Zealand is currently not well-placed to take advantage of this opportunity. The New Zealand goat meat supply chain is under-developed and suffers from a small and inconsistent supply, and farmers can face difficulties finding processers that kill goats when required.

The 2016 goat kill was 121,000 – less than 1 percent of New Zealand's lamb kill of 19.5 million lambs. The small quantity of goat meat produced in New Zealand is exported, with 90 percent being from feral goats.

To strengthen the supply of goat meat so New Zealand processor/exporters can maximise export market opportunities, a coordinated effort is required to increase both the number of goats on suitable farms in New Zealand, and the size of goat herds.

2. PRODUCTS AND MARKETS

Worldwide demand for goat meat is driven by a variety of ethnicities, including Hispanic, Muslim, Caribbean and Chinese consumers. There is fast-growing demand in countries with growing ethnic populations, e.g., the United States and Canada.

World production of goat meat is an estimated 5.7 million tonnes (2015), with China being the largest global producer, at 40 percent of total global goat meat production (2.2 million tonnes). India is ranked second with 9 percent, then Pakistan and Nigeria with 5 percent each respectively, and finally Sudan, with 4 percent. [33]

Globally, from 2007–2015, the average annual rate of growth in prices for goat meat was 16.5 percent. This varied from country to country. China recorded the most marked growth in terms of price trends – in 2015, prices reached US$9.60/kg. In 2016, Australia set a new record of A$7.70/kg with a previous 5-year average (2011–2015) of $5.92.

The largest importers of sheep and goat meat in 2013 were the United States, China, United Arab Emirates, Saudi Arabia, Bahrain and Qatar.

In terms of exports, global goat meat exports reached 62,600 tonnes in 2015 (1 percent of global production) with Australia the largest exporter (51 percent of global exports), followed by Ethiopia (25 percent) and Pakistan (5 percent).

In New Zealand, just under 1000 tonnes, worth $8.1 million, was exported to 27 markets in 2016. [34] Twenty-seven percent of that export value was earned from the top market, the United States, with the Reunion Islands (19.4 percent), Canada (13.8 percent), Trinidad and Tobago (9.4 percent) and Martinique (8.4 percent) also in the top five.

Despite the large number of meat processors throughout New Zealand, only a limited number will process goats. These include Auckland Meat Processors, Crusader Meats, Te Kuiti Meat Processors, Taylor Preston, Lean Meats and Blue Sky Meats.

For meat goat farmers, there is also the option to develop a branded goat meat product and sell to a local market. Either way, whether supplying export or local markets, cooperation between local suppliers will help provide volume required for processor engagement.

32 *New Zealand Goat Industry Report to Federated Farmers NZ* – Massey University, March 2017

33 FAOSTAT, Food and Agriculture Organisation of the United Nations, retrieved April 2017

34 Statistics NZ, retrieved April 2017

3. PRODUCTION REQUIREMENTS

Although in New Zealand goats are often farmed on small lifestyle blocks, commercial pastoral goat farming can often be more effective for a farmer when incorporated into existing livestock farming systems with sheep, beef, dairy cattle or deer, where they can provide a number of benefits to the overall farm system including:

- increased revenue and profitability from the sale of meat and fibre;
- improved productivity from the livestock presently farmed;
- improved pasture quality and lower-cost weed control;
- a non-chemical alternative for weed control.

Ideally, goats introduced into an existing system should make up 10–25 percent of stock units. Pastoral goats can handle a property of steeper contour, with some weeds.

In terms of farming, firstly ensure boundary fences are secure, then the property can be broken into 'blocks'. Each block can contain several paddocks, with these blocks being goat proof to enable some rotation through the farm, enabling some control and management.

Goats have high mineral requirements, and therefore seek and need a varied diet. A diet that contains hay, tree fodder, grass, mineral blocks, straw and pellets will help to meet these needs. Trees like willow, tree lucerne and poplar, as well as pine needles, will help with overall digestive health. Herbs like fat hen, plantain, chicory and others aid digestion and give vitamins. However, typical hill country with grasses, clovers, pasture and scrub weeds will usually be adequate if there is enough.

Be aware of the plants on the property and know how to recognise visually what is poisonous. Some poisonous plants are: rhododendron, yew, azaleas, hydrangeas, bay trees and all flowers and bulbs, and to be safe, anything that is sprayed.

4. INFRASTRUCTURE REQUIREMENTS

The overriding message on infrastructure is that it needs to be secure and practical. The main infrastructure associated with a goat enterprise is:

- fencing;
- water;
- yards;
- handling equipment;
- shelter.

Fencing

Secure fencing is a must, as goats are one of nature's great escape artists. Fences are generally 7–8 wire (9-wire for boundary fences). Best practice is a bulldozed line with a post and batten fence and a bottom wire no higher than 75 mm from the ground. Barbed wire can be used on the bottom if erosion is a problem. Netting should be avoided, as goats with large horns can become entangled. An electric wire on an outrigger is useful but optional.

Water

Access to sufficient quantities of high-quality fresh water is beneficial. Goats drink 4–10 litres per day. If possible, water should be supplied through a reticulated water system.

Yards

Handling facilities are always good to have for routine animal health jobs. For an existing farming operation, there may be existing stock yards or something similar already available. Yards can be as simple as a race leading to a small pen, which will make animal handling safer and easier.

Shelter

Shelter is less of an issue for pastoral goats, although it is crucial for goats at kidding and in cold, wet environments.

If natural shelter is not available, A-frame shelters or similar can be made from bits and pieces lying around the farm. Small shelters made from corrugated iron and plywood will suffice. Shelter made from pallets and plywood can be added on to make the shelter accommodate more goats as required. Untreated materials should be used in construction, as the goats may try to eat them. Portable shelters can also be purchased from rural supply stores, if the budget allows.

5. ENVIRONMENTAL ISSUES

Goats are browsers, which means they eat a variety of plants and weeds. Broom, gorse, thistles and most kinds of weeds are a delicacy to a goat. Goats will improve pasture by eating the weeds and allowing grass and desired pasture to grow. There is less need for herbicide use, so this makes for sustainable for farming.

Goats are infected by the same internal parasites as sheep. However, they are different for cattle, therefore farming goats with complementary stock such as cattle helps to reduce the parasite problem for goats.

Foot infections such as scald and footrot are less of a problem for pastoral goats, as problematic animals have been culled from herds. For animals that aren't culled, trimming hooves and foot baths/spray can help overcome these problems.

Good grazing management is about having enough of the right quality feed to allow stock to achieve their target performance, and doing this in a way that enhances the natural ability of pasture to grow while at the same time minimising feed wastage.

6. INVESTMENT AND RETURN

By farming meat goats alongside existing farming systems, e.g., cattle, the investment can be held to low levels with perhaps improvements to fencing being the most significant factor.

The related benefits that goats provide to the farming system, i.e., improved pasture quality and reduced weed costs, can help bolster the case for pastoral goat farming for meat.

Goat meat pricing in New Zealand currently varies between $3.50–4.50/kg, somewhat below the Australian five-year average of A$5.92 (or NZ$6.58 at A$0.92).

However, for the New Zealand goat meat industry, growth in supply is required to overcome supply shortages and the inability to fulfil orders. This will help the industry attain better pricing and participate more fully in the opportunities of a relatively buoyant export market.

Nitrogen leaching: low–medium

7. SOURCES/USEFUL LINKS

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Farming Goats for Meat, Meat & Wool NZ, 2008 (http://maxa.mpi.govt.nz/sff/about-projects/search/04-059/farming-goats-for-meat.pdf)

Going into Goats, Meat & Livestock Australia (https://www.mla.com.au/Extension-training-and-tools/Going-into-goats)

POULTRY FARMING

EGGS

1. LAND USE OVERVIEW INFORMATION

Egg consumption in New Zealand has increased by 50 percent over the last 20 years, showing a robust industry. From an annual consumption of around 61.5 million dozen eggs per year in 1995, New Zealanders consumed 93.8 million dozen eggs in 2016 with the retail sales of eggs worth upwards of $286 million.

New Zealand currently has around 146 egg farms. Conventional cages account for the majority of eggs produced (75 percent), while the remaining eggs are farmed in barns (5 percent) or free-range (19 percent). Organic eggs make up around 1 percent of eggs produced.

Farming using conventional cages is due to be phased out by 31 December 2022, and replaced by colony cages. Colony cages retain some of the advantages of cage farming, such as higher levels of hygiene and relatively efficient low-cost egg production, while also creating more space for hens to move around and express their natural behaviours.

Barn and free-range egg farming are increasing in popularity due to public concerns about hen welfare in cages, and consumer demand for cage-free eggs.

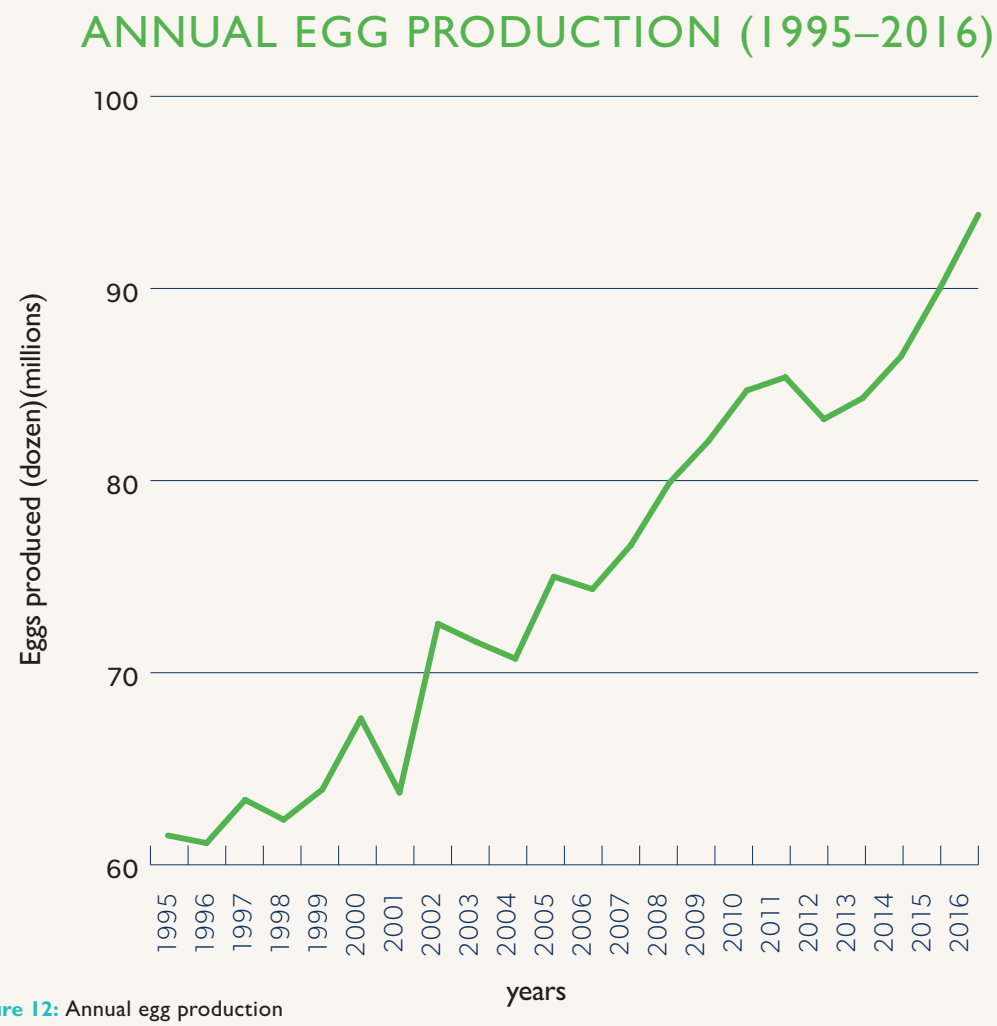

Figure 12: Annual egg production

The move towards cage-free egg farming has been given impetus by announcements in 2017 by the two main supermarket chains in New Zealand – Progressive Industries (Countdown supermarkets) and Foodstuffs (NZ) Ltd. (New World, Pak 'n' Save supermarkets) – that they will only buy cage-free eggs in the future – Progressive from 2024 and Foodstuffs from 2027. This change may produce opportunities for more free-range producers and other investors to enter the industry, particularly if some existing cage-egg producers use this structural change to the industry as a reason to exit or reduce their holdings.

A move toward cage-free eggs would increase the general pricing on eggs, as low-cost cage-produced eggs would no longer be available.

2. PRODUCTS AND MARKETS

Eggs are well known for providing high protein at a low price, and New Zealanders are now eating around 226 eggs per person per year. Up to 85 percent of commercially farmed eggs are sold as 'table eggs', with the remainder used in the baking and catering industries.

Table eggs are divided into: caged eggs, colony eggs, barn-raised eggs and free-range eggs. Retail prices vary considerably due to the size, brand and weekly specials, however when bought in one-dozen packs, prices are generally:

- caged eggs $3.24–4.44/dozen
- colony eggs $6.00/dozen
- barn or free-range eggs $6.96–9.00/dozen
- organic $12.00/dozen

Nitrogen leaching: unknown

3. PRODUCTION REQUIREMENTS

The majority of commercial layer hens in New Zealand are either the Hyline Brown or Brown Shaver variety. Both are brown-feathered with some white plumage, especially in the tail. These hens will lay around one egg each day, and are capable of laying until up to 80 weeks of age. Commercial layer hens are special birds, chosen for egg farming because they lay more high-quality eggs than many other breeds. In New Zealand, around three million commercial layer hens are produced each year. Their breeding is managed by poultry breeding companies to ensure the hens are the best they can be and to keep up with international genetic developments.

The layer hen diet consists of feed made from mainly wheat, maize, corn and soybean meal or bone meal. Hens must also have ready access to clean drinking water. The exact composition of the feed will depend on the cost and availability of these ingredients to farmers, but must comply with the requirements of the Agricultural Compounds and Veterinary Medicines Act 1997.

Poultry feed and premixes are approx. $1.00–1.40/kg, and make up a big component of the farm budget.

Hens produce most when they are warm, so the nesting areas need to be heated, especially during winter months.

4. INFRASTRUCTURE REQUIREMENTS

Depending on the type of farming undertaken, there will be requirements for a shed fitted either with colony cages, or a barn with a litter floor, fitted with nest boxes for egg laying and perches for roosting and sleeping. The marketing term 'cage-free' is often used to describe barn farming.

For free-range farming, birds require access to the outdoors through pop-holes in the shed walls.

Infrastructure includes barn/sheds, feed silos, feed lines and related feed equipment, watering system, poultry feeders, environmental control equipment, etc.

If egg farming is cage-free, then a cost-effective system to collect eggs must be developed. Barns/sheds can contain 5000 or 10,000 or more hens.

5. ENVIRONMENTAL ISSUES

On a free-range farm, because hens can range outdoors, they are more vulnerable to disease, predators, parasites and weather, so close monitoring and other preventative measures are very important in managing the health and welfare of free-range flocks.

Preventing disease and illness through good hygiene practices and regular monitoring is a priority for egg farmers, who carry out daily checks on their hens to ensure they are in good, healthy condition and to identify any signs of injury or illness that need attention. Antibiotics are only used in layer hens when prescribed by a registered veterinarian to treat diagnosed illness.

HYPOTHETICAL SENSITIVITY ANALYSIS – CAGE-FREE EGGS

Supermarket profit margin	Supermarket pays per dozen	Egg farmer receives
20%	$6.00	$700,000
40%	$4.50	$525,000
60%	$3.00	$350,000

Cage farming methods have been shown to reduce the instance of disease and illness in birds, although there is growing opposition to cage farming.

In terms of the maximum indoor stocking density for barn-farmed hens:

- NZ Code of Welfare: 7 hens/m^2
- NZSPCA: 7 hens/m^2
- EU standard: 9 hens/m^2

In terms of flock sizes for barn-farmed hens:

- NZ Code of Welfare: Not specified, dependent on individual farm size;
- NZSPCA: 5000 hens per enclosure;
- EU standard: Not specified, dependent on individual farm land size.

For free-range hens, the maximum outdoor stocking density is 2500 hens per hectare. No research is available for nitrogen leaching on poultry farms, however it is not considered to be in the high range. Any land use change to poultry farming planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

6. INVESTMENT AND RETURN

Capital investment in a poultry layer farm depends on the size of the farm, and would be significant. A barn with an estimated building cost of $400–600 per square metre would equate to approximately $500,000 for a 1000-square-metre barn fitted out with cages or nest boxes/perches to house 5000 hens.[35] Feed silos, watering lines and environmental control equipment would be additional. Five thousand brown shaver hens at $5.00 each would be $25,000.

Commercial layer hens lay around 280 eggs each per year. For 5000 hens, this amounts to 1.4 million eggs or 116,667 dozen per year. For cage-free eggs retailing at $7.50 per dozen, this equates to revenue of $875,000 at the retail level.

Supermarket profit margins on eggs are commercially sensitive, therefore accurate farm-gate returns can't be listed here. However, a hypothetical sensitivity analysis for a year's shipment of 116,667 dozen cage-free eggs that retails at $7.50/dozen provides an idea of what farm-gate returns may be (see the table above).

Therefore, a gross return to the farmer may be $350,000–700,000 for this year's shipment of cage-free eggs. Other factors and charges would also need to be taken into account, for example, not all eggs produced would be of the same quality, retail pricing varies throughout the year, more popular brands may receive better pricing, different supermarkets would have different supplier arrangements, etc. However, this gives a general idea of a range of returns.

7. SOURCES/USEFUL LINKS

Poultry Industry Association of New Zealand – www.pianz.org.nz

Egg Producers Federation – www.eggfarmers.co.nz

Michael Brooks, Executive Director
E: info@eggfarmers.org.nz / info@pianz.org.nz
T: 09 520 4300

Poultry Management in New Zealand, MAF 2011 (http://www.mpi.govt.nz/document-vault/2956)

'Countdown extends free-range egg pledge to include all brands', *Stuff*, 28 Mar 2017 (http://www.stuff.co.nz/business/90950403/countdown-extends-freerange-egg-pledge-to-include-all-brands)

35 Costs estimated using Lincoln University Financial Budget Manual equivalents

SHEEP AND BEEF FARMING

Sheep and beef farming has played a large part in New Zealand's economy for the past 160 years. However, over the last decade, there has been a decline in sheep and beef stock numbers of around 28 percent. This compares with an increase in dairy cow numbers of around 26 percent over the same period, indicating a shift towards the higher profitability of dairy cow farming. Over the last couple of years, this rate of change has slowed due to low dairy prices.

With the commodity nature of the sheep and beef products and 90 percent of production exported, the value of the New Zealand dollar and exchange rates play a large part in the profitability of sheep and beef farming.

Within the Lake Rotorua catchment under the proposed Plan Change 10 rules, sheep and beef farming may be a marginal activity depending on livestock numbers and classes, stocking rates and farm policies and processes.

Nitrogen leaching for drystock is considered to be in the range of 15–20kg/N/ha/yr, however there are useful practices that can reduce nutrient leaching on a sheep and beef farm, such as those listed below. The full list can be found at: http://www.farmmenus.org.nz/en/Drystock-farms/.

ON FARM PRACTICE	FACTORS TO CONSIDER
Nutrient management	Do a whole farm nutrient budget. If necessary, talk to a farm consultant/adviser who can use OVERSEER to create a nutrient budget for the whole farm.
Increase sheep to cattle ratios to reduce large urine spots (and soil damage)	Effectiveness depends on farm contour. Profitability of change depends on sheep vs beef schedules and capital stock sales required. Altering ratios may increase management challenge for pasture quality, with fewer cattle to manage long rank pasture.
Reduce number of old cattle (R3s) to reduce large urine spots	Male stock also distribute urine more widely, so urine patches are less concentrated. Would also lower live weight on farm for winter wet periods with benefits for soil health and water quality.
Strip graze towards waterway, rather than away from them	Applies to grazed paddocks in wet weather with overland flow that converges to form small channels of running water. Have as large a grass strip as possible between the winter grazed strip and the waterway, for as long as possible. Benefits will depend on fertility, slope and feed type. There may be local rules that set the minimum width.
Use winter active crops	Winter active crops (oats, rape, Italian rye) may help reduce N leached over winter
Manage or retire bogs and swampy areas [36]	Controlled summer grazing of swampy areas can be useful for keeping weeds down. Keeping stock out of swampy areas and wetlands will reduce stock losses and mustering time. If they are areas with high stock traffic and high water flows, excluding stock will be highly effective in reducing P losses to waterways.
Use low N crops	Fodder beet and radish have a low N content and will lower urinary N deposition. Benefit may not apply if stocking rate is increased.
Actively manage grazing of winter crop areas to reduce risk of N leaching, run off, soil loss and compaction	Graze from top to bottom of paddock contour. Avoid leaving stock on during wet periods, for long periods, or concentrated on small sections of the crop.
Cultivate along contours (rather than up and down the slope) where slopes greater than 3°	Slows down run-off and reduces erosion. Row orientation should follow contour. Avoid cropping on steep land.
Fence stock out of waterways with a minimum setback of at least 3 metres	Fencing could range from permanent 8 wire to temporary electric during grazing periods, depending on individual farm needs and preference. Two wire electric with sheep under grazing may be appropriate where exclusion of large stock is the priority. Provide a minimum setback of at least 3 m. Fencing adds capital value, reduces stock losses and benefits animal health. Can also be used to improve subdivision and pasture utilisation. Costs include reticulated water.

36 Link to video about managing and retiring bogs and swampy areas: https://www.youtube.com/watch?v=vE-_xia8WIM&feature=youtu.be

LAND USES – HORTICULTURE

BLUEBERRIES

1. LAND USE OVERVIEW INFORMATION

The foundations for New Zealand's fresh blueberry export industry were laid during the 1970s. Blueberry cultivars were imported from the United States for field evaluation by the Ministry of Agriculture and Fisheries. The best-performing cultivars were subsequently released for commercial production.[37] New Zealand-bred cultivars have lengthened the harvest season by up to six weeks. This has helped New Zealand producers to obtain premiums for early and late season fruit in the fresh export markets.

Blueberries are classified into three major commercial types according to their stature:

- rabbiteye blueberry, *Vaccinium virgatum* is the tallest;
- highbush blueberry, *V. corymbosum*, is intermediate size, and the most common; it includes southern highbush and northern highbush; and
- lowbush blueberry, *V. angustifolium*, the smallest in size.

The two main types of blueberry grown in New Zealand are:

- Highbush – native to the north-eastern areas of the United States. These make up most of the early plantings in New Zealand. They are the earliest berries to ripen, and with the addition of New Zealand-bred cultivars can start fruiting from mid-November and continue through to mid-February. This requires a mix of cultivars. The bushes are deciduous and can grow to six metres high if unpruned.
- Rabbiteye – native to the south-eastern United States. The rabbiteye bush differs in several ways from the high bush: they are evergreen, more vigorous, and yields are usually higher. In New Zealand these, together with New Zealand-bred cultivars, make up the main producer of late season fruit, starting production early January and continuing to mid-April.

Around 700 hectares of blueberry crops are now grown in New Zealand, with about 25 commercial growers and another 50 part-time growers[38] producing around 3900 tonnes of blueberries in 2016.[39]

Worldwide production in 2014 was over 525,000 tonnes and valued at more than US$1 billion, with the United States and Canada being the main producers.[40]

2. PRODUCTS AND MARKETS

Blueberries are known to possess a range of healthy properties. They contain higher antioxidant levels than just about every other fruit and vegetable. It appears the blue pigment, anthocyanin, is the major contributor to its high antioxidant levels. Antioxidants prevent cell damage that occurs from everyday wear and tear. It is believed a diet high in antioxidants helps avoid such health problems as cancers and heart disease, as well as promoting good eyesight, urinary tract health and brain function.

Blueberries are available in a range of products including fresh fruit or frozen, fruit juice, powder, wine, jams, sauces and chutneys, with products available from growers, at grower markets, through supermarkets and retail outlets and online.

The majority of New Zealand blueberry value is derived from exports of fresh fruit or individually quick frozen (IQF) fruit at around $40 million compared with domestic sales of around $18 million.[41]

37 'Blueberries – a 20th-century fruit is part of New Zealand's expanding horticulture industry'. *Growing Futures*, Martech Consulting Group (http://martech.co.nz/images/13blueberry.pdf)

38 'Jumbo blueberry to boost NZ industry by $8m in two years', *NZ Farmer*, February 2017 (http://www.stuff.co.nz/business/farming/89250609/Jumbo-blueberry-to-boost-NZ-industry-by-8m-in-two-years)

39 Fresh Facts 2016, Plant and Food Research (http://www.freshfacts.co.nz/files/freshfacts-2016.pdf)

40 FAOSTAT, United Nations Food and Agricultural Organisation

41 Fresh Facts 2016, Plant and Food Research

42 'Infoshare, Statistics NZ

TOTAL BLUEBERRY EXPORTS[42]

Year	Tonnes	$ FOB	$/tonne
2010	1034	18,904,918	1829
2011	1138	18,633,022	1639
2012	1158	20,232,448	1747
2013	1357	26,404,156	1946
2014	1631	28,168,641	1728
2015	1488	28,983,786	1948
2016	1882	40,371,088	2146

The quantity of total blueberry exports (in-cluding fresh and IQF) has increased by 82 percent over the seven years to 2016. At the same time, the value of the exports increased by 114 percent. Fresh exports constitute approximately 80 percent of exports by weight, and IQF approximately 20 percent. New Zealand's distance from overseas markets means that fresh blueberries need to be air-freighted, putting New Zealand at a price-disadvantage in those markets.

Predictions are that the export industry could be worth more than $60m by 2022. New Zealand's top ten blueberry export markets for 2016 were:

Country	Value	Country	Value
Australia	$37,716,185	Taiwan	$246,875
Thailand	$814,741	Hong Kong	$139,984
USA	$382,121	Malaysia	$125,213
Vietnam	$352,721	United Arab Emirates	$64,823
Singapore	$292,368	Fiji	$56,562

3. PRODUCTION REQUIREMENTS

When planning to establish a blueberry orchard, careful consideration needs to be paid to the selection of the site, the varieties of blueberry to plant, the source and quality of water available, harvesting, including the picking labour source, marketing and distribution channels.

Site selection and preparation

Blueberries require slightly acidic well-drained soils with an organic content of at least 3 percent and a pH of 4.0 to 5.5. The optimum pH is considered to be about 4.8. Soils with a natural pH of above 5.5 are difficult to adapt to blueberry growing and should be avoided. On the other hand, cultivated land that has been limed in the past may have an artificially high pH, which can be lowered by adding sulphur. As sulphur takes a considerable time to break down and adjust the pH, this should be done at least six months before planting.

Low-lying areas with a high water table are not recommended. Blueberries do not tolerate standing water or grow well in excessively wet areas.

Varieties

Blueberry types differ by way of their winter chilling requirement, fruiting season and deciduous or evergreen habit, thus it is important for growers

to select species suited to their particular climate. Proper selection of varieties will have a large influence on the profitability of the blueberry operation.

Firstly, find out which cultivars are suited to local climate and winter chilling requirements, and then decide on the market being produced for.

Chill hours

Temperatures at or below 7°C are required to provide winter chilling.

Highbush blueberry varieties include southern highbush, which requires a moderate-to-low (below 700 hours) amount of winter chilling, and northern highbush, which requires a high winter chilling (over 1000 hours).

Rabbiteye varieties require a moderate amount of chilling (400–700 hours). Some of the variety releases from the Plant & Food Research blueberry breeding programme also require moderate to lower chilling.

Rabbiteye production in New Zealand has expanded in recent years, largely because of the ability of this species to crop late in the season (February–early April). Rabbiteye blueberries can be grown in most localities, but require temperatures of 20–25°C in late summer to fully ripen the berries. Rabbiteye plants require cross-pollination, so two or more varieties are required.

Bumblebees are considered the most efficient pollinators of blueberries.

Market selection

It is important to decide on the market being produced for. Local nurseries should be able to advise.

- Early fresh market (November to mid-December, generally good export prices). Cultivars could include Nui, Reka, Sunset Blue, Puru, Misty, Oneal, Marinba and/or Early Blue.
- Mid-season (mid-December to end of January, export/local fresh market/pick your own; lower prices. Easy to get pickers during school holidays). Cultivars could include Blue Crop, Duke, Toro, Dixi and/or Tifblue.
- Mid-season process market (mid-December to end of January, low prices). Cultivars could include Jersey, Atlantic, Dixi and/or A9.
- Late fresh market (February to mid-April, good export prices). Cultivars could include Elliot, Maru, Rahi, Powder Blue, Tifblue, Centurion, Southland, Ono, Delite, Whetu and/or Centra Blue.

Irrigation

Blueberry plants require 25–50 mm water per week during the growing season. Newly established plants have the most critical water needs and can be damaged by either over or under watering. Short periods (one to three weeks) without rain can stress plants severely. Trickle irrigation is the most common system that growers use. The recommended rate is 35–50 litres per plant per week. Water requirements increase as the plants age and grow and vary due to soil type, organic matter available and natural climate conditions.

Purchasing plants

Plants are usually ordered from nurseries during October to be propagated during the summer from softwood cuttings. These are supplied to the grower the following May to July as small plants in 25 x 25 pots (tubes). They need to be potted up into PB 5 planter bags or grown in beds the following summer before being planted out in the field the next autumn/winter. These are then considered to be two-year-old plants. Some nurseries will supply two-year-old plants if required.

Plant spacing

Highbush should be spaced up to 1.2 m apart within rows, and rabbiteye up to 2.0 m apart as they are more vigorous. Rows should be 3.0–3.6 m apart to allow room for mowers/sprayers to be used in a mature planting. Most highbush plants are self-fertile so can be planted up in larger blocks of a single cultivar. A density of 1.5 x 3.6 m provides for 1876 plants per hectare.

Production

After planting in the field as two-year-old plants, all the flower buds should be removed for the first two seasons to help the plants become established. The third season, the plant should be allowed to carry a small crop. Production will double every year until

Nitrogen leaching: unknown

the plant reaches maturity, and will then be subject to the various seasonal influences. A mature block can produce in excess of 10,000 kg per hectare.

Timetable

- 1st year – October order plants
- 2nd year – May/June pick up plants, pot up or plant in beds during winter, make adjustments to soil in the orchard if required (pH, organic matter), drain as required
- 3rd year – cultivate rows, plant out plants, install irrigation if required, remove fruit buds
- 4th year – remove fruit buds
- 5th year – remove most of the fruit buds to allow the plants to carry a small crop. Make arrangements to pack/market the produce

4. INFRASTRUCTURE REQUIREMENTS

The amount of infrastructure required depends on the scale being sought, the area available and the degree of sophistication that will be implemented in the orchard.

A small operation may be set up on one or two hectares with mowing and spraying equipment and a shed for packing and selling to the local market and perhaps to an exporter. A large operation may be set up on 50 hectares, fully enclosed with bird netting, harvesting machinery, grading and packing facilities, with its own exporting arm.

Specialist harvest machinery may be needed. Harvesting machinery is often used to pick fruit destined for processing. Hand-picking fruit ensures top-quality fruit is selected, however labour can be one of the biggest cost centres.

Not all infrastructure is required immediately. Bird netting, harvesting and grading machinery may not be required until year three or four onwards, with more equipment required as fruiting reaches its peak.

Typical infrastructure may include: tractor, mower, sprayer, cultivating equipment, irrigation (including the ability to provide overhead frost protection), bird netting and framing, harvester, grading machinery, packing shed, trailers.

5. ENVIRONMENTAL ISSUES

Fertility

Blueberries are not a quick-growing plant, and have relatively low nutrient requirements. When adding fertilisers for nutrient deficiencies, formulations that also help with other soil properties can be used. For example, if the plants need nitrogen, the addition of ammonium sulphate or di-ammonium phosphate, will also make the soil more acidic – a useful side benefit. Slow-release fertilisers are the best, and a 'less is best' approach is good for new growers. Blueberries are very susceptible to over fertilising because of the position of the feeder roots near the soil surface.

No research is available for nitrogen leaching of a blueberry orchard, however it is not considered to be in the high range. Any land use change to a blueberry orchard planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

Frost tolerance

Winter frosts are usually no problem for established plants, but heavy, late-spring frosts can damage flowers and soft new growth, and early autumn frosts may damage the fruit of late-cropping varieties, so frost protection may need to be considered in more frost-prone areas.

Wind/shelter

In most areas, shelter is not a primary factor in successful blueberry production. It can in fact be detrimental, if the shelter shades the plants or if it forms barriers that prevent air drainage and create frost pockets.

Sunshine hours

Blueberries need plenty of sunlight to help develop the maximum number of flower buds.

Rainfall

Having consistently optimum soil-moisture levels throughout the growing season is crucial to achieve maximum growth and yields. Drought and flood are both detrimental to this crop, so supplementary irrigation will be needed in most districts of

New Zealand and extra drainage measures may be required in high-rainfall areas.

Soil

Before planting, a soil test should be carried out. Soil pH should lie between 4.0 and 5.2. Blueberries have shallow, surface feeding, fibrous roots and require the soil to be moist and free draining if they are to grow well. They also like an acidic soil, with a high proportion of organic matter.

Well-drained peat soils are ideal, but mineral soils such as sandy or silt loams are also suitable, provided peat moss or mulch is added during planting and on a regular basis afterwards. Heavy clay soils that crack in summer and become waterlogged in winter are generally not suitable for blueberries unless heavily amended with organic matter and sand.

Drainage

The shallow, fibrous root system is particularly sensitive to extreme fluctuations in soil-moisture levels. Water-logged soil encourages the root-rots and diseases to which blueberries are especially vulnerable, so efficient drainage is a must.

Weed control

Perennial weeds are a major problem in blueberry blocks and are best controlled before planting. Planting rows should be thoroughly worked (rotary hoed or similar) and weed free at the time of planting. A weed-free strip 1.2 m wide should be maintained, centred on the middle of the row at all times. Mulching with organic materials such as sawdust or pine bark is expensive but very beneficial. Mulching helps keep weeds under control and the soil moist and cool.

Pests and diseases

Blueberries are relatively free of pests and diseases. Leaf rollers, scale insects and grass-grub do affect the bushes but are easily controlled with insecticides. The main fungal disease is crown rot, caused by *Phytophthora* if the ground conditions are too wet.

Birds can be a problem. Bird-scaring devices give a measure of short-term control. Bird guard netting can be used or a completely netted enclosure constructed for long-term control.

6. INVESTMENT AND RETURN

Blueberry plantings are relatively expensive to establish when compared to short-term crops, but they remain productive for a long period of time, perhaps up to 50 years. Depending on the scale of the operation, establishment costs may be $50,000 per hectare or more.

Factors to consider include:

- council consents;
- design issues/advice – block layout;
- equipment – some of the expenditure may be delayed until crops are yielding, or through the use of contractors;
- trellis design, posts and other structures;
- soil tests and fertilisers including start-up fertiliser for major soil amelioration, e.g., sulphur required as part of lowering pH for blueberry;
- pest and disease control, and weed control;
- irrigation, including design, pumps, main lines, laterals, sprinklers, drippers;
- netting, including posts – height, size, layout, wire, supports, bracing and style of netting;
- packing sheds, cooler facilities, storage facilities, transport;
- pollination.

Blueberry plants cost approximately $10 per plant. Used blueberry harvesters may be available from $50,000–100,000.

Returns depend on the final use of the fruit. Frozen product reaches $4–5/kg while fresh blueberries can return up to $15/kg. For an orchard producing at a peak of 10 tonnes per hectare with an 80/20 split between fresh and frozen, gross returns can reach $100,000–130,000 per hectare.

7. SOURCES/USEFUL LINKS

Blueberries NZ
Jan Bishell
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PO Box 13029, Hillcrest
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T: 07 856 6809
E: bishell@clear.net.nz

Blueberries NZ (http://blueberriesnz.co.nz)

Tharfield Nurseries (http://www.tharfield.co.nz/crop.php?fruitid=23_Blueberry)

'Blueberries – a 20th Century fruit is part of New Zealand's expanding horticulture industry', Martech Consulting Group (http://martech.co.nz/images/13blueberry.pdf)

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FAOSTAT, United Nations Food and Agricultural Organisation (http://www.fao.org/faostat/en/#data)

FEIJOA

1. LAND USE OVERVIEW INFORMATION

Feijoa are very hardy and versatile fruit trees that require a minimum of care once established.

Indigenous to Brazil and Uruguay, the feijoa is an exotic fruit of subtropical origin that can be readily grown in many parts of New Zealand. Feijoas can be considered as either warm climate or subtropical. First introduced into New Zealand in the early 1900s, the fruit was small, and it was another 20 years before new, larger cultivars with improved flavour were imported.

In May 2017, myrtle rust arrived in New Zealand. This serious fungal disease affects plants in the myrtle family, which includes pōhutukawa, mānuka and feijoa. At the time of writing, no feijoa trees have been infected, but it hasn't been determined what, if any, long-term impact myrtle rust will have on the feijoa industry.

2. PRODUCTS AND MARKETS

Feijoas have good levels of vitamin C and dietary fibre. One fruit will provide 23 percent of an adult's daily vitamin C needs. They are low in calories and a great source of minerals, fibre and antioxidants. Feijoas are a good source of one antioxidant in particular, proanthocyanidins. These have been shown to help reduce inflammation, counter the effects of ageing, and reduce the risks of some cancers.

An extensive range of feijoa products is now being made, including feijoa juice, chutney, relish, jelly, jam, liqueur, beer, wine, schnapps, chocolate, fudge, balsamic glaze and dressings, breakfast cereal, dried slices, aerated drinks, cosmetics, yoghurt and ice cream.

International demand has yet to be addressed through more aggressive promotion to increase demand beyond the domestic market. The main export market is Australia, with demand coming from ex-pat New Zealanders living there. The United States is a smaller but important market.

Increasing the quality of the fruit produced is important, firstly so more fruit is eligible for the export market, and secondly because the export market pays higher prices for the fruit, thereby increasing returns to the grower.

Local market

Local market feijoa sales totalled about 500 tonnes in 2015, and make up about 50 percent of total production. Demand for large-sized premium-grade fruit is increasing, helping to boost the perceived value of the fruit. In recent years wholesale prices (exclusive of GST) for premium-grade fruit have been:

- Large (90+g/fruit): $7 per kg in March and early April, falling to $4 per kg in the peak of the season, in early May;
- Medium (65–90 g): $5 per kg in March and early April, falling to $3 per kg in the peak of the season, in early May;
- Small <65 g/fruit): prices can be good early in the season, fetching $3.50 per kg, but these fall to around $2 per kg at the peak of the season.

Prices for mediocre and poor fruit are normally much less.

Export

Fresh fruit sales in the year to May 2016 increased 15 percent from the previous year, to a total of around 54 tonnes and a value of $462,000 – the highest in both value and volume since New Zealand records began. Australia was the largest market in 2016 (44 percent) followed by the United States (27 percent), Hong Kong (17 percent) and Singapore (9 percent). Australia can take all sizes, but demand for the larger sizes is higher. Most smaller sizes go to the United States.

Processing

Processed volumes are steadily increasing, and in 2015 year totalled about 450 tonnes. Most of the fruit goes into blended juices and wines. Prices received by growers (at the gate) vary from around $0.70–1.10 per kg, depending on the processor purchasing the fruit and the growers' willingness to supply in the lower price range.

Nitrogen leaching: unknown

3. PRODUCTION REQUIREMENTS

Feijoas are a medium-vigorous tree, moderately compact and easy to manage. Plants are trained up on a single stem to 40 or 50 cm in the nursery for ease of harvest once the tree matures. Trees can also be trained to grow espalier-style on wires to make fruit picking more ergonomically efficient.

For most areas of New Zealand, planting in either spring or autumn is recommended. For areas subject to cold winters, planting should be done in spring so the trees are established well before being subjected to cold conditions. For areas with mild winter conditions and/or subject to dry summers, planting should be done in autumn so the trees are established well before being subjected to hot, dry conditions.

Most feijoa varieties require cross pollination, hence it's necessary to plant more than one variety to ensure good fruit set. Alternating rows per variety is the most practical arrangement. Pollination is generally by birds, which are attracted to the brightly coloured flowers. In the North Island, blackbirds and mynas are the main pollinators, along with bees and bumblebees. Only the Unique variety is sufficiently self-fertile to be planted as a single block cultivar. Trees should be planted 3.5–4.5 m apart. At this spacing, trees will meet in the row after five years and will give 500–600 trees per hectare.

Feijoas fruit over a period of six weeks, from March through to June, depending on the region and cultivar. Commercially, fruit needs to be hand harvested (touch-picked) earlier rather than waiting until the fruit drops, to ensure it stays in good condition longer to reach export markets and achieve higher prices.

By year three the plant should yield approximately 2 kg of fruit, doubling each year until providing 20–25 kg of fruit.

4. INFRASTRUCTURE REQUIREMENTS

Infrastructure required will be influenced by whether the farm's existing assets can be used or modified for re-use. It also depends on the expected value of returns over subsequent years balanced with the necessity to acquire specific asset/s.

Typical infrastructure may include: packing shed, cooling room, implement shed, irrigation, shelter belts, fencing, mower, sprayer and miscellaneous equipment.

5. ENVIRONMENTAL ISSUES

Feijoas prefer to grow in full sunlight. The trees are frost-hardy and will handle temperatures as low as -10°C. However, the fruit will only tolerate temperatures down to -2.5°C. Strong winds can affect feijoa fruit production. Orchard shelter should always be regarded as a necessity for commercial plantings, and ideally should be established before the crop is planted.

For quality fruit production, the soil must be free draining, slightly acid (pH 6.0–6.5) and reasonably fertile. Many New Zealand soils meet these needs. Waterlogged conditions are not desirable. On dry sites irrigation will be beneficial just before flowering to improve fruit set, and also in March and April to allow fruit to reach their potential.

No research is available for nitrogen leaching of a feijoa orchard, however it is not considered to be in the high range. Any land use change to a feijoa orchard planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

Feijoas are relatively pest and disease free. Leaf rollers, scale and thrips can attack feijoas, and if severe attack occurs can be controlled with insecticides. Guava moth is also moving slowly down the North Island from Northland and currently has no proven control, although pheromone traps designed to catch adult guava moths are available.

As mentioned, the fungal disease myrtle rust arrived in New Zealand in May 2017. The disease affects the myrtaceae family, which includes 3000 species, among them feijoa, pōhutukawa, rata, ramarama and mānuka, plus various garden ornamentals.

At the time of writing, infected locations are being treated with fungicide, and affected and at-risk plants are being safely destroyed. At this point, feijoa has not been affected and it is not known what long-term impact, if any, myrtle rust might have on the feijoa industry.

6. INVESTMENT AND RETURN

Depending on the degree to which existing infrastructure can be re-used, set-up costs may run to $50,000 per hectare.

Potential returns will depend on the number of trees planted, how well the fruit can maintain a premium quality, and the state of the market. Gross return for 600 trees per hectare: 20 kg fruit/tree at $4/kg × 600 trees = $48,000/hectare.

7. SOURCES/USEFUL LINKS

NZ Feijoa Growers Association
President: Frans de Jong
Mailing address:
PO Box 29045, Ngaio
Wellington
New Zealand
E: info@feijoa.org.nz
Website: www.feijoa.org.nz

Tharfield Nursery (http://www.tharfield.co.nz/crop.php?fruitid=19_Feijoa)

Waimea Nurseries (https://www.waimeanurseries.co.nz/our-products/fruit-trees/feijoas/)

Lincoln University Financial Budget Manual 2016

Statistics NZ, Infoshare website (http://www.stats.govt.nz)

LAND USES – TREE CROPS

CHESTNUTS

1. LAND USE OVERVIEW INFORMATION

The chestnut is one of the more important nut crops found throughout the temperate zone, worldwide. With species indigenous to all three continents, the chestnut has long been cultivated and consumed throughout Asia, Europe and America. In the Mediterranean region, chestnuts have been cultivated for at least 3000 years.

Chestnuts were first introduced to New Zealand by some of the earliest European settlers. Nowadays, importing overseas cultivars is extremely difficult to avoid the risk of introducing overseas pests and diseases, such as chestnut blight and gall wasp. These would not only destroy our chestnut industry but could also attack some of our own fruit and tree species.

As of 2016, fresh nut production was around 300–400 tonnes per annum, with only a small amount (i.e., <1 tonne) exported, predominantly to New Caledonia, at a price of around $7.60/kg in 2016. The emphasis has now largely shifted away from fresh export to frozen export and/or value-added processing.[43]

Globally, chestnut production has constantly been rising, growing from almost 650,000 tonnes in 1993 to over 2 million tonnes in 2013 according to FAOSTAT figures. As at 2013, China was the world's largest producer with 1.72 million tonnes (82 percent), followed by Bolivia 76,000 tonnes (3.6 percent), Republic of Korea 64,000 tonnes (3.1 percent), Turkey 60,000 tonnes (2.9 percent) and Italy 55,000 tonnes (2.6 percent).

In 2013, total global exports were 125,000 tonnes with the major exporters being China (31.2 percent), Portugal (12.9 percent), Italy (11.3 percent), Spain 10.9 percent and Republic of Korea (9.8 percent). Total imports were 124,000 tonnes with the major importers being Italy (25.8 percent), China (9.5 percent), Japan (8.4 percent), France (6.1 percent) and Thailand (4.3 percent).

The New Zealand season corresponds to the off season in the Northern Hemisphere.

Background

Chestnut trees are a member of the Fagaceae botanical family, which also contains beech and oak trees.

Commercial chestnut orchards have been established in New Zealand for many years, with the nuts being exported to Japan, Australia and Singapore. However, unlike other nuts such as hazelnuts, chestnuts cannot be stored, due to their high water content. Therefore they are treated as a fresh perishable product, like vegetables, with a limited shelf life of around two to three weeks when stored properly in the refrigerator. Chestnuts can be frozen – fresh or partially cooked – but should be used immediately after thawing, i.e., not refrigerated, as shelf life is dramatically reduced after freezing.

New Zealand nuts are perceived as being of a large size and excellent quality. Growers are looking to diversify and develop a range of chestnut products, rather than just exporting fresh nuts.

2. PRODUCTS AND MARKETS

Overseas, chestnuts are readily processed into a wide range of user-friendly long-life products designed for everyday consumption, and are available on supermarket shelves. By developing a range of processed products, the New Zealand chestnut industry hopes firstly to avoid the pitfall of over reliance on fresh nuts, which could become over supplied at some stage, thus crashing growers' returns, but secondly and more importantly, to develop added-value products to build the industry in New Zealand.

Overseas processed products include peeled frozen free flow chestnuts, canned whole peeled chestnuts, vacuum-packed whole peeled chestnuts, sugared confectionery, purees, ice cream, baby foods, chips, yoghurts, dried whole chestnuts, flour for bread and biscuits, etc. Many products are sold on the health market for premium prices.

Other products include chestnut fettuccine, chestnut-flavoured chocolate, chestnut puree and chestnut flour, which retails in New Zealand for $27–38/kg.

Currently New Zealand nuts are mostly exported and the local market is fully supplied, but expanding. A recent development is the production of chestnut

43 NZ Horticulture Export Authority – Chestnut Trade

meal in New Zealand, for the food industry. Overseas markets pay highest prices for processing quality nuts, but this has not yet happened here.

Chestnut timber is also highly sought after overseas. Timber from *Castanea sativa* is naturally ground durable. However, the lifespan of chestnut trees can be anywhere from 200–800 years, with nut output peaking at 35–50 years.[44]

A new product category may be possible, using chestnut waste as animal feed. From 2012–2014, a joint MPI Sustainable Farming Fund R&D project, partly funded and supported by the NZ Tree Crop Association, was completed.[45] Inspired by overseas studies, this project looked at how the inclusion of even a relatively small amount of high-tannin 'ingredients' in animal feed, in this case chestnut shell and pellicle (inner skin) waste, could bring about much-improved animal health in a variety of animal species and, in particular, a significant reduction in problems caused by intestinal worms and harmful gut bacteria, potentially improving livestock health and condition and reducing or even eliminating the need for chemical intervention and/or antibiotic use, along with reduced levels of N and P excretion and methane production.

A key finding was that when included in the normal daily feed for alpacas (alpacas being especially sensitive to diet-, feed- and worm-related problems), chestnut by-product/waste produced a significant benefit in terms of animal health (via reduced worm counts), even when included only at low rates. No chestnut-fed animals needed worming over the trial period.

This may open up a new product category for chestnuts and significantly, with important benefits to the agricultural industry.

3. PRODUCTION REQUIREMENTS

Chestnut trees are small to large deciduous trees, meaning the trees lose their leaves and become dormant to withstand cold winters. The large edible seeds are called chestnuts and are produced annually on the tree inside a prickly case called a burr. In the autumn, when ripe, the burr splits open allowing the chestnuts to fall free, onto the ground.

The most commonly planted varieties are the Euro/Japanese hybrids, known by the following numbers: 1002, 1005 and 1015. All are characterised by rapid vegetative growth when young and are early bearing. Nut production will commence in the second or third season after planting if desired. To a much lesser degree there are plantings of the Japanese chestnut varieties Mayrick King, Mayrick Queen and 902, which appear to crop more heavily in warmer areas such as the coastal Bay of Plenty, and northern regions. The Japanese chestnut varieties often produce the largest nuts, but the trees are not always as hardy as the Euro/Japanese varieties.

All these varieties produce chestnuts with difficult-to-remove inner skins. The easiest way to prepare them for cooking is by using specialised chestnut peelers.

Layout

The most common spacing pattern is to initially plant the orchard at 6 x 6 m (256 trees/ha) and when the trees begin to intergrow, to thin out the temporary trees to a final spacing of 12 x 12 m (64 trees/ha). Alternatively some growers plant at 12 x 12 m (64 trees/ha), particularly where the land between the trees can be intercropped, although selection of the secondary crop would require nitrogen leaching analysis and a nutrient management plan.

Flat to gently sloping land is preferred for the orchard for ease of operation (especially mowing and harvest).

Chestnuts must not be thinned by cutting trees down. Dying roots could cause fungal infections in the remaining trees, therefore thinned trees must be dug out. Most growers are planting three varieties. Harvest must be by variety. Nut quality is modified by the pollinator. Very little is required in terms of day-to-day orchard management, except for mowing or spraying under the trees to enable easy nut collection.

Harvest

Trees produce nuts from years three to four, with up to 50kg/tree by year twelve (100 kg max per tree). Given reasonable conditions, most orchards are capable of achieving around 4 tonnes/ha once the trees reach maturity by year ten.

Nuts are harvested every two to three days, washed to remove orchard debris, (grass, etc.) and dipped to control surface moulds. They are placed in a cool store on the day of harvest.

44 'The Chestnut Tree', Pierre Laszlo http://www.pierrelaszlo.com/science-writings/plant-of-the-month/9-the-chestnut-tree

45 'A New High-Tannin Animal Stockfood System', David Klinac, *The Chestnut Grower,* Winter 2016 http://www.chestnutgrowers.org/2016january.pdf

When the nuts fall to the ground, they must be harvested within a day to avoid deterioration. The prickly burrs can be a problem, so thick gloves and protective shoes are necessary. Various machines (vacuum and 'hedgehogs') can be used to pick up the nuts. After harvest, the nuts must be chilled for fresh sale or processed, dried, etc., reasonably quickly and are usually stored in cool stores.

4. INFRASTRUCTURE REQUIREMENTS

Expenditure on infrastructure depends on whether a farm's existing assets can be modified for re-use.

Basic gardening equipment such as a mower, weed sprayer, etc., is all that is needed for most chestnut plantings. Infrastructure may grow to include packing shed, cool store, implement shed, irrigation, shelter belts, fencing and miscellaneous equipment.

Fencing is required to keep out pests (e.g., rabbits) from eating young trees.

5. ENVIRONMENTAL ISSUES

Fertiliser

Chestnut trees respond well to a balanced fertiliser programme, whether that's organic or artificial. They need good supplies of nitrogen, potassium and magnesium in particular. Fertiliser should be applied in early spring and again mid-summer – 'a little and often' rather than in one heavy application, which can cause root burn and is usually largely wasted.

No research is available for nitrogen leaching of a chestnut orchard, however it is considered to be in the low range. Any land use change to a chestnut orchard planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

Pests/diseases

Overseas, there are many serious and crippling pests and diseases that often make chestnut production uneconomic. New Zealand is fortunate to be mainly free of most of these serious problems, and this is the reason for the strict border controls and lengthy quarantine periods placed on the introduction of overseas chestnut plant material, including seeds.

People travelling overseas should not bring back fresh chestnuts, as many of these pathogens are spread by contaminated chestnuts that appear quite healthy. In New Zealand, the main problems are:

- Root rot caused by the soilbased fungal disease *Phytophthora cinnamomi* which usually kills the tree (at any age) and is more prevalent on heavier soil types. Trees can be infected at the nursery stage, so growers should ensure their nursery supplier is certified as meeting the nursery standards as specified by the NZ Chestnut Council. Control with fungicides is difficult, however the use of trunk injections or foliar sprays with phosphorous acid as a preventative for healthy trees is currently under trial evaluation and showing promising results. To reduce exposure to root rot diseases it is not recommended that orchards are established on poor-draining soils that are prone to waterlogging.
- Infection of the nuts while on the tree with the fungal diseases *Phomopsis* and *Botrytis* (and other fungi) can lead to rotten nuts at harvest and can cause serious losses even under cool storage.
- Puriri moth, grass-grub beetles, cicadas and possums can cause serious damage to young trees. The grass-grub beetle will eat the soft new-season foliage of chestnut trees in the late spring when they fly at dusk, often in quite staggering numbers. Young trees may be completely stripped. Possums are especially damaging, eating the bark, leaves and breaking branches. They relish eating the nuts when they fall to the ground at harvest. Rabbits and hares will eat the bark of young trees.

Nitrogen leaching: low

Climate

In general, the more humid conditions found in the North Island produce a bigger tree and bigger final nut. However, humidity also increases the chance of root rot and other diseases in the tree.

Winter chilling and frosts

Frosts are generally not a concern to chestnut trees as they flower late in the spring, although late spring frosts can burn new-season foliage. Care must be taken with early autumn frosts, as these can affect both foliage and fruit.

Rainfall and irrigation

Irrigation and shelter is helpful in exposed situations. Irrigation can make establishment easier and increase

crops. A hot summer (i.e., 30°C) is helpful to ripen nuts. Regular rainfall is required over summer–autumn months, otherwise irrigation may be required. Chestnut trees do use a lot of water, especially near harvest, as they are filling out the nuts.

Wind

Although chestnut trees are reasonably wind hardy and demand a high light intensity to promote female flower production, they grow and produce much better with effective shelter from strong prevailing winds, especially over late spring and early summer when new foliage is at its softest and prone to windburn. Effective shelter is most needed when the trees are first planted and over their next few years, when vegetative growth is at its maximum. Ideally, shelter lines should be planted one to two years before the orchard trees.

Soil

Soil type needs to be free draining year-round, down to 2 metres, with an acid pH of around 5.5–6.5. Heavier, poorly drained soils increase the likelihood of root rot problems (*Phytophthora spp*). Soil fertility is not usually a problem.

Weed control

Weed control under trees is essential to allow nut pickup. Grass in the rows is usually mowed. Growers thinking of grazing sheep between the trees should be very careful – sheep will and do eat the bark from around trees, which kills them by ring-barking.

6. INVESTMENT AND RETURN

Estimating grower returns and production levels per hectare is easier said than done, given the vagaries of the market place from year to year and the wide variation in tree performance from one site to another.

However, growers' gross returns (at gate) can range from $2.00/kg for local market to $3.00/kg for fresh export or processing, depending on size or grade of the nuts, with the larger or earlier season nuts usually fetching a premium. Small nuts are difficult to sell at a profit on the fresh fruit market and are utilised for processing into value-added products.

Harvesting costs range from 50c to $1.00/kg depending on tree age. Given reasonable conditions, most orchards are capable of achieving around 4 tonnes/ha once the trees reach maturity by year ten. Average gross returns at maturity (calculated at say $2.50/kg average) would translate to $10,000/hectare.

Further processing by drying, crumbing or making into other value-added products would add to the income.

Compared to many horticultural crops, a chestnut orchard is cheap to establish and maintain, and has a low time input requirement (except at harvest). This allows most orchard owners to follow additional vocations as well.

7. SOURCES/USEFUL LINKS

New Zealand Chestnut Council
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Chestnut Fact Sheet, New Zealand Chestnut Council (http://www.nzcc.org.nz/)

Chestnut Crop Summary, New Zealand Tree Crops Association Crop Guide (http://www.treecrops.org.nz/crops/nut/chestnut/)

Anavon Orchard, (http://chsntz.weebly.com/value.html)

Chestnut Traders, (www.chestnut-traders.co.nz)

FAOSTAT, United Nations Food and Agricultural Organisation (http://www.fao.org/faostat/en/#data)

Infoshare – Statistics NZ (http://www.stats.govt.nz)

HAZELNUTS

1. LAND USE OVERVIEW INFORMATION

Hazelnuts have been grown commercially in New Zealand since the 1980s and are found from Waikato to Southland. With good management and careful planning at set-up, commercial operations may be able to supply domestic demand and possibly export hazelnuts from New Zealand to global markets.

The commercial hazelnut industry in New Zealand is based on selections of *Corylus avellana*, a species of wind-pollinated shrubs or small trees native to temperate areas of Europe and Asia Minor. Most existing orchards are in Canterbury, Otago or Nelson.

Hazelnuts are one of the five most commonly traded nut crops worldwide, along with almonds, walnuts, pistachios and cashews. The average annual world production (2009–2013 FAO data) is approximately 830,000 tonnes (in-shell). World production of hazelnuts increased 7.7 percent in the ten years from 2003–2013 (FAO data), but the total hazelnut crop continues to fluctuate, affected by a strong biennial bearing pattern and the dominant influence of the Turkish crop.

Turkey is the largest global producer, with approximately 74 percent (range 64–78 percent) of world production. Italy is the second-largest producer (12–16 percent) followed by Spain, the United States, Georgia, and Azerbaijan (approximately 3 percent each).

The local New Zealand market for hazelnuts is small but increasing. Imports amount to 200–250 tonnes per annum. Most hazelnuts are imported from Turkey (80–90 percent) but quantities are increasing from the United States.

There are no accurate figures for local production, but it is estimated to be less than 100 tonnes per year. The trees on the 350–400 hectares already planted in New Zealand, once in full production, should be capable of producing 600–1200 tonnes per annum. This exceeds the current volume of hazelnut imports. New large-scale plantings would therefore need

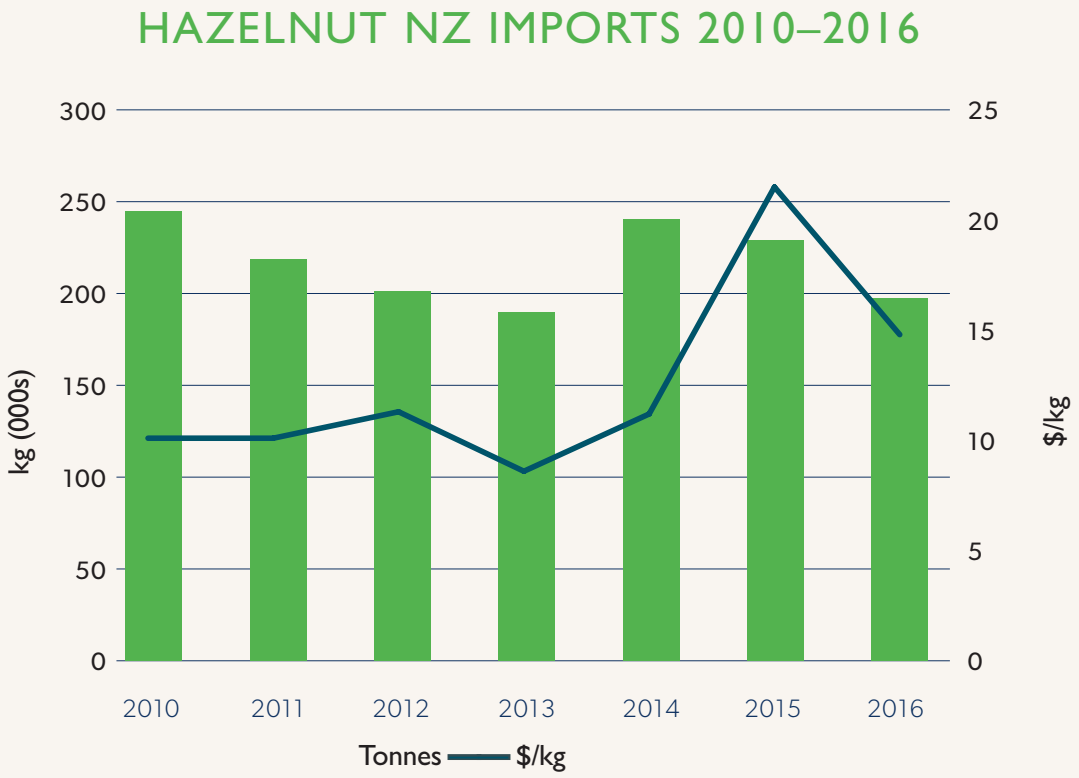

Figure 13: Hazelnut New Zealand imports

to plan to supply export markets. Potential export markets exist in Australia and Asia.

2. PRODUCTS, BENEFITS AND MARKETS

The global demand for exported hazelnuts is around 240,000 tonnes (2013). Globally, Europe is the largest market for hazelnuts, with Germany being the largest single European market at 28 percent, followed by Italy (15 percent), France (8.5 percent), Belgium (4.8 percent) and Canada/Switzerland (4.4 percent each). In recent years, Italy and Spain have become net importers of hazelnuts.

Apart from the sale of dry-roasted and raw hazelnuts ($30–40/kg), hazelnuts can be processed into a variety of products including hazelnut meal ($40/kg), hazelnut oil ($75–100/litre), hazelnut flour ($10–20/kg), hazelnut spread/paste ($40–60/kg) and roasted hazelnut butter ($50/kg), which can go on to be used in confectionery and other end uses.[46]

46 Typical retail prices from New Zealand websites

New Zealand has several processors including The Hazelnut Company, which has a medium-sized processing plant in Canterbury, and Uncle Joe's Nuts in Marlborough, through to smaller grower-processors who sell through farmers' markets and small local retail outlets. Many also offer internet sales. Internet sales have seen small quantities of New Zealand hazelnuts exported to Australia, the United States and Europe. There are no large processors in the North Island.

3. PRODUCTION REQUIREMENTS

The foundation for successful hazelnut growing is laid when the orchard is established. Landowners intending to grow hazelnuts commercially should use accurate and up-to-date information from local and national sources to guide them through the establishment phase. Information required includes:

- suitable varieties for the targeted market and orchard location;
- suitable pollinisers for the variety selected;
- suitable tree spacing for the selected varieties and local growing conditions;
- shelter requirements;
- suitable pasture species for the orchard floor;
- irrigation requirements and regulations;
- soil characteristics.

Hazels are deciduous trees and are planted over winter when dormant. Hazel roots grow through the winter whenever soil temperatures are above 4.5°C, so planting as early as possible enables the plants to develop a working root system before bud burst.

Established hazelnut orchards need to be managed with the aim of maximising the area of fruiting canopy and ensuring the orchard floor is maintained to enable efficient harvesting and high-quality nuts.

Different cultivars flower at different times in different locations, so the choice of crop trees, and particularly pollinisers, will depend on the location.

Hazelnut orchards depend on specific pollinisers to successfully pollinate each commercial variety. These pollinisers must have pollen that is compatible with the flowers of the commercial variety, and this pollen must be shed during the main flowering period each year. An ideal polliniser is one that sheds compatible pollen at, or immediately following, the peak of female flowering of the main crop cultivar.

Layout

Block layout is a personal choice. Most growers use a distance of 4.5 m between rows and 3 m between trees within the row. This gives approximately 600 trees per hectare when an allowance is made for headlands and shelterbelts.

Shelter

Hazels are easily damaged by strong winds, so good shelter is essential. Shelterbelt design is an important part of planning a new orchard – the maximum block size will depend to a large degree on what shelter species are chosen. Most shelterbelts use fast-growing deciduous species that will grow to 15–30 m, such as poplars and alders. Be aware that some shelter species (such as poplars and willows) have vigorous root systems and will compete with crop plants for water.

Different varieties of each species have different growing habits and requirements, and some varieties may be susceptible to diseases under certain conditions. Local tree nurseries that have experience in shelter design should be able to recommend shelter species appropriate to conditions, to help determine the appropriate block size.

Harvest

Currently there are no commercial harvesting contractors in New Zealand, so orchardists must either share harvesting equipment with other orchardists or invest in their own equipment.

Harvesting systems fall into three main types:

1. Hand collection with small tools or small hand-propelled collectors.
2. Vacuum systems:
    a. small two-stroke powered vacuum harvesters, either bac-pack type or mounted on a small trailer;
    b. medium-sized four-stroke powered vacuum harvesters that are towed or mounted on a smaller trailer;
    c. large vacuum harvesters that are self-propelled or power take-off (PTO), driven behind a tractor.
3. Mechanical systems:
    a. medium-sized harvesters that are usually front mounted with side sweepers;
    b. large harvesters that are usually self-propelled and fitted with side sweepers;
    c. large harvesters that are either towed or self-propelled and that rely on separate sweeper machines to windrow the crop.

Keeping the ground under the trees clear of foliage is essential near harvest, to allow efficient collection of the nuts from the ground.

The handling of hazelnuts after harvest can be described as having two stages. In the first stage, the shell is cracked and the kernel separated. In the second stage, the kernel may undergo a variety of processes, namely: blanching, roasting, slicing, mincing, pulverising or being made into a paste.

Yield

The key influences on the economics of hazelnut production are yield, market price and the scale of operations. Both high nut quality and high yields are necessary for profitable hazelnut growing and are achieved through:

- choice of suitable climate and soils;
- choice of suitable varieties for the environment and markets;
- appropriate planting system (suitable nursery stock, orchard layout and early training);
- good orchard management techniques (pruning, soil nutrient management, orchard floor management, irrigation).

The yields achieved in hazelnut orchards are variable. While orchards in Oregon expect to yield around 2.5 to 3 tonnes/ha, average yields in countries like Turkey, with less intensive orchard management, fall below 1.5 tonnes/ha.

Early production is an important factor in economically viable production. Hazels should have a small crop in the third year after planting, with the first commercial harvest in the fourth or fifth year. Growers should plan to harvest 1 tonne/ha by year six and 2.5 tonnes/ha by year ten. These yields have been achieved by New Zealand growers with good management in suitable environments.

4. INFRASTRUCTURE REQUIREMENTS

Expenditure on infrastructure will be influenced by the expected value of the returns over subsequent years balanced with the budget available, and will depend on whether the farm's existing assets can be used or modified for use.

Typical infrastructure may include: packing shed, implement shed, irrigation, shelter belts, fencing, mower, sprayer, harvesting and miscellaneous equipment.

The capital cost of harvesting equipment increases with the sophistication of the equipment, from hand-held devices available at $150 each to self-propelled machines in excess of $75,000.

5. ENVIRONMENTAL ISSUES

Nitrogen leaching: low

Commercial hazelnuts require a mild temperate climate. The main hazelnut-growing areas in the northern hemisphere are characterised by mild summers and cool winters without extremes of heat or cold. Key temperature characteristics are:

- average annual temperature 12°C to 16°C;
- maximum temperature 35 to 36°C;
- minimum temperature -8 to -10°C;
- winter chilling of 600 to 1200 hours (depending on variety).

No research is available for nitrogen leaching of a hazelnut orchard, however it is considered to be in the low range. Any land use change to a hazelnut orchard planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

Hazelnut trees have soft leaves and do not tolerate extreme heat, wind or moisture stress. In New Zealand conditions, good shelter is essential.

Ideal annual rainfall is 800–1200 mm, with rain evenly spread throughout the growing season. Locations with rainfall well distributed up until February may not require irrigation. Locations that experience prolonged periods of dry weather between November and the end of January should install irrigation, especially if the soils are free draining (sandy or stony). Water requirements are estimated at about 1–1.5 million litres of water per hectare per season for every 150 mm of annual rainfall less than 900 mm. Rotorua averages 1300 mm of rainfall per year.

Warm dry weather over the harvest period (late February to early April in most areas of New Zealand) is advantageous. Dry weather lets husks dry quickly so that nuts fall free, the moisture content of the harvested nuts is low, and dry ground conditions favour easy machinery operation and clean nuts.

Out-of-season frosts in November and December have caused hazelnut crop losses in parts of New Zealand. Temperatures recorded in orchards affected by frost damage in the South Island suggest that air temperatures of -2 to -3°C may be sufficient to cause damage to nut clusters at this time. However, damage has been inconsistent, both within orchards and regions.

Pests and diseases

- Big bud mite reduces the amount of productive growth on the tree, and therefore reduces crop yields. Some cultivars are more susceptible than others and the effects may depend on the season or climate. Small infestations can be controlled by removing affected buds, or severe infestations can be controlled by spraying with sulphur.

- Hazel leaf miner causes premature defoliation of trees; no controls are known at present.
- Lemon tree borer causes branches to break and weakens vegetative growth. The borer usually only affects trees that are already performing poorly, and can be controlled by pruning out affected growth.
- Green shield beetle feeds on the nuts, causing distortion of the kernel and a bitter taste. The beetle can be controlled by insecticides and good orchard hygiene.
- Hares and rabbits: hares can severely damage young trees by nipping the tops off them around knee height. Rabbits can damage young trees by nipping off and eating the branches, and can damage older trees by gnawing at the bark (weakening the trunk and also leaving a wound where disease can enter).
- Possums and rats do not generally affect the trees but may steal nuts for their own winter food. Prompt harvesting will reduce the opportunity, as will a secure storage location (a sealed shed with no access points, a steel tank, or onion bags suspended from the ceiling).
- Bacterial blight mainly affects young trees while they are being established, and is especially problematic for trees that are already stressed (by wind, sun or lack of water). The blight causes dieback of leaves and shoots and can damage new growth buds so that they don't develop properly (in which case the next season's crop and growth are also affected). In extreme cases, the blight may weaken the tree so much that it dies. Bacterial blight is controlled using copper sprays in spring and autumn. The bacterium appears to thrive in moist conditions, so control requirements will vary from season to season and from location to location.

6. INVESTMENT AND RETURN

Costs of establishing a hazelnut orchard vary according to how much development work (shelter, irrigation, land preparation) is required, ranging from about $8,500/ha (established shelter, no irrigation required), up to $25,000/ha starting with bare undeveloped land requiring significant modification.

Gross margins for well-managed hazelnut orchards in Australia, Oregon (USA) and Italy are commonly in the range of $4,000–7,000/ha. In New Zealand, assuming yields of 1 tonne/ha by year six and 2.5 tonnes per ha by year ten, and based on an average price of $3.50/kg for nuts in-shell, returns would be $3,500/ha by year six and $8,750/ha by year ten.

However, returns also depend on whether nuts are processed further. Adding value through further processing into flour, meal and oils in packaged products would likely increase returns.

7. SOURCES/USEFUL LINKS

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E: info@hazelnut-growers.org.nz

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MĀNUKA – HONEY, OIL

1. LAND USE OVERVIEW INFORMATION

Mānuka or kahikatoa (*Leptospermum scoparium*), called 'tea tree' by Captain Cook, is a rather variable plant ranging from flat creeping forms and small shrubs to tall trees (up to 7 m). Mānuka/kahikatoa is common throughout the North, South and Stewart islands, in lowland to low alpine regions up to 1800 m above sea level. It can be found in many different habitats including wetlands, river gravels and dry hillsides. When mature, it is very tolerant of drought, waterlogging, strong winds and frost, and it can grow at less fertile, colder, wetter and more acidic sites than kānuka.[47]

For more than a century, mānuka has been an obstacle for New Zealand farmers, with thousands of hectares of mānuka cleared to make way for farmland. However, recent discoveries have changed the landscape, with many hectares of mānuka now being planted again.

The main driver for the interest in mānuka has been the finding that mānuka honey has important anti-bacterial properties that makes it different from other honey.

In 2008, it was discovered that the cause of much of this difference was a compound called methylglyoxal (MGO). A year later, scientists at the University of Waikato (Christopher Adams, Merilyn Manley-Harris and Peter Molan) published research showing that the methylglyoxal in New Zealand mānuka honey originates from the chemical compound dihydroxyacetone (DHA), which is present in the nectar of mānuka flowers to varying degrees.[48] (Some mānuka plants have more DHA in their nectar than others.)

DHA does not have antibacterial properties, but over time DHA converts to MGO through a natural chemical reaction. DHA is unique to mānuka nectar, and has not been found in any other floral types of honey. Moreover, storage of these honeys at 37°C led to a decrease in the DHA content and a related increase in MGO. In other words, if the nectar has a high DHA level, then the resulting honey will have a high UMF rating.

UMF stands for Unique Mānuka Factor, and is a quality trademark and grading system identifying natural unadulterated mānuka honey that has a special unique natural property found only in some strains of mānuka honey.

These anti-bacterial properties are unique to New Zealand mānuka honey, hence the name 'unique mānuka factor', and have been responsible for the production of high-value medical-grade honey products that assist in treating wounds, as well a range of bio-medical products to address a variety of skin conditions. Also, research is starting to show that medical-grade mānuka honey may be able to help in the fight against antibiotic-resistant infections by improving the effectiveness of the antibiotics.

Below is a table comparing the UMF rating with the minimum rating of methylglyoxal (MGO) required.

47 Mānuka/kahikatoa and kanuka, Dept of Conservation

48 DHA and MG explained, Analytica Laboratories

COMPARISON OF UMF AND MGO RATINGS[49]

UMF Rating	Minimum MGO rating (mg/kg)
–	30
UMF 5+	83
UMF 10+	263
UMF 12+	354
UMF 15+	514
UMF 18+	692
UMF 20+	829
UMF 25+	1200

49 Unique Mānuka Factor Honey Association

THE 10 BIGGEST HONEY EXPORTERS OF 2013 BY VALUE[50]

50 FAOSTAT, United Nations Food and Agricultural Organisation

2013 Global exports	US$ (000)	Tonnes	US$/Tonne
China	258,467	128,654	2,009.01
Argentina	212,637	65,180	3,262.30
New Zealand	140,091	8,757	15,997.60
Germany	125,015	20,885	5,985.88
Mexico	112,352	33,458	3,358.00
Spain	92,835	21,579	4,302.10
Hungary	85,113	18,365	4,634.52
Vietnam	80,097	34,924	2,293.47
India	76,049	30,099	2,526.63
Belgium	66,722	20,144	3,312.25

In terms of the value that mānuka honey UMF factor contributes to total New Zealand honey exports, the table above shows the ten biggest exporters of honey (all types) in the world by value as at 2013. New Zealand is at number three, with a per tonne price around three or more times the price of other countries. This premium pricing is due, to a large extent, to the value of high UMF honey.

Overseas producers were quick to recognise the premium associated with mānuka honey, and unscrupulous operators rebranded their honey as mānuka honey to achieve better profits. Due to this product piracy, the Ministry of Primary Industries (MPI) is developing a testing regime with the industry to distinguish legitimate mānuka honey from pirated product.

There are many options available for landowners to be involved with mānuka production, from minimal involvement – providing the land for the mānuka to be planted on and contracting a company to look after the rest of the process, through to high involvement – setting up a business growing mānuka, collecting honey and/or oil and marketing the product through distribution channels. Returns are higher for the latter, as is the level of skill, experience, knowledge and resources required.

Myrtle rust

The recent discovery of myrtle rust in New Zealand and its potential danger to mānuka and other plants has raised questions about the future of the industry, and will necessitate intensive research into the likely impact this will have on the mānuka honey and oil industry.

Myrtle rust is a serious fungal disease that affects plants in the myrtle family, which includes pōhutukawa and mānuka. In early May 2017, the disease was first detected on mainland New Zealand in plants at a nursery in Northland. It has since spread to Taranaki, the Waikato and the Bay of Plenty.

MPI and other partner government agencies have short- and long-term strategies to combat myrtle rust. The immediate aim is to eradicate the pathogen at source, and if that is not possible, the long-term strategy is containment, monitoring and learning to manage myrtle rust.

2. PRODUCTS AND MARKETS

Mānuka honey and mānuka oil are the two main products from mānuka. Retail prices for mānuka honey attract a premium, especially those with a high UMF rating. Top of the range UMF20+ mānuka honey retails for $260.00 for 250 g, i.e., $1,040 per kg.

One hundred percent pure mānuka oil retails for $600–3,000 per litre.

The global honey market is growing, and in 2013 was worth over US$2 billion, with the top ten importers growing by over 50 percent in the five years from 2009 to 2013, from $946 million to $1.5 billion.

New Zealand honey is exported to 48 countries around the world. In 2016, 6924 tonnes were exported at a FOB value of NZ$258 million, giving a price per tonne of NZ$37,271. Mānuka honey figures are not separated out in Statistics NZ figures, although it was estimated that 1700 tonnes of mānuka honey were produced in 2016.[51]

51 'Riddle of how 1,700 tons of mānuka honey are made... but 10,000 are sold', *NZ Herald*, 23 Aug 2016

52 FAOSTAT, United Nations Food and Agricultural Organisation

THE 10 BIGGEST IMPORTERS OF HONEY[52] IN 2013

Country	Value (US$000)
United States	497,886
Germany	313,458
United Kingdom	125,974
Japan	116,357
France	112,616
China	81,216
Italy	75,207
Saudi Arabia	66,423
Belgium	63,438
Spain	53,047
TOTAL	**1,505,622**

3. PRODUCTION REQUIREMENTS

Successful mānuka plantations rely on a number of variables, including careful planning and plant husbandry, good relationships between landowners, beekeepers, mānuka nurseries and honey/oil marketing companies and, for honey, an understanding of bee behaviour.

Cultivar selection is highly important in establishing a successful mānuka plantation. Mānuka cultivars need to be chosen for the specific geographic areas where they are likely to flourish. All mānuka will not necessarily grow anywhere. However, if possible, planting several cultivars can extend the flowering period from 6 to 12 weeks. Mānuka nurseries will be able to provide advice on this.

Ideally, mānuka cultivars should be able to produce high UMF, i.e., high DHA level in their nectar, as well as good growth rates, high disease resistance and good flowering ability. Work developing new mānuka cultivars is ongoing.

Natural mānuka lifespan is 25–50 years, although the mānuka productive lifespan is based on 25 years.

When planting for honey, mānuka can be planted on marginal and hilly land, which may help improve the productivity of more marginal land, at a stocking rate of approximately 1100 stems per hectare or at 3 x 3m spacing. When planting for oil, ideally land would be flatter and the stocking rate could be increased to maximise productivity, to as high as 3000 stems per hectare. For the first three years of the crop, areas may need to be fenced and protected from predators that will eat or damage younger mānuka plants, including hares, goats and deer.

Unfortunately, bees prefer other floral crops to mānuka, and therefore, if given other food source options, will likely avoid mānuka. Therefore mānuka plantation layout becomes important, and should be undertaken with beekeepers so as to limit bee choices. Current industry wisdom is to plant mānuka for honey in large contiguous blocks of 20–30 hectares or more, and the plantation should be laid out so that hives can be positioned towards the centre of the blocks to provide fewer food source options for the bees.

Hives should still be sited according to apiculture industry norms, i.e., in sunny, sheltered positions with good access for vehicles.

The first honey harvest begins in year three, with maximum honey yields occurring from year eight onwards. For plantation models of mānuka honey where there is more control over the environment and inputs, yield may be able to be brought forward, with a 20–30 percent harvest by the end of year one, and maximum honey production achieved by the end of year three.

Hive stocking rates can range from approximately one hive per hectare for indigenous mānuka, through to plantation stocking rates of four or more hives per hectare. Yield varies according to a number of factors, including climatic conditions, dilution from other nectar-producing plants, and bee health; however, a yield of 25–40kg/hive is considered reasonable.

Once the honey has been harvested, MGO levels increase over a 12–18-month period. Most beekeepers store their honey until the MGO levels reach their peak.

There are two general approaches to harvesting mānuka for oil – planting and harvesting mānuka on flatter land or harvesting existing mānuka, which is usually on hillier land. If the mānuka is to be planted, flatter land is preferable, as this allows the leaves to be harvested by machine, which is more efficient. This also influences the layout, for example, planting in hedgerows, which allows a higher number of trees per hectare, typically 2000–4000 trees per hectare. Irrigation can also be installed to promote faster growth. Approximately one tonne of mānuka foliage can produce between two and three litres of pure mānuka oil.[53] The harvesting rotation may vary according to how heavily the mānuka is pruned or cut back, from annually to every second or third year for heavily cut back mānuka.

Pruning can be undertaken annually, which helps promote new growth and encourages the tree to bush rather than turn into a tree with a canopy.

Mānuka growing on hillier ground can also be harvested for oil, but will likely require manual harvesting, which decreases efficiency and may provide more variable results.

Oil distillers must have the knowledge and expertise to know how to produce therapeutic-grade essential oils.

53 'https://manukabiotic.co.nz/organic-manuka-oil/ Accessed June 2017

DISTILLATION OF MĀNUKA OIL

Mānuka oil can be extracted from the foliage by steam distillation or carbon dioxide (CO_2) super-critical extraction.

In the steam distillation process, steam is passed through the foliage and when condensed it contains a small quantity of pure mānuka oil. This oil floats on top of the condensed water and is drawn off.

In the CO_2 extraction process, which requires less heat, carbon dioxide is pumped under pressure into a chamber filled with plant matter. When carbon dioxide is subjected to pressure it becomes 'supercritical', i.e., has liquid properties while remaining in a gaseous state. Because of the liquid properties of the gas, the CO_2 functions as a solvent, pulling the oils and other substances such as pigment and resin from the plant matter. In some cases, CO_2 extraction can provide a superior product.

4. INFRASTRUCTURE REQUIREMENTS

The infrastructure required varies according to whether planting for honey or planting for oil.

When planting for honey, mānuka can be planted on more marginal and hilly land so minimal infrastructure is required, although areas may need to be fenced to protect from predators.

Planting for oil will require more infrastructure, including machine harvesters to increase efficiencies, and facilities for extracting and packaging oil, including distillation units.

5. ENVIRONMENTAL ISSUES

- Mānuka does well in a range of soil types: sand, volcanic, clay, peat, limestone, alpine and pakihi; swampy soils where the roots of the plant never dry out.
- It can be planted on barren windswept hillsides where it may be constantly battered by salt-laden winds.
- A good site is a sheltered valley with high hills on either side.
- Mānuka thrives on north- and east-facing hillsides.
- Avoid proximity to large sources of non-mānuka nectar.

No research is available for nitrogen leaching of mānuka, however it is considered to be in the low range.

More research is required into fertiliser regimes for mānuka. It is thought that mānuka produces higher UMF honey in low pH and low fertility soils (don't add lime or fertilise soil). Add sulphur to soil if necessary, to reduce the pH.

Mānuka is particularly susceptible to invasion by scale insects and consequent sooty mould growth.[54]

Areas of planted mānuka may need to be fenced for the first three years of the crop to protect from predators, including hares, goats and deer, that will eat or damage younger mānuka plants.

6. INVESTMENT AND RETURN

Mānuka honey income is affected by a number of factors, including the climatic conditions of the season affecting nectar flow and bee activity, the DHA levels of the nectar, the species, area and density of the mānuka and the presence of other floral food sources.

The cost per hectare to plant mānuka can vary widely according to the stocking rate and quality and size of plants, etc. Initial estimates for planting on marginal land range from $2,000–3,000 per hectare including plants and labour. Fencing costs average $15 per metre.

For plantation mānuka, costs would be higher due to a higher stocking rate and additional infrastructure such as weed matting and irrigation.

Returns for honey to the landowner can vary considerably from year to year. For mānuka honey, there is insufficient past data to provide a demonstrable rate of return, however estimates by Comvita and Kauri Park provide for a return of between $500[55] and $1,360[56] per hectare to a landowner.

Returns from mānuka oil can vary according to the ecotype of mānuka harvested, the ease of harvesting the mānuka foliage and the type of extraction method used, which all flows through to the quality of the oil produced. One tonne of foliage can produce two to three litres of pure mānuka oil with a value of $600–3000 per litre.

Mānuka plantations are eligible for funding under the Afforestation Grant Scheme (AGS).[57] The AGS provides $1,300 per hectare to successful applicants towards the establishment of trees on their land, in return for the first ten years' worth of carbon credits. The 2018 funding round will open in the first quarter of 2018.

7. SOURCES/USEFUL LINKS

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Stephen Lee, Commercial Manager
T: 020 4122 2858
E: stephen@mānukafarmingnz.co.nz
W: http://www.manukafarmingnz.co.nz/resources/

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54 https://tararuacropping.files.wordpress.com/2016/08/essential-oil-manuka-may-2014_kanuka.pdf, Crop and Food Research, July 2000, Accessed June 2017

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57 http://www.mpi.govt.nz/funding-and-programmes/forestry/afforestation-grant-scheme/

Nitrogen leaching: low

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FORESTRY – RADIATA PINE

1. LAND USE OVERVIEW INFORMATION

New Zealand is home to 1.7 million hectares of managed exotic plantation forestry, of which around 90 percent is planted in radiata pine. Nearly all of New Zealand's industrial usage comes from this exotic forest resource. Forestry employs around 20,000 people throughout the country and accounts for over $5 billion in export earnings.

It is important to understand the timeframe for most forestry crops, with most trees needing at least 30 years before maturity. During this time, they will need inputs of labour, with very little potential for any return. Plantation forestry crops work well on a mixed-style property. They suit marginal land such as hillsides and gullies, leaving the more productive flat land available for conventional farming or other crop options.

Radiata pine is an excellent exotic plantation species that can usually be harvested after 28 years. The timber has a straight grain and is relatively knot free. Radiata pine is used for a range of industrial purposes including logs and chips, paper and paperboard, lumber for building, and wood pulp. New Zealand has strong export markets for these products in China, Australia, South Korea and Japan.

As at 1 April 2016, there were 1.53 million hectares[58] planted in radiata pine in New Zealand, or around 90 percent of the total 1.70 million hectares planted in exotic forest.

The annual harvest reached a new record in 2016 of 30 million cubic metres – an increase of 5.4 percent from the previous year – and this is set to climb further, driven by high log prices. Wood availability will increase over the next five years due to the high rate of planting in the early 1990s.

2. PRODUCTS AND MARKETS

Radiata pine has several growing regimes to produce different types of timber that can have a number of uses, including:

- knot-free clearwood, the highest-value timber, used for finishing, mouldings, furniture, plywood, etc;
- structural-grade timber, with small knots and preferably higher-density wood;
- roundwood (posts and poles);
- lower-value boxing and packaging timber, for logs with large knots;
- pulp wood, the lower-value market for the roughest logs.

Each forestry regime produces several, possibly all grades of logs and timber, but in differing proportions. A clearwood regime gives the highest returns per hectare, but requires significant investment in pruning. A framing (structural) grade regime needs higher stocking rates to control branch size, but avoids pruning, and can be quite profitable. Roundwood (posts and poles) regimes are shorter, with high stocking rates.

Harvested logs are either sent for export or utilised at domestic sawmills.

Indicative average log prices as at May 2017 are outlined in the table below.

58 National Exotic Forest Description, April 2016

Log grade	$/tonne at mill	$/JAS m^3 at wharf
Pruned (P40)	188	180
Structural (S30)	113	–
Structural (S20)	103	–
Export A	–	141
Export K	–	134
Export KI	–	126
Pulp	50	–

Table courtesy PF Olsen. Actual prices will vary according to regional supply/demand balances, varying cost structures and grade variation. These prices should be used as a guide only and specific advice sought for individual forests.

Figure 14: Forestry export revenue

JAS (Japan Agricultural Standard) is a Japanese method of calculating the volume of logs, which has been widely adopted.

Export

Logs provided the largest portion (43 percent) of forestry export revenue 2016 at $2.224 billion. This is forecast to increase to $2.640 billion in 2017. Other key forestry products included sawn timber and sleepers (17 percent), pulp (14 percent), paper and paperboard (11 percent) and panels (10 percent).

Over 70 percent of New Zealand's log exports were sent to China in the 2016 calendar year. This market has been extremely volatile in the past, with import demand being driven by fluctuations in the housing market.

Domestic demand

Locally, recent sawn timber production increases have been driven by the domestic market. Increased building activity in Auckland and Canterbury has driven domestic consumption of sawn timber up 7 percent in the year to September 2016. This has affected the export market, with companies redirecting product towards the domestic construction market where possible. Growth in residential building is forecast to slow, but remain at high rates over the next five years. This means that a large proportion of sawn timber consumption will continue to be consumed in the domestic market.

3. PRODUCTION REQUIREMENTS

The best sites for growing good-quality trees are lower fertility, well-drained sites, without full

exposure to wind. Tree form will be better on moderately sheltered and somewhat shady sites, than sites exposed to full wind and sun.

Stocking rates

Typical stocking rates are around 1000 per hectare, but depending on a number of factors could range from 600–1500 seedlings per hectare. Initial stocking needs to be between two and three times the final crop stocking, to allow for adequate selection of final crop trees. A planting at 3.3 x 3.3 m spacing will give 1000 trees per hectare (1 tree per 10 square metres).

Releasing or spot-spraying is normally done a short time after planting to prevent seedlings being smothered or killed by vegetation competing for moisture and nutrients.

Pruning (for clearwood regime)

The objective of pruning is to remove the branches from the trunk when it is 10–20 cm in diameter, and then grow a thick sheath of high value knot-free clearwood around this knotty core.

Normally pruning is carried out in three lifts, but sometimes in two or four, to a final height of 6.5 m. This allows for 6.1 m pruned butt log, the maximum length commonly traded. Logs of 4–6 m long are all tradable.

A typical clearwood pruning regime is as follows:

- Age 2–3 years. Do sail pruning if toppling is a threat. (Toppling is when young trees are blown over due to a combination of heavy or wet soils and windy or exposed sites.) Removal of double leaders is optional.
- Age 3–4 years. When trees are about 5 m high, clear lift prune to a trunk diameter of about 10 cm, rather than a constant height. Leave about 2.5–3 m of green crown. Note that trunk diameter correlates strongly with the crown height above.
- Aged 4–6 years (or 8–18 months after the first lift, depending on growth rate). When the tree height is about 8 m, prune to a trunk diameter of 10–11 cm, leaving 3–4 m of green growth. Average pruned height should be about 4 m.
- Aged 6–8 years (8–18 months after second lift, depending on growth rates). Prune to a 6.5 m target height. Prune to 10–11 cm trunk diameter leaving 3–4 m of green crown.
- If necessary, return in about 12 months to prune smaller trees to 6.5 m target height.

The number of trees pruned per hectare will depend on the site, objectives and costs. Typically, 400–600 stems per hectare will be pruned on the first lift, decreasing to about 200–400 per hectare on the final lift. To ensure an adequate sheath of clearwood (15 cm), trees must be grown to a DBH (diameter at breast height – 1.4 m) of at least 55 cm and preferably to 60 cm. Fewer trees can be grown to such diameters on lower-fertility sites than on higher-fertility sites. Typically, hill country sites will not be able to grow more than 300 trees per hectare to adequate diameters.

Thinning

Thinning is the removal of trees not selected for the final crop. Do not leave unpruned trees competing with pruned trees for too long, because they may suppress them. However, thinning too early encourages excessively rapid early diameter growth of low quality juvenile wood and heavy branching of final crop trees.

Early thinning is normally to waste, but from about year ten, production thinning for roundwood and later for low-grade sawlogs may be an option on accessible sites. There are a number of factors to consider here, and it is best to discuss options with local operators.

Rotation

The desire to fell trees early for financial reasons is understandable. However, younger trees will produce a high proportion of low-quality wood, so foresters ideally should aim for rotations of around 30 years to maximise the quality of the wood.

4. INFRASTRUCTURE REQUIREMENTS

No infrastructure is required, assuming a forestry company will be managing the forest.

Nitrogen leaching: low

5. ENVIRONMENTAL ISSUES

Radiata pine is a very site-tolerant species, but limitations include:

- Wet feet and fluctuating water tables can lead to toppling and root rot. This is the most common limitation for radiata pine.
- On high fertility sites, especially high N (nitrogen) sites, trees will have poorer form, larger branches, and lower-density wood.
- Humid sheltered inland sites can have problems with fungal disease, particularly dothistroma and cyclaneusma.
- Consolidated and impervious subsoils, e.g., papa, can cause rooting problems on some skeletal hill country soils.

6. INVESTMENT AND RETURN

Investment costs will depend on a number of factors including the area to be planted, the site, the number of seedlings required, the regime undertaken (and therefore the quantity of pruning and thinning needed).

Returns will also depend on the regime undertaken, the quality of road access to the forest, the distance to the nearest sawmill or port and the market pricing at the time of harvest.

A website tool, dNITRO, has been developed, which gives a more detailed picture of investment costs and return for radiata pine. The tool was designed to provide land owners within the Lake Rotorua catchment an indication of the financial implications of changing land use to either radiata pine commercial harvesting land use, or a mānuka honey land use.

dNITRO estimates returns for growing either a mānuka or commercial pine crop to maturity using default variables, or allowing users to input values for each variable of their own choosing. dNITRO can either provide a ball park average figure for landowners, or users can develop a tailored cashflow projection based on their view of where log prices or honey prices, or a host of other variables, best sit.

Income from the potential purchase of nitrogen allowances by the Lake Rotorua Incentives Board, carbon credits and afforestation grants are included within the dNITRO analysis.

dNITRO can be found at http://www.dnitro.co.nz/

For more information on the establishment of farm woodlots, see Bay of Plenty Regional Council fact sheet 16 'Planning Farm Woodlots'.[59]

7. SOURCES/USEFUL LINKS

New Zealand Farm Forestry Association
Bay of Plenty branch
Tony van Veen
9 Taupo Ave
Mt Maunganui 3116
T: 07 575 8235
E: aval.vanveen@xtra.co.nz
Website: http://www.nzffa.org.nz/

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POTENTIAL LAND USES

APICULTURE – BEES AND HONEY

1. LAND USE OVERVIEW INFORMATION

Although not strictly a land use, apiculture or beekeeping does require land users' involvement to operate, and so has been included here.

The apiculture or beekeeping industry in New Zealand has experienced significant growth over the last 10 years, and as of April 2016 is now overseen by Apiculture New Zealand, the peak body that administers and represents the industry.

Despite a poor harvest season in the past year, and issues such as fake mānuka honey[60] affecting credibility in recent years, the industry is in a growth phase, and the aim is to grow New Zealand honey exports from $315 million in 2016 to $1.2 billion by 2028.

As of 2016, the number of registered beekeeping enterprises is 6735, a 21 percent increase from 2015 and a 106 percent increase since 2011. A third of all hives are managed by 29 enterprises.[61]

Total registered hives reached 684,046 in June 2016, an increase of 108,174 hives from the previous year, and more than double pre-varroa levels. Strong market demand for mānuka honey is driving the increase in hive numbers, with expansion led by corporate and iwi investment.

The main issues facing the apiculture industry are ongoing concerns about bee health, competition for apiary sites, and maintaining the confidence of overseas consumers and regulators in the integrity of New Zealand mānuka honey.

The recent discovery of myrtle rust in New Zealand and its potential danger to mānuka and other plants has raised a new question and will necessitate intensive research into the likely impact this will have on the mānuka honey product category.

Myrtle rust is a serious fungal disease that affects plants in the myrtle family, which includes pōhutukawa and mānuka. In early May 2017, it was found in plants at a nursery in Northland, the first detection of the disease on mainland New Zealand, and has since spread to Taranaki, Waikato and the Bay of Plenty.

2. PRODUCTS AND MARKETS

Honeybees are kept primarily for honey, pollen, propolis, beeswax, pollination services of food and seed crops, and the sale of live bees.

While honey, and particularly mānuka honey, has received most attention, demand for pollination services is increasing with ongoing expansion in several horticulture sectors including kiwifruit, pipfruit, avocados, stonefruit and blueberries.

Beekeepers benefited from a significant lift in average export prices for honey, driven by strong demand for New Zealand honey in export markets and a greater proportion being sold in retail packs, rather than in bulk. While export prices rose for New Zealand honey during 2015–2016, world honey prices fell. There are strong indications that consumers are prepared to pay a premium for New Zealand honey, putting it into a niche product category.

Top of the range UMF20+ mānuka honey retails for $260.00 for 250 g, i.e., $1,040 per kg.

The widely reported incidence of the sale of fake mānuka honey overseas has prompted the Ministry of Primary Industries to develop a scientific definition to authenticate New Zealand mānuka honey, to be introduced in 2017. This should ensure that New Zealand mānuka honey has verifiable criteria to support its premium pricing and preclude imitators from the market.

Industry performance 2015–2016

Total New Zealand honey production in 2015–2016 was 19,885 tonnes, having more than doubled in production in the past six years. The average 2015–2016 yield was 29.1 kg/hive, down from 34.2 kg/hive the previous year. Yield has ranged from 24.2 kg to 39.4 kg in the past six years.

In 2015–2016, the number of hives in New Zealand increased by 108,174 hives or 19 percent, to 684,046 hives. However, honey production only increased 0.1 percent over the year, a reflection of the lower yield.

Despite this increase in the number of hives, especially in the North Island, hive yields for 2016 in many areas were down on recent years due to a

60 http://www.telegraph.co.uk/news/health/news/10935779/Popular-with-celebrities-but-could-that-manuka-honey-in-your-cupboard-be-fake.html

61 2016 Apiculture Monitoring Programme factsheet, Ministry of Primary Industries

PRICES PAID TO BEEKEEPERS FOR THE YEAR 2015–2016

Product	2015–16 Pricing
Light and dark honey varieties	$8.00–14.50/kg
Mānuka honey	$12.00–148.00/kg depending on UMF
Beeswax light and dark	$9.00–15.00/kg
Pollen	$25.00/kg
Pollination pipfruit, stonefruit and berryfruit	$60.00–150.00/hive
Pollination kiwifruit	$130.00–400.00/hive depending on region
Live bees – bulk	$31.00–35.00 per 1kg package
Live bees – queens (local)	$35.00–60.00 per queen

range of factors including weather effects, irregular flowering of certain crops, and hive stocking issues.

South Island hives yielded better than those in the North Island, led by Canterbury, which had a particularly good season. Mānuka honey yield was quite variable across the country and even within beekeeping areas. Mānuka in Northland performed well overall, while the Coromandel had a poor season with heavy rain over the Christmas-New Year period. Later-flowering mānuka areas such as Taranaki and the central plateau also had a poor season, due to frequent rain and cooler temperatures in January and February 2016.

The value of New Zealand's pure honey exports increased by 35 percent in 2015–2016 to $315 million, driven by a lift in export prices. Bulk honey accounted for only 560 tonnes (6 percent) of export volume, down from a peak of 3799 tonnes (51 percent) in 2009 as more processors shift to retail packs.

3. PRODUCTION REQUIREMENTS

A good beekeeper understands bees, and so the first step when getting into beekeeping is research. According to the Kiwimana Beekeeping website (http://kiwimana.co.nz), simple steps to become involved in beekeeping are:

- buy a good beekeeping book, e.g., *Practical Beekeeping in New Zealand*, by Andrew Matheson and Murray Reid (Exile Publishing, 2015);
- attend a local beekeeping class, seminar or workshop;
- join a local bee club (e.g., the Rotorua Honey Bee Club, http://www.rotoruahoneybeeclub.co.nz);
- obtain some beekeeping supplies;
- get some bees;
- find a local mentor.

Hives need to be sited in a sheltered, sunny location with sufficient food sources nearby and good access for vehicles. Providing high-quality nutrition will help bee colonies resist diseases, pests and exposure to pesticides and improve pollinator security in New Zealand.[62]

Food sources often flower at different times of the year, and so the hives may need to be moved once or several times per year. Hives can be sited in remote locations if there are sufficient food sources and returns outweigh the cost of helicopter access. Some beekeepers are focusing more on maximising economic return from each hive rather than maximising honey yield per hive.

The flowering season starts in the far north first, in early November, and continues until March, moving down the country.

For businesses involved in the secondary processing of edible bee products, there is a bee products Code of Practice that sets requirements. This covers the extraction of honey and the

62 *Pollination in New Zealand*, Linda E. Newstrom-Lloyd, Landcare Research

processing, packing and storage of honey, dried pollen and other edible bee products.

4. INFRASTRUCTURE REQUIREMENTS

Minimal infrastructure is required for beekeeping:

- beehives to house the bees;
- beekeeping suits and related equipment;
- a truck to transport the hives;
- extraction equipment.

The most important asset is knowledge, hence why working with knowledgeable beekeepers while gaining experience is invaluable.

A key step when branching out is gaining permission to access landowners' properties. APINZ have Land Use Agreement templates on their website for either profit share or site rental arrangements.[63]

There is also the issue of boundary riding – the practice of beekeepers putting hives on land adjacent to a neighbour's mānuka to access the nectar. Historically there was always a protocol among beekeepers about not crowding each other's patch, however, nowadays old informal protocols are being overridden by the chase for mānuka honey. This leads to hives clustered around a good crop of mānuka, which raises problems of overstocking, bee health and biosecurity and a whole range of issues.

The onset of varroa mite has meant there is now more work required, reducing the number of hives that can be maintained by one person. While previously the maximum number of hives one beekeeper could maintain was around 800, the number has reduced to around 350 hives.

63 https://apinz.org.nz/land-use-agreement/

Technology is also bringing change to the industry. Software is being developed to assist beekeepers manage their businesses through hive monitoring equipment that can transmit information about the state of a beehive to a centralised operations centre.

5. ENVIRONMENTAL ISSUES

Nitrogen leaching: low

Changes in climate can have a large impact on honey production, increasing volatility of yields with year on year decreases of 40 percent recorded along with spectacular annual increases of over 100 percent. Therefore, beekeepers need to be prepared for volatility.

Due to the varroa mite, pesticides and a severe decline in varieties of nutritional floral resources (food) available, bees are in decline and now rely on humans to survive. Therefore, hives need to be placed near good sources of food. Although undeveloped land is often a good source of food with a range of weeds, gorse, broom, etc., the 'Trees for Bees' campaign set up in 2009 by Federated Farmers encourages farmers and others to plant bee-friendly trees to help boost the bee population.

Bee health is of vital importance to the industry. All New Zealand beekeepers are legally required to register their hives/apiaries with the National American Foulbrood Management Agency. American foulbrood disease (AFB) is a disease of honey bee larvae and pupae. It is the most serious honey bee disease in New Zealand, and its control is a major cost to beekeepers.

Unlike in most other countries, New Zealand beekeepers do not use antibiotics to control AFB (the use of drugs to control AFB is illegal under New Zealand law). Control is through managing honey bee colonies to reduce the spread of disease and the destruction of colonies that are found to have AFB.

The necessity to prevent the spread of AFB places restrictions on the way beekeepers manage their hives. When control measures fail and disease levels get out of control, AFB can result in the complete destruction of commercial beekeeping businesses.

Some New Zealand beekeepers have also shown that elimination on a national level is possible. By destroying colonies with AFB instead of using antibiotics, and using management techniques to avoid the spread of the disease to other hives, they have effectively eliminated the disease from their own businesses.[64]

Varroa mite and American foulbrood need to be reported, monitored and controlled.

Beekeepers also need to be aware of tutin, which is a neurotoxin present in tutu bushes. It is neurotoxic to mammals, including humans, but not to

64 American Foulbrood Management Agency, http://www.afb.org.nz

bees, and in certain circumstances it can make its way into honey. Human ingestion of contaminated honey can cause giddiness, exhaustion, vomiting, stupor and coma. In severe cases, death is possible.[65]

6. INVESTMENT AND RETURN

Given the range of revenue opportunities open to a beekeeper, costs and returns can vary dramatically.

Costs

The costs associated with starting an apiary will vary depending on the number of hives, and how much travel is involved, along with compliance costs, testing costs and subscriptions to industry organisations.

The cost of bee colonies increased further in 2015/16, driven by increasing returns from beekeeping. Professional valuations of beekeeping businesses placed the value of hives at up to $2,000 per hive, based on their income-generation history. Such costs would be borne by those looking to start in the industry, while established beekeepers are able to increase hive numbers by simply splitting existing stock. Beekeepers providing 'one box' hives could expect typical returns of $560–800, double the price received the previous year.

Beekeepers paid $789–1,009 per tonne dry weight for sugar in 2015/16, similar to the previous year. With higher sugar prices anticipated for 2016–17, there are increasing reports of mānuka honey producers retaining bush honey or clover honey to feed their bees, rather than using sugar for feeding bees over winter.

Beekeepers enjoyed lower fuel prices in 2015/16 compared with recent years. The average price paid for apiary site rentals rose again in 2015/16, as competition for sites increases, especially in the North Island, with 97,387 additional hives in the past season.

A full breakdown of beekeeping costs can be found in the *Apiculture Monitoring Report 2016* – Estimated Expenditure for Beekeeping Operations, 2014, 2015 and 2016.[66]

Returns

To be economic, a beekeeper requires scale. Beekeepers with more than 350 hives are considered to be commercial beekeepers. Of the 6735 beekeeping enterprises in 2016, 297 had more than 500 hives each, with 36 of those having more than 3000 hives each.

Using the pricing table outlined earlier, for 100 hives producing light or dark honey at the average yield of 29 kg/hive at say $10/kg, revenue would equate to $29,000 per year.

For the beekeeper producing the same yield of mānuka honey receiving an average of $30/kg, revenue would be $87,000.

Many beekeeping enterprises are also involved in the marketing and distribution of their own branded products, ensuring they retain a greater share of the profit margin.

7. SOURCES/USEFUL LINKS

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Rotorua Honey Bee Club
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Website: http://www.rotoruahoneybeeclub.co.nz

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65 Understanding tutin and the risks fact sheet, APINZ, Bee Products Standards Council

66 https://www.mpi.govt.nz/document-vault/16621

ECHINACEA

1. LAND USE OVERVIEW INFORMATION

Echinacea is one of the most widely known of the medicinal herbs. Originally from the prairies of North America, this crop can now be found growing in a range of countries around the world. Echinacea is known for its striking purple coneflowers and its important medicinal attributes.

Herbalists claim this plant will help with things such as the immune system (making the user more tolerant of colds), as an anti-inflammatory, and as an aid in wound healing. American Indians used echinacea to treat snake and insect bites.

Although there are nine species of echinacea, only two have been grown on a commercial basis. These are the purple coneflower (*Echinacea purpurea*) with a fibrous root, and the narrow-leafed purple coneflower (*Echinacea augustifolia*) with a tap root.

2. PRODUCTS AND MARKETS

The entire echinacea plant is medicinal and is a potent tonic for the immune system – especially when the root is dried, ground and used in high doses. However, the flowers, leaves and seeds are also healing. Echinacea is widely revered and used for its immune-stimulating, anti-bacterial and anti-viral qualities.

Echinacea enhances resistance to colds and the 'flu', and is used for septicaemia and skin complaints. It is also used as an antiseptic for burns, wounds and skin ulcers.

Echinacea is a commodity crop, so is susceptible to the rise and fall of market demand. There is export potential of a high-quality product to the main consumer markets in Europe.

3. PRODUCTION REQUIREMENTS

Planting should begin in a greenhouse, where seedlings become established. After three to five weeks, they can be moved to a plot and transplanted into a well-prepared bed. Crop establishment should take place in spring. Planting in rows 20 cm apart has been proved to be sufficient in trials held in New Zealand and Germany.

Echinacea needs at least three years to grow before root harvest, however, harvesting of leaves and flowers can begin in the first year when the plants are in full blossom, if they have been planted early enough. Leaving enough flower and leaf growth is important to developing the root system, so selective harvesting of 10–20 percent of flowers and leaves is the recommended amount.

Using transplanted plugs seems to be the best way to get an echinacea crop established. However, direct seeding is possible if good pre-sowing herbicides and stale seed beds are used. An ideal spacing seems to be around 20–30 cm between plants, giving a final density of around 10 plants per square metre.

After crop establishment, little is needed apart from water and weed control.

After planting in the spring, the crop is left to grow for the summer period. Although there are no firm rules for this, in general the following autumn the crop is cut off at ground level and these tops dried for sale. The plant then overwinters as a root before coming away in the spring. In the second autumn, the tops are cut again and dried for processing before the roots are lifted. Friable soils mean this is a relatively easy job. Dirt is washed from the roots and they are dried for sale using low-temperature driers.

For harvesting the flowers and leaves in the first season, manual cutting with a field knife will be required to ensure viability of the plant for the following season.

4. INFRASTRUCTURE REQUIREMENTS

After preparing the ground and planting, most work on an echinacea block will be done mechanically. This means requirements for a tractor, harvest machinery, bins, etc.

5. ENVIRONMENTAL ISSUES

Echinacea grows in a wide range of climates and soil types all over the world. There are no special climate requirements as the plant is fairly drought and frost resistant.

Nitrogen leaching: unknown

Echinacea grows best in full sun and well-drained loamy soil. For good yields, however, it needs a good soil type, and adequate water will ensure quality harvests. Soils with high clay content should be avoided as it makes the washing and preparation of roots for drying more difficult and could affect the quality of the root. The ideal pH level sits between 5.5 and 6. It can benefit from top-dressing fertilisers, which should be ascertained through annual soil testing during its several years of growth.

Echinacea does best if the roots are kept moist with a combination of rainfall and irrigation. Overhead watering is the best method for this crop, as it is grown on a broad acre scale. Irrigation is needed in the early stages and a consistent water supply increases growth, but once the plant has been established, it is typically drought-tolerant.

Starting with a clean seedbed is the key to success with this crop. Echinacea germination is slow, meaning weeds can easily smother the crop. Using transplant seedlings is one way to get around this problem, even though it does add to the production cost. Once established, echinacea is a competitive plant that will out-compete weeds.

No research is available for nitrogen leaching of echinacea, but it is not considered to be high. Any land use change to echinacea planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

Pests and diseases

Very few insects and diseases affect this crop.

6. INVESTMENT AND RETURN

Returns

Experience in the United States suggests echinacea plots may yield between 1.1–5.0 tonnes per hectare of dry root product after two years, and echinacea leaf may yield 1.6–1.8 tonnes per hectare after two years.[67]

It is very difficult to estimate financial returns for New Zealand-grown echinacea. The global market for echinacea in 2012 was estimated at US$320 million, although it is unclear how accurate this figure is. Growing a high-quality product, marketing off New Zealand's 'clean green' image and finding niche markets will be the key to success.

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Otago Crop Database

67 http://www.meadowsweet-herbs.com/article/echinacea-growing-harvesting-and-processing-this-useful-plant/

GINSENG

1. LAND USE OVERVIEW INFORMATION

Ginseng is a herbaceous perennial plant native to the deciduous forests of North America and Asia. Ginseng has been used as a traditional medicine in Asian and Native American cultures for many centuries. Asian ginseng and American ginseng are considered to have the best medicinal properties and are therefore the most important from an economic perspective.

Background

Ginseng use can be traced back in China for over 4000 years. One emperor named it the most potent herb known to man. It is known as a tonic and prevents conditions such as poor blood circulation, slow metabolism, poor digestion and a lack of vitality.

Ginseng use in the world today is based around two species. Asian ginseng (*Panax ginseng*) found in parts of Asia; and American ginseng (*Panax quinquefolium*) found in North America. Another medicinal product named Siberian ginseng is also available, but this is from a completely different plant. It does not have the active ingredients ginsenoside and panaxocide, that make true ginsengs useful in herbal medicine.

Ginseng can be grown a number of ways, each resulting in roots that can be sold. The only common factor is the need for shade from the sun. This plant grows naturally on the forest floor and does not tolerate bright sunlight – it seems to grow best in a light level of only 15–20 percent of normal.

2. PRODUCTS, BENEFITS AND MARKETS

Ginseng is used widely today in herbal, health food and cosmetic applications. Ginseng tonic is believed to enhance vitality, increase stamina, and help build up resistance to stress and disease.

Wild-harvested root is the most valuable of the ginseng roots, followed by roots grown in a natural forest environment, or wild-simulated ginseng, such as those grown in New Zealand. The third and most common method is growing ginseng under artificial shade structures, which results in the lowest-priced root.

Ginseng root prices vary depending on the quality of the harvested root, but for high-quality root, prices range between $1,000–2,000/kg.

Ginseng is used in health supplements using extracts of the active ingredients ginsenoside and panaxocide. Health supplements can be manufactured in New Zealand.

3. PRODUCTION REQUIREMENTS

Wild-simulated ginseng – growing, harvesting and processing

In New Zealand, wild-simulated ginseng is grown under a forest canopy, once pruning and thinning activities have been completed to allow for uninterrupted non-disturbance of the forest floor. If the forest area is divided up so a new crop area is planted each year, this allows for annual returns in successive years, following the initial crop in year seven, helping cashflow.

The following growing process has been developed by Maraeroa C, one of the larger growers of ginseng in New Zealand, who can advise on many of the details. For successful results, it is recommended to have a ginseng adviser oversee the growing and harvesting process, especially if on a large scale, to ensure the crop is well tended and the value of the crop can be maximised.

- Seed procurement and stratification or seedling procurement: Ginseng can be grown from seeds or seedlings. Seed can be planted at 15 kg of seed per hectare. Seeds need to be stratified before planting, i.e., a process of exposing seeds to a cycle of seasons over a 12-month period to improve germination rates. Seedlings can be purchased at one year or two years old, which reduces growing time by that amount. Planting seedlings may result in a greater yield because of a greater area utilised and a potentially greater survival rate. Approximately 100,000–130,000 seedlings can be planted per hectare, depending on conditions.
- Site selection – light and soil: Most commercial production of ginseng occurs in areas that experience a continental-type climate, with cold winters and dry summers. Simulated-wild ginseng grows best under a forest canopy with around

80 percent shade. Light conditions for a site can be calculated by a research organisation such as SCION. A soil test will be required to test suitability, however a sandy loam is preferable. This ensures the roots are not always wet (wet roots can lead to a range of different fungal and bacterial diseases), and it allows the roots to be easily harvested without damaging them. The optimum pH level is 5.5, so soils low in pH will require lime. Lime should be applied during the clearing stages and ideally before the soil is cultivated. A gentle slope will help facilitate the shedding of surface water. If irrigation is required during dry periods, a T-tape or drip system on the soil surface is thought to be the best.

- Site preparation: The site needs to be cleared of all weeds 12 months in advance, firstly sprayed in late summer/early autumn with a glyphosate-based chemical to kill weeds, and then after the weeds have died back, the site should be cleared to remove debris, tree thinnings and obstacles, with minimal soil and tree disturbance. The site will require at least one further cultivation/harrowing and one further spray before planting.
- Fencing: Site fencing is required to protect the plantation from predation by hares, rabbits and other browsing mammals. This entails the use of fencing and steel mesh sufficient to keep predators out. While a square layout requires less fencing, if planted in a pine tree layout, the plantation site would likely be long and thin, necessitating more fencing.
- Establishment: After planting seeds, nets need to be erected to protect from bird predation for the first two years. This can be achieved by suspending bird netting over the beds using steel posts and wire as the support structure. Following this period, the nets can be recycled onto other plantations. If planting seedlings, bird netting is not required, as the plants have passed the vulnerable stage.
- Monitoring and maintenance: Maintenance in the first season following planting is most important. Slugs and snails have the potential to cause extreme damage to plantations (though this may not be a problem in all sites and years), so slug bait may be necessary. Weeds may not be an issue due to the low-light conditions, however control of weeds in the plantation is important, either manually or through a spray programme. The periodic clearing of tree debris, including branches and windfall, will be required.
- Pest and disease management: Ginseng can be affected by fungal pathogens and other pests that affect horticultural crops. If properly established, there is reduced likelihood of pest and disease issues, though monitoring is important to keep any issues in check. The wild-simulated growing method involves minimal chemical inputs to ensure a residual-free and high-value end product. Therefore inorganic fungicides and pesticides should be used sparingly if necessary, and usage monitored.
- Harvesting: Wild-simulated ginseng root is harvested by hand, during late summer/autumn, when the ginseng plants have begun to go dormant (senesce). Harvesting correctly is a specialist task requiring the utmost care to meet the quality expectations of discerning buyers. Harvesting is by hand with simple gardening tools. Mechanical harvesting is not advisable due to the chance of damage to the ginseng root.
- Processing: Processing involves washing, grading, drying and packaging, and can be undertaken at one or several locations, depending on the location of a suitable factory. Care must be taken with washing to ensure the roots aren't damaged. Basic grading can be undertaken by packhouse staff, but further grading would need to be done by an industry professional. Low-grade ginseng would go into powder, medium-grade packaged in bulk for export, and high-grade individually packaged for sale.

4. INFRASTRUCTURE REQUIREMENTS

Infrastructure demands for ginseng aren't great, depending on the amount of post-harvest processing undertaken by the landowner or contractors. Some requirements are:

- predator-proof fencing around each site/block;
- netting structures erected over seeds for first two years;

- a packhouse/warehouse for washing, grading and drying, unless shared facilities can be accessed or a partnership with processing facility;
- seed drill if planting seeds;
- bobcat or similar for clearing work.

5. ENVIRONMENTAL ISSUES

Most environmental issues have been identified above within the growing process.

No research is available for nitrogen leaching of ginseng, however it is considered to be in the low range. Any land use change to ginseng planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

6. INVESTMENT AND RETURN

Establishment costs for a ginseng plantation is estimated to be between $30,000 and $40,000 per hectare for planting seeds. The establishment costs for planting 100,000 x 2-year seedlings is approximately $120,000 due to the seedling cost (est. $0.70) and the extra labour costs for planting.

The value of the return depends entirely on the quality of the ginseng root harvested and the amount harvested per hectare.

With 45,000 roots harvested per hectare, this roughly equates to 675 kg at $1,000–2,000 per kg.

Therefore, for seven-year-old roots that have no chemical residues and are high in ginsensoside, one hectare could return $675,000–1,300,000 in seven years.

7. SOURCES/USEFUL LINKS

Maraeroa C Incorporation
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M: 027 283 9828
E: glen.katu@maraeroac.co.nz
W: http://www.paharakeke.co.nz/

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Otago Crop Database

Nitrogen leaching: low

LAVENDER

1. LAND USE OVERVIEW INFORMATION

Regarded as one of the most sought-after herbs due to its beautiful flowers, its alluring scent and its extensive uses, lavender is a crop with a lot of commercial potential.

Believed to originate from the Mediterranean, Middle East and India, most lavender is commercially grown in the Provence region of France, which has mild winters and warm, sunny summers, which are ideal for lavender production.

While production costs are much higher in New Zealand when compared with countries like Bulgaria, which is one of the world's largest producers, New Zealand has a niche market due to our unique combination of climate and soil and resulting high-quality oil.

2. PRODUCTS AND MARKETS

World production of oil comes from a mix of three species.

- *Lavendula angustifolia* the narrow-leaved lavender. Commonly known as English lavender.
- *Lavendula latifolia* the broad-leaved lavender. Commonly known as spike lavender.
- *Lavendula intermedia* a cross between *L. angustifolia* and *L. latifolia.*

These selections are commonly known as lavandins. In general, lavandins selections are lower priced, but produce the most essential oil per kilogram of dry matter and account for about 80 percent of the oil produced worldwide. The rest tends to come from English lavender, which is priced more highly, with only a small amount from the spike lavenders.

The oil is used as a disinfectant, an antiseptic, an anti-inflammatory and for aromatherapy. An infusion of lavender is claimed to soothe and heal insect bites, sunburn and small cuts, burns and inflammatory conditions and even acne. Lavender oils are also used for internal medical conditions, including indigestion and heartburn.

Lavender oil is said to soothe headaches, migraines and motion sickness when applied to the temples. It is frequently used as an aid to sleep and relaxation. Typically sold in small 5 or 10 ml bottles, retail prices range from $2.40/10 ml ($240 per litre) for lower-quality oil up to $10–20/10 ml ($1,000–2,000 per litre).

Dried lavender flowers are used extensively as fragrant herbal filler inside sachets – to freshen linens, wardrobes and drawers. As an air spray, it is used to freshen in practically any room. Dried lavender flowers have also become popular for use at weddings as decoration, gifts and as confetti for tossing over the newlyweds.

There is a huge range of lavender varieties. It is recommended that those interested in growing lavender commercially talk with local growers with similar climates before deciding on which species to pursue. Trial plantings are recommended, to help decide which varieties best suit the property.

3. PRODUCTION REQUIREMENTS

You can expect to pay $1.50–2.50 for a lavender plant supplied in a 5-cm tube. Depending on the variety chosen, you will need to buy 6000 to 10,000 plants per hectare, depending on the variety chosen.

Once the ideal variety for the property has been selected, growing lavender is relatively straightforward. Plants are produced using semi-hardwood cuttings taken in either autumn or spring. Young plants should be placed in the field after the last spring frost. Irrigation and weed control are the two most important tasks as the crop develops.

Harvesting time will be late December/early January for the angustifolia varieties, and late January/early February for the lavandins (Grosso, Super, etc.) but can vary from region to region and from year to year as climatic conditions determine when the crop is ready.

Manual harvesting requires intensive labour, however a mechanical harvester is a significant investment and is not really justified until there is a large area to harvest. There are herb harvesters available for purchase, and some growers have made their own versions.

Some people cut by hand using sickles, hedge trimmers or serrated-edged knives (scissors and secateurs tend to become seized up from the resin in the stems). It is important not to allow the cut lavender heads to fall onto the ground – they must be kept free of other vegetable matter as this may affect

the oil when it is distilled with the lavender. Pruning of the bushes can be carried out straight after harvesting or left until there is more time available, as long as they are pruned before the first frosts set in.

It is preferable to distil on the same day as harvest, as the crop must be dry (even of dew) when harvested. It should be stored in conditions where it won't sweat. Some people store lavender in jute wool fadges or cotton duvet covers. Others spread their lavender out on the floor of a shed so that the field heat can escape, until they can get it to the still. A still can be a major capital investment, and unless you intend to be a major producer, it is probably better to get access to someone who will contract distil the crop. At present, there are several stills available throughout the North and South Islands.

The ultimate aim of most lavender growers is to make an income from oil production, and that involves marketing. Some produce oil for use in their own added-value products for sale, and some sell to brokers as a commodity.

Most modern lavender plantings are machine harvested. The plant material is ready for harvesting when approximately 80 per cent of the individual florets have opened and some are starting to senesce. The oil content in the plant is highest at this stage.

The heads are then steam distilled to extract the oil. Not many growers have their own distillation unit. Cooperatives working together can share the distilling capacity or more commonly pay a larger grower to process the plant material.

4. INFRASTRUCTURE REQUIREMENTS

After preparing the ground and planting, most work on a lavender block is done mechanically. This means requirements for a tractor, mower, spray unit, harvest machinery, bins, etc.

Larger-scale operations may require packing shed, distillation equipment, etc.

5. ENVIRONMENTAL ISSUES

Site selection is crucial. Lavender prefers a well-drained soil with a pH level of 6–8. Plants will not tolerate water-logged soil conditions. Even though lavender is a low-growing plant, shelter from the wind is advisable. This will reduce the amount of damage to the plants and subsequent disease problems. Be careful with design to allow the plants to get the maximum amount of sunshine during the growing season.

Lavender is tolerant of cold winters providing the soil is free draining. However, late frosts in November and December can cause loss of flower buds that will affect crop output. All lavender species originate in the Mediterranean areas of Europe; however with plant breeding, varieties have been developed that will grow in nearly every climate.

The expense and labour involved in weed control is frequently underestimated, and crop yields can suffer badly. Some small growers have planted into weed mat and this has proven to be an excellent option for reducing the amount of herbicides and hand-weeding needed during the season. Although it is expensive initially, it pays for itself in the long term. Weed mat will also protect the roots of the young plants from rabbits who will otherwise have a field day after the planting out.

Water is essential during the establishment phase of a lavender block. It is also necessary when the crop is developing its flower heads in the period leading up to harvest. If the crop doesn't receive irrigation or natural rainfall over this time, the oil yields can be significantly reduced.

No research is available for nitrogen leaching of lavender, but it is not considered to be high. Any land use change to lavender planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

6. INVESTMENT AND RETURN

Returns

Yields vary depending on location and variety. English lavender has been known to produce oil at about 1.0–1.5 ml of oil per kg of fresh flower (around 25 litres/ha) and lavendins have been known to produce oil at 10–25 ml per kg of fresh flower heads (around 140 litres/ha).

A wholesaling service is provided by Essential Oils of New Zealand.[68] There is also the option of developing a brand and marketing directly to the end user.

Given the estimated production figures listed above, if English lavender retails at $10 per 10ml bottle or $1,000/litre, gross revenue would be

Nitrogen leaching: unknown

68 http://www.essentialoil.co.nz/

$25,000 per hectare. For lavendins retailing at $2.40 per 10 ml bottle or $240/litre, gross revenue would be $31,600 per hectare.

7. SOURCES/USEFUL LINKS

New Zealand Lavender Growers Association researches, develops and promotes high-quality New Zealand essential oil and associated products. The association works with growers to achieve a defined standard of New Zealand lavender oil and to continue with further research projects that will benefit the industry.

http://www.lavender.org.nz/

Lavender farms can be found at:

http://www.lavender.org.nz/new-zealand-lavender-trail

'Lavender Blue', *New Zealand Geographic* (https://www.nzgeo.com/stories/lavender-blue/)

SAFFRON

1. LAND USE OVERVIEW INFORMATION

Saffron, the world's most expensive spice, has been used as a seasoning, fragrance, dye and medicine throughout history. Saffron refers to the three bright-red stigma in the male saffron flower. It is dried and used in cooking to colour, flavour and add a unique aroma to the meal. Each saffron flower produces three red stigma. They are 25–30 mm long and weigh, on average, 0.007 g combined once dried, so approximately 150 flowers are required to yield just 1 g of dried saffron. Harvesting the stigma is typically done by hand, peeling the leaves of the flower away and removing the stigma with a nail or knife. The manual labour involved in growing and harvesting saffron is one reason why it is so expensive by weight.

Background

The use of saffron as a spice is thought to have originated in the eastern Mediterranean nearly 4000 years ago. Since that time, it has maintained its position as the world's most expensive spice, worth more than its weight in gold.

Saffron is native to Mediterranean climates so prefers cold winters and warm dry weather in the summer. Therefore, in theory, saffron may seem like a marginal crop to grow in the Rotorua catchment, where some summers have a lot of rainfall. However, studies have shown that if the soil conditions are correct, it can be grown in other climates, hence its inclusion in the *Rotorua Land Use Directory*. It could be successfully grown in the parts of the catchment with the least rainfall.

Another plus for growing saffron in Rotorua is that the crop prefers cold winters and can withstand substantial frosts, which is an encouraging sign. Trials are required to ensure a crop in Rotorua can produce sufficiently high-quality saffron.

2. PRODUCTS AND MARKETS

Saffron products

Saffron threads: The highest-quality saffron (which fetches the highest price) must be picked from the flower within 48 hours, and dried quickly. It is important to dry the saffron correctly because over-drying results in a loss of colour and aroma, but insufficient drying can result in rot. Saffron is a known source of potassium, zinc and copper. Scientists are researching its potential as an antidepressant and as a treatment for Alzheimer's disease.

Saffron corms: There is potential to sell saffron corms to other growers. Wild About Saffron, located in North Canterbury, sells corms to commercial and private growers.

Saffron types

All saffron is produced from the flower of the *Crocus sativus*. There are various cultivars that give the saffron thread different characteristics in terms of colour and aroma, and these typically arise regionally due to climate, soil and other external factors.

The flowers coming from the crocus are actually sterile, meaning the only way to reproduce the corms is to use vegetative means, or by corm multiplication. They readily bulk up and small new corms are easy to divide from the parent.

Market size

There is potential to service the local market through boutique food stores, local restaurants and farmers markets, but there is also potential to export.

Export potential

There is export potential to Australia. Wild About Saffron sell their product to a buyer in Australia who has pre-ordered their entire crop. A quarter hectare of about 12,000 corms yielded one kilogram of saffron thread, which sold for between $15,000 and $20,000.

Export will put the producer in competition with countries like Iran that can produce a competitive price due to low labour rates. However, a high-quality product will fetch a higher price.

3. PRODUCTION REQUIREMENTS

Saffron comes from the flowers of the autumn crocus. This small corm flowers in the autumn, has foliage in the winter that dies off in the spring, and the corm goes through summer dormant. Corm sales begin in November and run over summer for planting in December to March. One thousand medium corms cost $2,012.50 through Wild About Saffron.[69]

69 Wild About Saffron. Figures retrieved from online store 08 March 2017 from http://www.wildaboutsaffron.co.nz/for_sale.html

Cultivation

Traditionally, saffron is grown on raised beds to allow good drainage and easy access for picking. Flower yield is highly dependent on corm density and corm size, and there is a lot of literature explaining the different corm quantities, spacing and depth methods used in various countries.

According to the Otago Crop Database, saffron beds can be planted 1 m apart with 50 corms per square metre. A density higher than that will result in the need to dig up, divide and replant the corms earlier than the typical four years, so a lower density will save a lot of work.

Corms are planted out during their dormant period in summer. Recommended planting depths for corms vary from 7.5–10 cm to 15–22 cm. Planting depth affects corm production as more buds sprout from shallow-planted corms than from deep-planted ones, resulting in more daughter corms.

Corm size has a significant effect on the production of daughter corms, the production of flowers and the yield of saffron. The larger the mother corm, the more daughter corms will be produced in the annual cycle, which increases the potential for higher yields in subsequent years.

Crop and Food research shows each original mother corm above 30 g produced an average of six new corms (in the second year), while the mother itself decayed. In the third year, the total mean corm number had risen to 22 new corms from each original mother corm, while in the fourth year that total had risen to 65.

The weight of corms produced is also affected by the weight of the original mother corm. When the original mother corm is above 30 g, the total weight of replacement corms doubles in the second season, is 10 times heavier than the original in year three, and in year four is about 16 times heavier.

New saffron corms also grow above the old ones each season, so they creep towards the soil surface by 1–2 cm each year. Therefore, the crop needs to be lifted and replanted periodically. This occurs about every four years in Spain, but fields may last up to twelve years or more under non-irrigated conditions in Kashmir. Replanting is normally done when yields begin to fall due to overcrowding or damage to corms that are too close to the soil surface.

At a Clyde crop studied by Crop and Food, large corms were planted at least 10 cm deep, while smaller corms were planted at 7–8 cm. Saffron was grown in beds with four or five rows, each 20 cm apart. Corms were planted 10 cm apart in the row. This gives a final density of 50 corms/m^2.

Fertiliser

In traditional saffron culture, large amounts of farmyard manure are applied to the saffron fields before planting, and typically 20–30 tonnes per hectare are incorporated during cultivation. This material supplies nutrients, but its other major role is to improve soil moisture-holding capacity and structure under non-irrigated conditions.

Under traditional growing systems, no further fertiliser was applied after corm planting. However, recent data suggest that at least some annual fertiliser applications are beneficial and a base dressing of 80 kg P/ha and 30 kg K/ha followed by a split application of 20 kg N/ha in autumn and again immediately after flowering is recommended.

General management

Some growers use a mulch of sawdust to cut down on the requirements for hand-weeding or the use of herbicides. Mulch is also a useful way of maintaining soil moisture.

Weed control is the main activity outside the harvest period. After about four seasons it is common for the beds to start to become crowded, and production drops. This is the time to lift the corms and divide to plant more area.

Harvesting

Harvesting saffron is an incredibly time-consuming and labour-intensive activity. Flowers are usually picked daily in the morning to catch the flower before it is open. This helps with the harvesting process. The flower is cut at the base of the flower stem with a slight twisting movement, or by cutting with the fingernail.

The flowers are then taken for processing, where they are opened by hand and the stigmas removed for drying. If this is not done immediately after harvest in the field, the flowers should be chilled.

A small domestic dehydrator set to 30°C for 24 hours will usually suffice for drying batches of stigmas. Once dried, the saffron must be carefully handled so it does not break. It is usually packaged in an airtight storage container for sale.

The drying process is extremely important to ensure a high-quality product. It should also be stored in the dark to avoid bleaching. The brightness of the saffron is an easy identifier of high-quality produce.

4. INFRASTRUCTURE REQUIREMENTS

Requirements will vary depending on the type of production. Installing raised beds, for example, will add significantly to start-up costs.

Rain or cold during the flowering season spoils the saffron, so shelter may be required. Fences may be required for pest management. Irrigation may be required if there is not enough rain during the autumn-winter-spring seasons.

After preparing the ground and planting, most work on a saffron block is done by hand. This means requirements for a spray pack and kneepads. At harvest, a dehydrator is needed to dry the crop.

5. ENVIRONMENTAL ISSUES

Climate

Saffron thrives in environments with cool to cold winters with autumn-winter-spring rainfall, and warm dry summers with very little rainfall. It can stand substantial frosts. Rain or cold weather during flowering spoils the saffron and persistent wetness and high temperatures encourage disease. If there is not enough rain in the autumn-winter-spring, irrigation may be necessary, so access to water and irrigation should be considered in the feasibility phase.

No research is available for nitrogen leaching of saffron but it is not considered to be high. Any land use change to saffron planned for the Lake Rotorua catchment would need to be modelled for nitrogen leaching.

Soil

Light, friable soils with high nutrient content are best, for example well-drained sandy or loamy soils. Saffron grows best in deep, well drained clay-calcareous soils with a loose texture that permits easy root penetration.

Pest and disease control

Rabbits, rats and birds can cause problems in saffron fields by eating or lifting corms.

Corm rot is a potential disease if conditions are moist/warm/humid in the spring and summer months, though this can be treated with anti-fungal agents.

To guard against possible fungal or bacterial diseases before planting, the corms can be dipped for five minutes in a solution of 20 g Benlate® and 10 g Captan® mixed in 10 litres of water.[70]

Wind

Even though saffron is a low-growing plant, shelter from the wind is advisable. It will reduce the amount of damage to the plants and subsequent disease problems. Be careful with design to allow the plants to get the maximum amount of sunshine during the growing season.

6. INVESTMENT AND RETURN

Yields vary depending on location and grower experience. Research done at Redbank near Clyde in the 1990s showed yields varying between 3–5 g of dried saffron per square metre of bed.

Although some small sales have been completed returning $20/g to the grower, bulk sales to commercial entities in the overseas markets are likely to be $6–8/g. Saffron grown in Kashmir is available for as little as $2/g. Quality lines will always attract higher prices.

7. SOURCES/USEFUL LINKS

Kiwi Saffron
E: info@kiwisaffron.com
W: http://www.kiwisaffron.com/

Wild About Saffron is a North Canterbury lifestyle block producer selling saffron corms commercially.

http://www.wildaboutsaffron.co.nz/

Growing Saffron – the world's most expensive spice Crop & Food Research August 2003 (http://www.boobookhill.com/Kiwi%20Saffron.pdf)

Morrell, N. (2013, November 27). 'Growing saffron: troubleshooting problems', *The Rural* (http://www.therural.co.nz/horticulture/growingsaffrontroubleshootingproblems)

70 Crop & Food Research, (2003). *Growing saffron – the world's most expensive spice*. Crop & Food Research [Broadsheet] Number 20, August 2003. Retrieved 7th March 2017.

Nitrogen leaching: unknown

APPENDIX – CROP PROTECTION

SHELTERBELTS

Below is a brief excerpt from the Bay of Plenty Regional Council fact sheet no. 17 'Farm Shelterbelts'[71] explaining the principles of shelter and aspects that should be taken into account when designing shelter on a property.

Talk to your local nursery staff for more information on which tree species are suited to your area.

INTRODUCTION

Wind erosion occurs on bare ground when soil particles are detached and transported by wind. Bare ground can occur through soil erosion, earthworks, overgrazing and soil compaction or cultivation.

In the Bay of Plenty, potential for wind erosion exists in most coastal zones as well as on exposed ash soils inland. To minimise wind erosion potential, especially where cultivation is being practised, the use of suitable shelter belts is recommended.

Shelter can also enhance farm productivity in a number of ways. Pasture growth may be increased by up to 60 percent on exposed sites, and crop yields can be increased by up to 25 percent. Animal health also benefits, with fewer lambing losses or lost live weight gain in other stock. Research has shown that heifers in sheltered paddocks have 34 percent more live weight gain than those in exposed paddocks on the same feed budget.

Milk production can also suffer when dairy stock are held in exposed conditions – not because of physical stress but because of disruption in grazing patterns (e.g., stock mobbing up for warmth).

SELECTING SHELTER SPECIES

Choosing which species to plant will depend on a number of factors. Shelter belts work by filtering and slowing down wind rather than simply stopping it. Shelter belts should have a porosity of 40–50 percent, which will give a wind speed reduction of 50 percent on the leeward side, over a distance equivalent to eight times the height of the shelter belt. Shelter belts should be placed at intervals of six to ten times the height of each belt for maximum effect. This guideline is readily applied in flat terrain, but other factors need to be considered in hill country.

There are also aesthetic and management objectives to consider. Ideally, shelter belts should be laid out to complement natural landscape values and should use suitable species. At the same time, practical objectives such as seasonal shelter (e.g., for lambing), maximum width of shelter belt, timber potential and bee fodder or wildlife habitat can be incorporated in the design of shelter belts.

Deciduous species can be used to reduce winter shading.

Site conditions also have a major influence on choice of species. Wet or dry soils and exposure to frosts or salt spray can limit which species may be used on particular sites.

ESTABLISHMENT

Good weed and pest control is vital for plant establishment.

Ensure fences are completely stock proof and at least two metres away from plantings. Herbicides give good weed control, but be careful around small seedlings or unrooted material such as poplar stakes. If planting this sort of material, do not use residual herbicides until plants are well established. Fertilisers may be used to aid establishment but should be used sparingly.

Excessive use can harm plants and heavy feeding can lead to wind damage of soft tender growth. Rather than plant a species that is going to be fertiliser-dependent under particular site conditions, select material that is well adapted to the site type. Check with the local Environment Bay of Plenty Soil Conservator, and see Sustainable Options LM15: Establishment Techniques for Revegetation Projects for more information.

SHELTERBELT LAYOUT

For farm shelter belts, most species should be planted at around four-metre intervals. For horticultural

71 https://www.boprc.govt.nz/media/100489/no_17_farm_shelterbelts.pdf

shelter, plant more closely (two to three metres) and side trim regularly.

Shelter belts should be as near as possible at 90° to the prevailing wind direction, and should be as long as possible with no gaps.

Wind velocity can increase by up to 25 per cent when passing through gaps or around the ends of the shelter belt. Physical restrictions also need to be accommodated, such as power lines, irrigation and drainage systems, roads or boundary lines.

GREENHOUSES

The *Rotorua Land Use Directory* does not include crops grown in greenhouses or hydroponic systems but rather focuses on land uses that are viable in the Rotorua climate without artificial support.

However, greenhouses are a useful way to expand production into crops that are otherwise not viable in the Rotorua climate.

Below is an informative article on domestic greenhouses, 'Why use a Greenhouse', by Michelle Herrick, an owner and director of Winter Gardenz, an Auckland-based manufacturer of greenhouses and glasshouses.

Why use a greenhouse?

You might think this is a simple question, but there is more to a greenhouse than you think. There are three main reasons for using a greenhouse:

1. Protection – greenhouses offer warmth and insulation, protecting your precious plants from the harsh elements such as frost, snow, wind and hail.
2. Wider crop variety – growing in a controlled environment such as a greenhouse means you can effectively cultivate a much wider variety of plants than you would normally be able to grow outside.
3. Extended growing season – because of the warmth and protection, you can start growing produce much earlier and (depending on your circumstances) grow right through winter compared to outside, thus extending your growing season into the cooler months.

A greenhouse can look great, add value to your home and offers a warm place in which to potter about on a rainy day.

What type of greenhouse is most suitable?

Years ago, most greenhouses were ugly structures at the end of the garden. Nowadays there are plenty of attractive models available, allowing the greenhouse to become a feature in its own right. Some important things to think about are:

- Size. How much do you intend to grow? How much space do you have available for your greenhouse? Is it just for seedlings or for year-round growing? From my experience, people often wish they had a bigger greenhouse. Somehow they always fill up!
- Shape: Long, short, tall? What is the shape of your available site? Will you need a permit from the council? Most councils allow a 10 m^2 structure on a site before a permit is required, but it's always a good idea to check with them first.
- Quality and construction. What is it made from? How long will it last? Generally, people have a good idea of what they are after, but do your research.
- Budget. How much am I prepared to pay for a greenhouse? There are plenty of cheap imported greenhouses available, but often these aren't designed for New Zealand's harsh conditions. You generally get what you pay for, so if you want a greenhouse to last, it's worth spending a little more to get a good one.
- Site conditions. Do you need a greenhouse which is frost proof, snow proof, strong enough to handle the wind? If you live in an exposed area you really need to consider how you are going to shelter the greenhouse and fix it to the ground.
- Personal circumstances. Can you take it with you if you move house? Is it safe for young children? Can you move it round the site to grow directly into fresh soil? These are all factors worth considering, depending on your own circumstances.

Glasshouses vs polycarbonate greenhouses vs poly/plastic tunnel houses

This is a hot topic. Each material has its own advantages and disadvantages.

Glass is the oldest traditional glazing for greenhouses, and if the glass doesn't shatter or smash, it can last for years. However, it doesn't offer much insulation and tends to let the frosts through in winter. Plants can also burn from the direct sunlight in summer, although you can get shade covers to go over the greenhouse, or alternatively paint the greenhouse white to reduce this effect. It's not the cheapest glazing, and replacing panes can be costly.

Polycarbonate (twinwall) glazing provides better insulation and is significantly stronger than glass, which means less breakages. A range of thicknesses is available, but you really need 6 mm, 8 mm or 10 mm to gain any form of insulation benefit. This effectively works like double glazing, with an air gap between the two layers that helps keep the warmth in and the cold out. It's easier and safer to work with than glass, and is also safe around children, pets and farm animals. It's almost unbreakable and easy to replace.

The polycarbonate has to be UV treated to last in direct sunlight. Good-quality polycarbonate usually lasts approximately 15–25 years under the New Zealand sun. Low-quality, cheaper polycarbonate tends to only last around 3–5 years, so check the manufacturer's warranty if you're not sure.

The single layer, flexible poly/plastic films that are often found on tunnel houses insulate a bit better than glass and are safer to work with. This is also usually the cheapest option in terms of $/$m^2$ however, bear in mind that poly/plastic film doesn't last long compared to glass or polycarbonate glazing and needs replacing every 3–5 years, so although these are cheaper, they might cost you more in the long run.

Greenhouse position

There are a few important facts to consider when choosing a site for your greenhouse.

- Sun or lack of sun, including shadows. This makes a big impact on the success of your growing, so try to ensure your greenhouse will be in sun during winter's short days to maximize your year-round growing potential.
- Slope/drainage. The site must be reasonably level, and drainage is also important to ensure you don't end up with a heated swimming pool!
- Water. Even if you plan on using a watering system, you will still need to have a hose or water supply in close proximity to provide water for the plants in your greenhouse. If your greenhouse has a gutter system, it's a great idea to collect the water off the roof and channel it into a water tank or water butt.
- Power. Do you plan on using lighting or heating in your greenhouse in winter?
- Wind. Consider where you plan on situating the greenhouse. How exposed is the site? If it's gusty, consider building a windbreak on the prevailing

side to protect your greenhouse. These can usually be easily constructed with a few fence posts and either wind break cloth, or possibly trellis. Once constructed this also creates a great place to grow beans or other climbing plants.

Greenhouse layout

The traditional method of growing in a greenhouse is to plant straight into the soil, which is fine – it gives you maximum height for growing. However, your soil will be slightly cooler than if you grow in bags or tubs. You'll need to dig over the soil thoroughly and also rotate your crops. If you opt for growing in a ground bed, try to build a mini raised bed, confining the soil with timber or blocks.

Most people find it easier to use bags, pots or tubs to grow in. It means you can move the plants around and it keeps the soil slightly warmer. You can also easily dump the used soil into the compost heap to rejuvenate it at the end of each season. Or you could use a combination of both, i.e., a ground bed down one side and bags/pots on the other.

Shelving

The easiest way to maximise growing area and space is by utilising shelving. There are plenty of options available, including hanging shelving, potting benches, staging, etc. You could build your own or you can use an old workbench. Just keep in mind that the material you use needs to be able to survive in the greenhouse environment. Hanging shelving is ideal for keeping the floor area clear and suits lightweight seedling trays, small potted plants, etc. and can be positioned high on the back or side walls where it's warmest. Potting benches are great as they can be placed anywhere in the greenhouse and are generally able to hold heavy pots and bags. Whatever you use, ensure it has the ability for air to flow through the shelving, reducing the risk of mould and fungi.

Seedlings and propagation

Growing seedlings in a greenhouse is easy. It's an ideal warm environment. Standard seed trays are the easiest to use, but you could simply use egg cartons or similar. If you are starting the seeds in the greenhouse and then planning on moving them outside once established, then it's often recommended to 'harden off' your young plants as a sort of transitional period between the two environments, which helps the plants to adjust to the outdoor conditions.

If you are growing produce that is to be fully grown in the greenhouse, you can plant the seeds straight into the bags/pots without any trouble. As

with all seedlings, be sure to label and date the plants. If you have a great-tasting variety of tomato, try and save those seeds for next season. Simply place the seeds on a paper towel and leave to dry on a windowsill. There are websites dedicated to 'Seed Saving and Swapping'!

Full-sized plants

Growing full-sized plants, such as tomatoes, beans, etc., is pretty straightforward. Be sure to stake your plants as you would outside. Remove any unnecessary foliage to ensure adequate air movement around the plants and keep the plants well supported. Often greenhouses have 'hanging clips or brackets' which you can clip/screw onto any upright wall and then create vertical string lines. Ideal for beans, peas, etc.

Heating and insulating?

The best thing about heating a greenhouse is that you don't need to do very much to make a big difference! A couple of degrees is all it takes to enable you to grow a much wider range of plants and start those seedlings earlier in the season. There are two main points to consider.

- Heating. You really need to think about how much you want to invest in heating. Heat pads will do the trick. A couple of other alternatives are big concrete pavers. These work by soaking up the sun's energy during the day and letting the warmth out at night. A big black barrel of water will do the same trick as well as keep the water warm for your plants.
- Insulation. This is about retaining the heat in your greenhouse while the sun is shining, and holding onto the warmth when the sun has gone. If your greenhouse has twin-wall glazing you'll find it already insulates well. If you have glass you'll need to be a little more creative. You just need to remember to keep the doors and windows closed after about 3 pm in winter, to keep that warmth trapped inside as long as possible.

Ventilation and shade

Ventilation and shade are more important in summer. You could go all out and install electric fans, but really you just need to be sure that your greenhouse has enough vents and door openings to allow adequate airflow. The general rule of thumb is 20 percent of the floor area should be reflected in ventilation, i.e., a 10 m^2 greenhouse should have approximately 2 m^2 of ventilation – preferably spread throughout the greenhouse to promote the through flow of fresh air. Roof vents are common, and louvre vents in the walls also promote good airflow. Remember to leave enough space between your plants so they can breathe, especially tomatoes.

As for shade, an easy method of blocking the sun's strong rays from your greenhouse is by using a shade cover system. These can easily be constructed by anyone with the right DIY skills, or alternatively some greenhouse manufacturers sell shade cover systems to fit their range of greenhouses. You might not need to do this if you have a polycarbonate or plastic film greenhouse, as these synthetic glazing materials are not as clear as glass and do a better job at diffusing the harsh sunlight. That said, in winter you'll need as much sunlight as possible to get the greenhouse warm enough.

Watering

Obviously the plants in your greenhouse won't be watered with each rainfall, as your outdoor plants will be, which can be good and bad. Good – you can control how often you water your plants and with what. You might decide to feed your plants nutrients, liquid fertilizer and the likes as a part of their routine watering cycle. Bad – as you need to remember to water them every other day or set up some sort of automated watering system on a timer. I use a big black barrel in the greenhouse and fill that with water and nutrients once a week, then water the plants with a watering can daily when I check my plants. The upside to this is that the barrel heats up and warms the water slightly, which seedlings seem to prefer.

Water storage

If you live rurally on tank water, you'll understand the need to catch every precious drop of water, especially with a greenhouse full of plants that require watering daily. The old water butt is a great method for storing rainwater from the roof. It's a fairly simple device, an old barrel or drum and a length of pipe or chain to let the water run down. Nowadays most greenhouses have a gutter system to aid in water collecting. Either

way, unless you have an endless supply of fresh water you'll want to collect rainwater for your plants.

Hydroponics

I've seen amazing results with hydroponic growing in greenhouses. It can be a little bit of trial and error when getting started, but the results are well worth it. When setting up your hydroponic greenhouse, it's best to dedicate the full greenhouse to hydroponic growing as it's not good mixing soil and hydroponics in the same area. Use shelving and brackets to make the most of your growing space.

Pest control

Just like in the rest of your garden, pests can be a problem. Eliminating the pests is up to you, whether you choose to go organic or not. There are sticky bug strips available, which are easy to use and spray-free. Otherwise talk to your local garden shop for further information on specific pests. Be sure to tell them you're growing in a greenhouse.

Common problems

- Mould. Generally fixed by creating better airflow.
- Weeds. Just like in an outdoor garden, weeds thrive in a greenhouse.
- Overheating. Again down to creating better ventilation.
- No pollination. This is best resolved by hanging a colourful flower basket near the entrance, to entice the bees inside.
- Space. Always my problem! No matter how much space I have I always seem to fill it with more and more plants!

What grows well in a greenhouse?

Tomatoes, chillies, capsicum, eggplants, beans, peas, zucchini, herbs, lettuce … and that's just the edibles! Many orchid, bromeliads and cacti growers use a greenhouse with fantastic results.[72]

72 This article was written by Michelle Herrick, owner and director of Winter Gardenz, also a very keen greenhouse grower!

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