Northland Hill Country & The Implications of Change for Landowners

Kellogg Rural Leadership Programme

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Disclaimer

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Authors Foreword

I have been fortunate in my current role as a farm consultant in Northland, and my previous role as a rural banker, that it has given me an appreciation of the varying pressure's a farmer faces, from broken fences and lame stock, to staffing issues and financial woes. This doesn't go unnoticed, so thank you for your contribution to the nation and the hard mahi you undertake on a daily basis.

These roles have also given me visibility across a wide range of businesses, being fortunate enough to see some incredibly talented and highly profitable farms along the way. The one common denominator that is most apparent to me, is the human capital-value of people. You need to invest in yourself, and you need to invest in the people involved within your business.

I have personal views on 'carbon farming' (large-scale plant and walk away pine planting) and I have consciously and quite deliberately not addressed 'carbon farming' as an opportunity within this project.

Executive Summary

A significant challenge presented in the 21st century, will be meeting the food needs of an exponentially increasing world population, and ensuring agriculture implements the principles of sustainable development.

There is evidence to suggest, observed from environmental research such as the Climate Change Councils' report (*A low emissions future for Aotearoa, 2021*), that agriculture contributes to environmental concerns, such as water quality and greenhouse gas emissions. This has been met with fierce resistance from agricultural lobbyist groups such as, '*Groundswell Aotearoa'* and '*50-Shades of Green*' whom promote the significant role that agriculture plays in supporting the growing demand for world food and concurrently highlighting agriculture's significant economic and socio-economic contribution to Aotearoa, achieved through domestic and export revenue from meat, fibre and milk, in addition to the significant employment opportunities generated through these primary industry supply chains. What if, there was a way we could achieve both essential objectives?

This project explores the evolving landscape of Northland hill country farming, highlighting the current position of Northland hill country sheep and beef farming, the significant uptake of forestry competing with the sheep and beef industry for land-use on these hills, and the opportunity for integration of these industries to collaborate in meeting both our environmental, economic, and socio-economic objectives. The implication for landowners, is that the decisions we make today, will not only initiate short-term change, but may also present long-term and inter-generational implications that necessitate a need for holistic and well-informed decision-making process'.

Through my research project, it has highlighted:

- The need for hill country landowners to understand their whole farm system, including specific strengths and limitations of land, the relative profitability of all land classes on their property, and the logistical role each hectare of land plays within the business.

- Integrating indigenous and exotic forestry regimes on hill country can provide improved financial resilience, profitability, and environmental benefits with well-planned and well-executed management advice.

- Understanding your resources and the relative profitability of various land classes provides economic insight, however a need for more holistic considerations such as environmental and socio-economic implications should be adopted.

- Hill Country Farmers are going to have to continue to adapt their farming operations and become more financially and environmentally resilient through a multi-faceted continual improvement process in productivity, achieved though decisions such as genetic merit of livestock and stock classes, as well as adaptation to policy

implementation and awareness of their environmental obligations under Kaitiakitanga.

My recommendations to hill country landowners are:

- It is imperative that any landowner considering land-use change engage industry expert advice to understand what the implications of land-use change decision may present to their business to encompass; financial, environmental, logistical, and socio-economic implications of change.

- Hill Country Farmers must continue to adapt and become more financially and environmentally resilient through continuous improvement in productivity achieved with improvements in areas such as the genetic merit of livestock, stock class & policies, as well as adaptation to policy implementation and awareness of their environmental footprint.

Contents

1 Introduction

Recently, the increasing competition for land use on Northland Hill Country sheep and beef farms has primarily been driven from forestry, incentivised by external policy pricing mechanisms, such as the Emissions Trading Scheme (ETS) and the financial carrot-dangling incentives from carbon trading. This has tested the waters for many landowners, with social stigmatism and judgment from selling to forestry being well documented through media.

The decision process for individuals regarding land use change can be summarised by Journeaux et. al, 2017 who report's that; land use change is driven by three key drivers, these are:

1. **Productive value** – the value relative to the rent or profits, obtainable from the land.
2. **Consumptive value** – this includes amenity factors such as recreational opportunities and scenery, plus intangibles such as a rural setting is a nice place to live, a great place to bring up kids, you're your own boss, and farming is a great lifestyle.
3. **Speculative value** – the ability of an asset to retain its value/the return on the asset as an investment.

With these drivers in mind, through this project, I seek to understand:

What is the current position of Northland hill country sheep and beef farming? What is driving land-use change, and what are the implications a landowner needs to consider for an integrated afforestation regime on a sheep and beef farm?

New Zealand has a goal of becoming carbon neutral by 2050 (*Zero Carbon Act, 2019*). To help achieve this goal, modelling undertaken by the Productivity Commission (Dorner, et al., 2018), indicates that land-use change, particularly the conversion of sheep and beef land into forestry, is likely to be a key-way New Zealand can achieve low-emissions targets by 2050. However, contrary to this, the Climate Council Change Commission (CCC) has raised concerns that the ETS over-incentivises forestry offsets and doesn't do enough to encourage actual reductions in emissions. The commission stated that 'the current NZ ETS settings may incentivise more large-scale pine plantations than is desired to meet 2050 targets and could lead to forestry displacing gross emissions reductions, in addition to a reduction in food production and socio-economic implications.

The implications of change, understanding your resources, knowing what opportunities there are for change, and the implications of the change are intrinsically linked to one another. Therefore, they need to be explored by landowners before implementing change.

2 Aim of the Project

The broad aim of the project was ascertaining a better understanding of the current position of Northland hill country farmers and the implications associated with land use change in Northland. The more focused aim of the project was to answer my project question:

What is the current position of Northland hill country sheep and beef farming? What is driving land use change? And what are the implications a landowner needs to consider for an integrated afforestation regime on a sheep and beef farm?'

3 Objective Of the Project

The objective of the project is to provide a macro-focused and thought-provoking decision support tool for landowners to encourage a long-term and rationalised philosophy when looking at a land-use change in the hill country of Northland. The report explores the potential implications that the decisions we make today, will have in the future. The genesis of the project was motivated by discussions with farmers, repeatedly hearing:

"*What are the best options for my land?"*

"What is the most profitable use of our land?"

"I know forestry is a good option, but how does it impact our whole farm system?".

The target objectives of the project will be achieved, if a landowner comes away from reading this report with a more holistic view of their farming operation and the implications associated when looking at integration of afforestation as an opportunity for their farm.

4 Methodology

The methodology for this report comprises three elements. These are:

1. A literature review of relevant policy and publications.
2. Engage with farming and forestry industry experts for opinion.
3. Reviews of previous case-studies undertaken that provide relevance to this project.

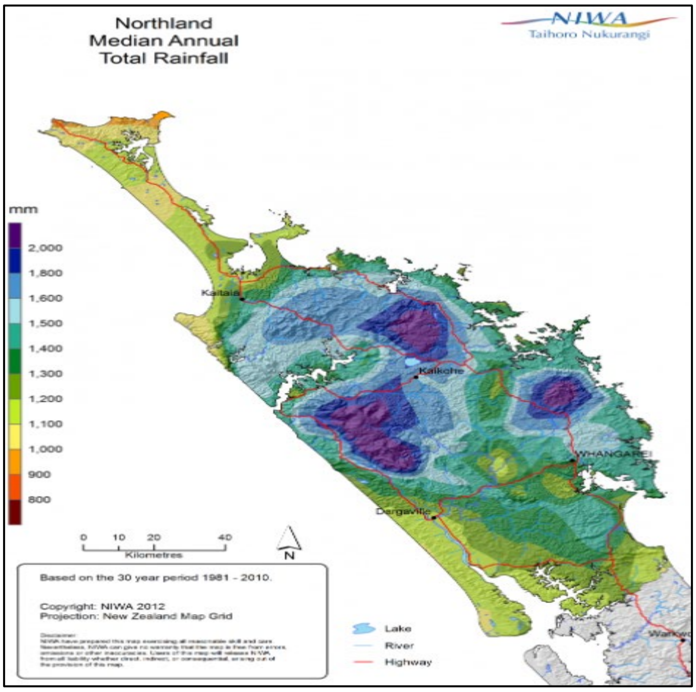
The format for these three elements are amalgamated and present themselves throughout the report.

5 Snapshot of Northland

In order to provide context to the broader report, the following sections will incorporate a high-level overview pertaining to; geography, economy, and existing land use and capability within the Northland region.

5.1 Geography & Climate

(Figure 1: Regional Location Map of Northland)

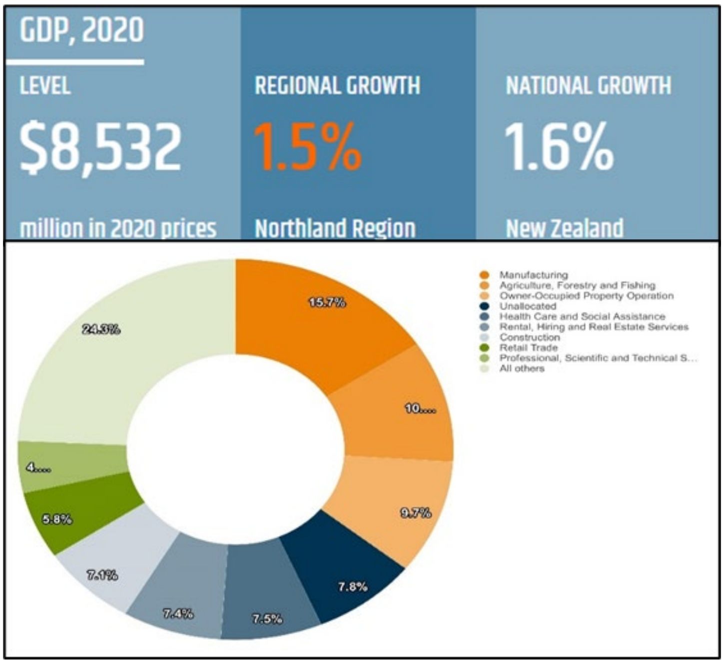


(Figure 2: Distribution of Rainfall, NIWA 2021)

Northland encompasses an area of 13,940 km2, a little over five percent of the country's total area (*Statistics NZ, 2021),* beginning from the narrowest point of the peninsula, just a little north of the town of Wellsford *(figure 1)* and extending as far as the tip of the North Island, Cape Reinga *(Northland Regional Council, 2021).* At the last census, Northland was home to 195,000 people. Approximately 50% reside in the region's largest city of Whangarei, and approximately one-third of Northland's total population identify as Māori *(Statistics NZ, 2021).*

Northland presents large variability in its sub-tropical climate and boasts the highest average annual temperature in New Zealand, ranging from 13 degrees in the winter to 26 degrees in the summer *(Northland District Health Board, 2021).* Typical annual rainfall can range from 1500 – 2000mm. However, the distribution of this rainfall is disproportionate across the wider region *(NIWA, 2021),* as depicted in *figure 2.* This can specifically dictate a preference for some land uses and stock policies, such as a higher proportion of autumn calving dairy cows in the far north, as it dries over summer on the sandy soils.

5.2 Economy Snapshot



(Figure 3: Northland GDP Statistics, 2020)

In 2020, Northland's Gross Domestic Product (GDP) was $8.553 million and represented approximately 2.6% of the National Total GDP *(Stats NZ, 2021)*. Manufacturing represents the highest contribution, most of which is from NZ's only oil refinery, located at Marsden Point. This is a crucial point in the supply chain for export products from Northland. Collectively, agriculture, forestry, and fishing are the second-largest contributors to Northland's GDP. Dairy Farming contributes $319 million or 3.7%, Sheep & Beef Farming $178 million or 2.1%, and Forestry $147 million or 1.7% of the Northland's Total GDP *(Stats NZ, 2021*

5.3 Land Use Capability in Northland

The land use capability (LUC) classification is a system of arranging different kinds of land according to its capacity to support long-term sustained production after considering the physical limitations of the land.

Figure 4: Land Use Capability Guide

Increasing limitations to use ↓

LUC Class	Arable cropping suitability†	Pastoral grazing suitability	Production forestry suitability	General suitability
1	High	High	High	Multiple use land
2	↓	↓	↓	
3				
4	Low			
5	Unsuitable			Pastoral or forestry land
6				
7		Low	Low	
8		Unsuitable	Unsuitable	Conservation land

Decreasing versatility of use ↓

There are eight broad land classes under the system, along with several more detailed sub-classes and units. For example, class 1 land is considered the most versatile and productive in conventional agriculture, horticulture, and forestry whereas class 8 land has such limitations that it is considered incapable of productive use (Northland Regional Council, 2021). The below figure shows a summary of the suitability of LUC classes for different uses.

There are four physical limitations recognised in the LUC subclasses, which are:

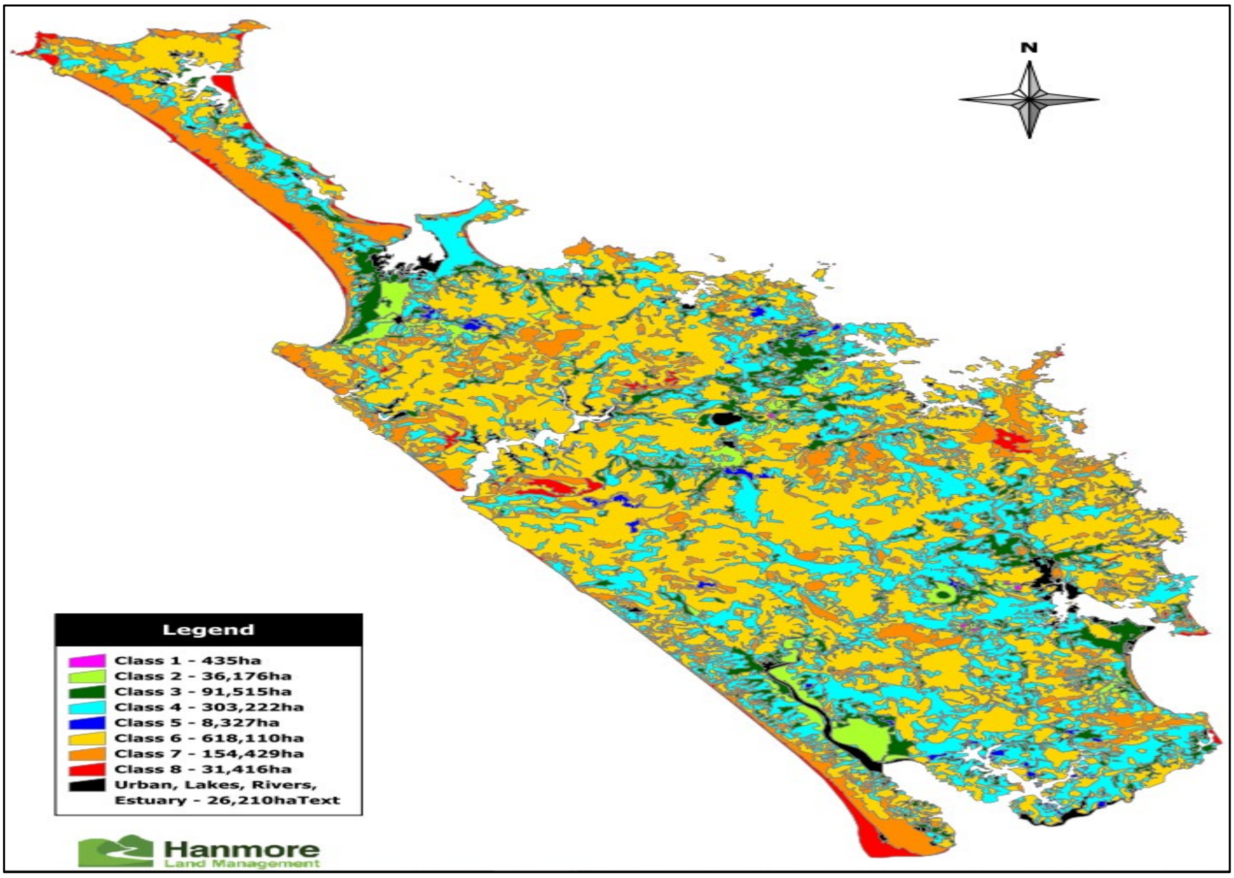
Erodibility 'e' – where susceptibility to erosion is the dominant limitation.

Wetness 'w' – where a high-water table, slow internal drainage, difficulty/high cost to drainage required, and flooding constitutes the dominant limitation.

Soil 's' – where the dominant limitation is within the rooting zone. This can be due to shallow soil profiles, subsurface pans, stoniness, rock outcrops, low soil water holding capacity, low fertility, salinity, or toxicity.

Climate 'c' – where the climate is the dominant limitation. This can be summer drought, excessive rainfall, unseasonal or frequent frost and/or snow, and strong winds or salt spray exposure.

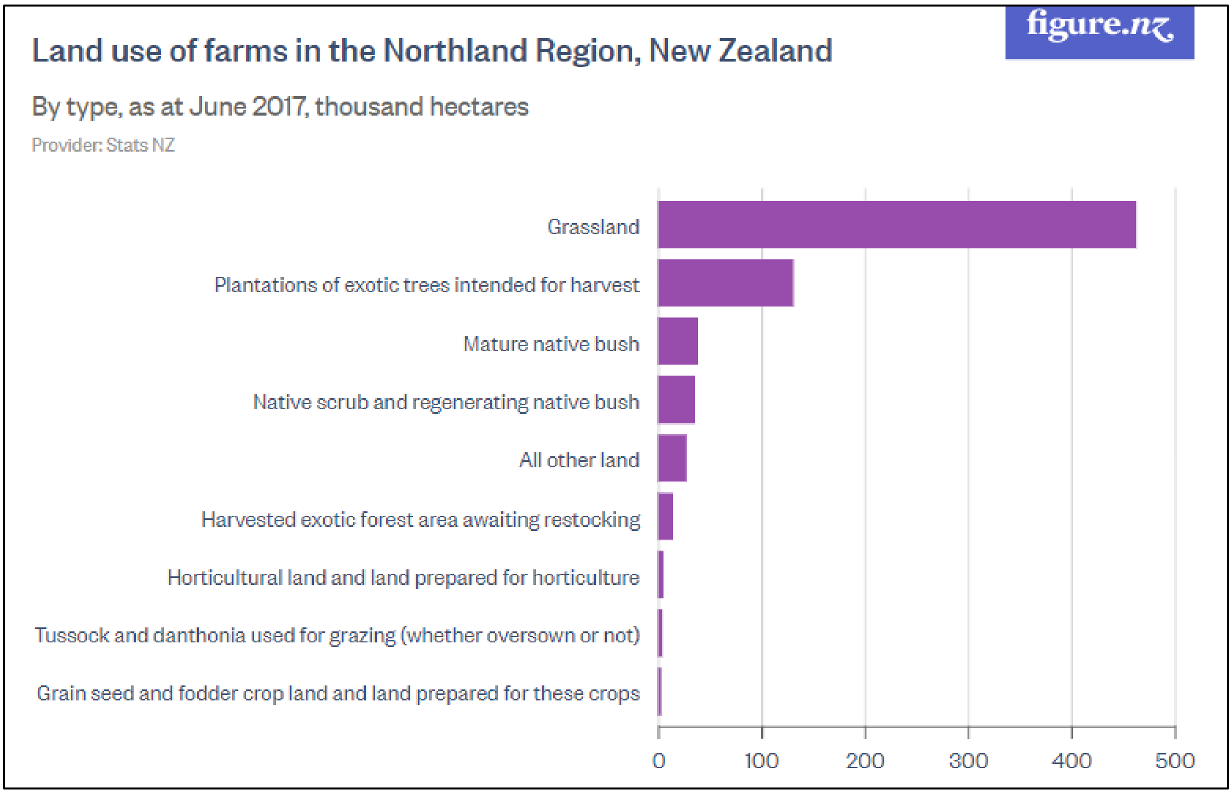
Figure 5: Northland Land Use Capability Map



5.4 Soils, Existing Land Use and Land-Use Change

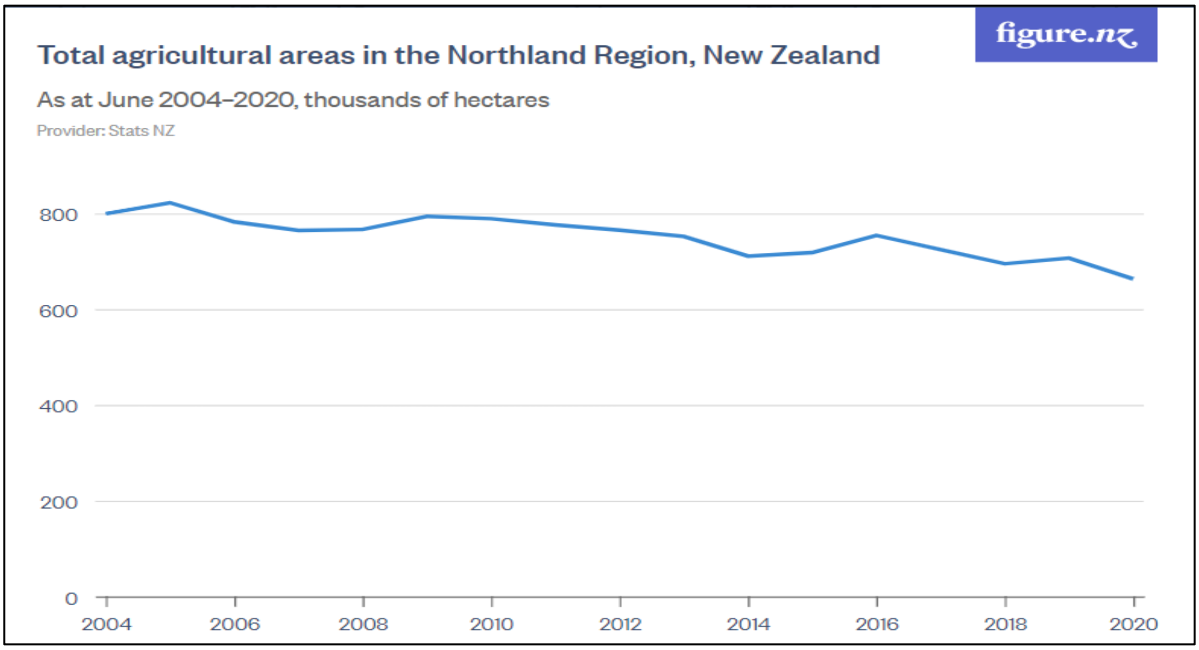
Northland has a unique climate in comparison to the rest of the country, from sub-tropical flat sandy-loams in the Far North (Kaitaia – North) to heavy clay and peat soils with rolling to medium-steep topography in the lower region near Wellsford. There are 29 parent soil suites identified in Northland (*Cox et al*. *1983*) which makes it attractive for a variety of land-uses, from farming to horticulture. Representative areas in each of these land uses are found below:

Figure 6: Existing Land Use in Northland



As at 2017, the dominant land use remains as pastoral production at 462,960 hectares comprising farming (dairy, sheep, beef, deer). Exotic plantation trees are the second-highest use of the landscape at 187,500 hectares. Mature bush comprises 38,832 hectares, re-generating bush 39,966 hectares, and horticultural land comprises 5,285 hectares. The implication is that this versatility of land in Northland has seen a decline in the total area used for agriculture. This is depicted below by Statistics NZ:

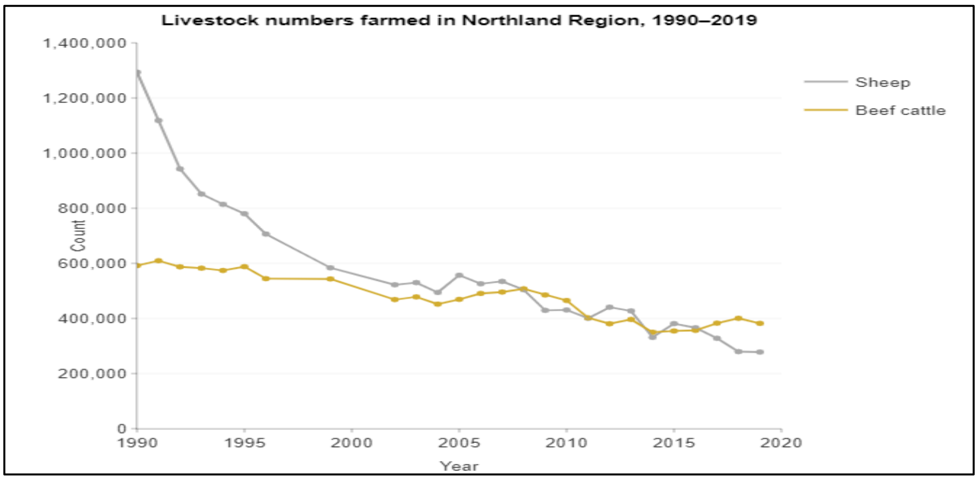
Figure 7: Agricultural Land Use Area in Northland 2004-2020



The land used for agricultural/pastoral farming has rapidly declined, reducing from 789,169 hectares in 2010 to 663,375 hectares in 2020, a reduction of 125,794 hectares over ten years. Contributing factors in this reduction are seen by rapid expansions of horticulture, forestry, plantation and re-generating scrub, and urban growth in Northland.

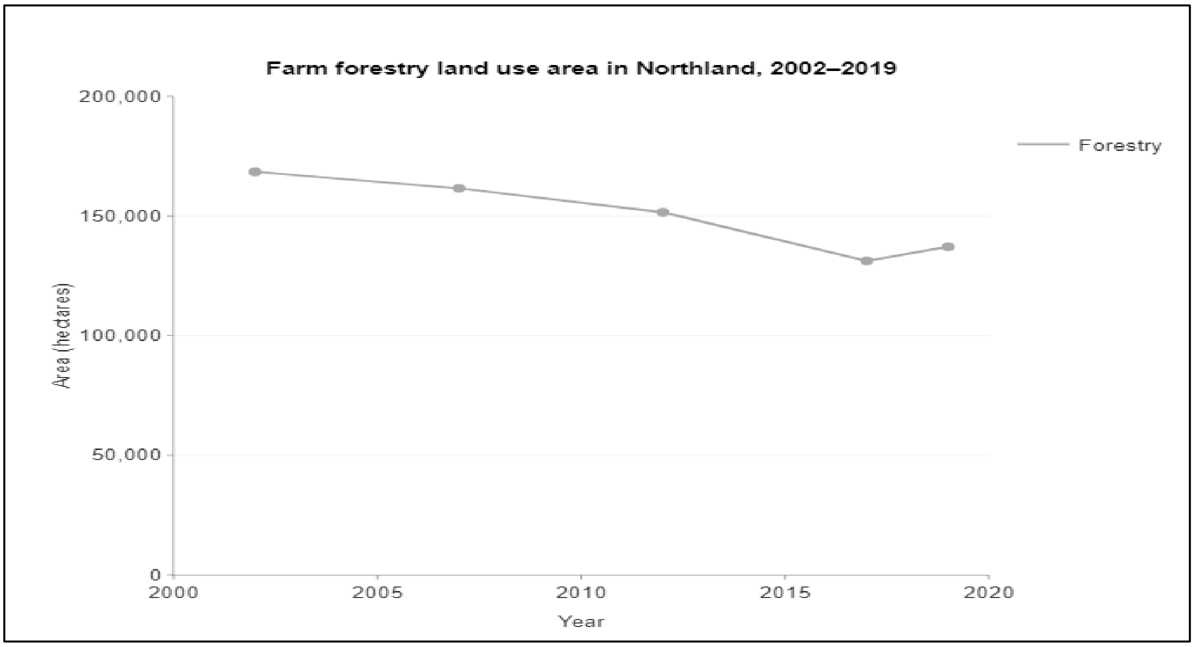
The below graph of sheep and beef livestock numbers in Northland in July 2021, validates the trend observed in the reduction of total agricultural area in the Statistics NZ analysis *(figure 7)*. This decline reflects the changing landscape of Northland, accommodating less sheep and beef livestock to the lowest point observed in over a 30-year period. The driver of this change has largely been driven by competition for land use.

Figure 8: Sheep & Cattle Livestock Numbers in Northland 1990-2019



To validate this competition for land use from forestry on the hills of Northland, the observed trend in forestry land use can be seen below.

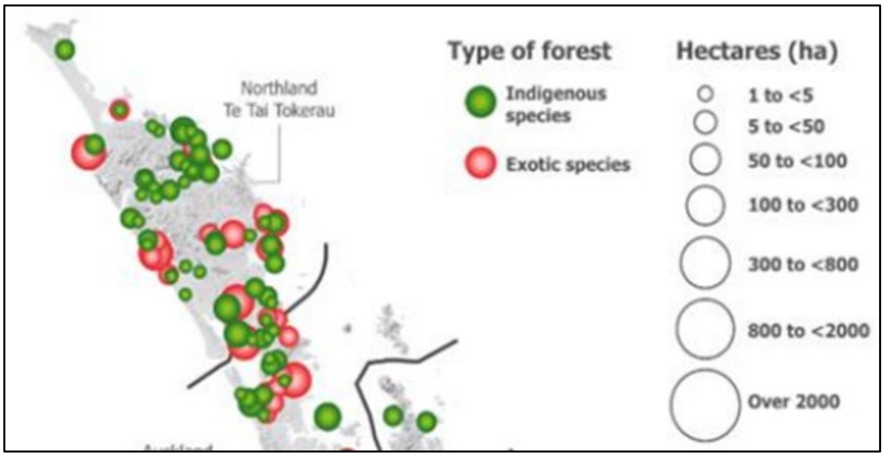
Figure 9: Northland Farm Foresty Land Use 2002-2019



The land area occupied in forestry had been decreasing from the year 2000 to 2015, but a recent resurgence from 2017 has been observed. From 2017 to 2020, exotic forestry for harvest has grown to 202,600 hectares *(Northland NZ, 2021).* An increase of over 15,000 hectares from 2017. The catalyst for this observed growth, is believed to have been driven from 'speculative value', through external policy mechanisms, such as the Emissions Trading Scheme and One Billion Trees (1BT) - a government programme to incentivise afforestation in New Zealand by providing economic incentives for planting.

In agriculture, land use conflicts can occur because of short-term economic incentives which often trigger switches in land use. Evidence of this, is cited in a report commissioned by Beef + Lamb New Zealand (*Socio-economic impacts of large-scale afforestation on rural communities in the Wairoa District*, 2019) by BakerAg, and found that between 2018 and 2020, 47,382 hectares within existing farms was approved for planting, funded by the One Billion Trees programme, geographic uptake of the scheme in Northland can be seen below in figure 10.

Figure 10: Uptake of One Billion Trees Grants in Northland



Further analysis indicates that, of the 92,118 hectares of total farms sold in New Zealand over the four years, approximately 5,375 hectares has been in Northland. The breakdown of areas identified for afforestation can be seen below in figure 11.

Figure 11: Summary of Farmland to Pine Plantation 2018-2020

LUCAS 2016 Layer	Northland	Gisborne-Hawkes Bay	Rest of North Island	South Island	Grand Total (Hectares)	Percentage by Total
Cropland - Annual				75	75	0.1%
Grassland - High producing	3232	3624	13150	2280	22285	24.2%
Grassland - Low producing	427	7929	21646	8101	38103	41.4%
Grassland - With woody biomass	365	1064	2569	2204	6202	6.7%
Natural Forest	752	1154	8635	4259	14801	16.1%
Planted Forest - Pre 1990	267	293	1114	651	2325	2.5%
Post 1989 Forest	326	907	4221	2731	8185	8.9%
Other		31	0	0	32	0.0%
Settlements or built-up area				1	1	0.0%
Wetland - Open water	3	34	29	6	71	0.1%
Wetland - Vegetated non forest	4	1		34	39	0.0%
Grand Total	5375	15037	51365	20342	92118	100.0%

Summary:

- The gross land area of whole farms purchased for planting in New Zealand is estimated at 92,118 hectares.
- Between 2018 and 2020 an additional 47,382 hectares within existing farms was approved for planting, funded by the One Billion Trees programme (1BT) or as part of the Crown Forestry Joint Ventures scheme.
- Close to 26,500 hectares or 19% is likely to be planted with Manuka or indigenous species between whole-farm purchases and partial plantings.

- In total, it is estimated that 139,500 hectares of land has been or will be planted soon, taking this land out of sheep and beef production.

Analysis of the 2016 LUCAS layers suggests that in Northland, 68% of the land planted was in clear pasture and 6.8% in reverting pasture. Of these properties identified in Northland, the majority (90.2%) of land being converted is land of LUC 6 and above. However approximately 9.6% of the area is in LUC 4, 66.6% in LUC 6 and 23.6% in LUC 7. This suggests that portions of the afforestation have been on relatively high productive areas of land when the LUC framework is evaluated, most likely in production of food through red-meat farming.

6 New Zealand Agriculture's Response to Land Use Change

Beef + Lamb New Zealand's national economic service manager, Rob Davison reports that since 1990-91, the number of commercial sheep and beef farms across New Zealand has declined by 53 per cent from 1990-91 to 2019-20 from both land use change and amalgamation of existing farms. The change in land use includes a variety of contributors including farms converted to dairy production, blanket forestry, reversion to scrub of poorer pastoral country, pasture to native vegetation and conversion of farms into small lifestyle blocks near cities. However, New Zealand's 'Silicon Valley' (Davison, R. 2021) has responded with immense increases in productivity, achieved through genetic improvement, feed management, improved pasture species and response to changing market requirements (such as heavier lamb carcass weights) necessitating an increase in productivity on farm. This achievement can be summarised in figure 12 below.

Figure 12: New Zealand Farm Productivity Summary 1990-2020

Livestock Productivity
New Zealand's "Silicon Valley" powerhouse

beef+lamb new zealand

		1990-91	2019-20p	% change
Ewe lambing %	%	100.4%	127.1%	+27 lambs
Hogget lambs as % all lambs	%	-	5.0%	
Lamb weight	kg/head	14.35	19.03	+31%
Lamb sold	kg/ewe+hgt	9.37	18.56	+98%
Mutton weight	kg/head	20.56	25.65	+25%
Wool production	kg/head greasy	5.28	5.09	-4%
Steer weight	kg/head	297	310	+4%
Dairy production	KgMS/cow	259	383	+48%

Summary:

- The large increase in lambing percentage and increase in average lamb carcase weights both reflect improved nutrition as well as genetic improvement.
- Lamb production (tonnes hot weight) has decreased -8 per cent during this time however this is from 52 per cent fewer sheep.
- Kilograms of lamb carcase weight sold per ewe wintered, is another expression of the improved productivity of the ewe flock that combines the previous two measures.
- Wool production per head reflects the flock decline with the predominant wool type from crossbred sheep due to more emphasis on lamb meat production than wool in recent years.
- The average steer weight increase shows a small underlying improvement.
- A 48% milk solid per-cow increase reflects both genetic and feed management improvement and increased per cow production while the dairy cow herd expanded 85 per cent from 1990-91 to 2017-18.

This importance of this, is that it highlights agriculture's ability to respond to adversity and challenge through innovation and opportunity and challenging the way we have historically farmed to continue feeding a growing world while all whilst experiencing land-use competition and policy change.

7 Industry Socioeconomic Contribution

The Multiplier Effect

In 2020, Te Uru Rakau commissioned a report (*The economic Impact of Forestry in New Zealand, 2020*) to look at the socio-economic impact that forestry and sheep and beef farming has on the New Zealand economy. PWC examined what's known as 'The Multiplier Effect'. This can be broken down into three classes of impacts. Direct, indirect, and induced, summarised below in figure 13. Put simply, the multiplier is the resultant economic impact an industry has on employment and the flow-on effect of employment to come from that industry. For example, a farmer grows a lamb then sells it through a stock agent, who sells it to the freezing works, the freezing works processes the lamb and then sells parts of the animal to both domestic and international markets, this lamb then gets served on a plate in a restaurant resulting in the economic flow from farm-to-fork.

Figure 13: Socio Economic Multiplier Value Chain

Industry	Direct	Indirect	Induced
Forestry and logging	Forestry and logging workers Forest managers	Forestry consultants Port service workers	Chefs of restaurants in rural forestry hubs
Processed wood product manufacturing	Wood processing workers	Builders Carpenters Truck drivers	Retail assistants in shops in rural centres
Pulp, paper, and converted paper product manufacturing	Pulp and papermill operators	Port service workers Truck drivers	Checkout operators in supermarkets in rural centres
Meat and meat product manufacturing	Farmers Shepherds Abattoir workers	Veterinary workers Agricultural scientist Agricultural consultants Shearers	Baristas at the local café

The PWC report was followed by research undertaken in 2019 by Beef and Lamb New Zealand, who commissioned Baker Ag to prepare a report on the socio-economic impacts of large-scale afforestation in the Wairoa district (*Harrison, E & Bruce, H., 2019).* The report specifically compared sheep and beef against forestry models, focusing on economic returns, direct local expenditure, and employment. The report presented statistics per 1000 hectares, stating that sheep and beef consistently generates 7.4 local jobs per annum compared to forestry at 2.2 local jobs per year, except in the year of harvest (year 28-30) where this would rise to 5.1 local jobs. The employment contribution to the region can be summarised below in figure 14.

Figure 14: Socio Economic Employment Creation

	Direct effect	Indirect effect	Induced effect	Total
Forestry value chain				
Value-add ($m)	2,877	3,107	1,941	7,926
FTEs	18,460	30,629	15,800	64,889
Sheep and beef value chain				
Value-add ($m)	4,908	4,395	3,475	12,777
FTEs	55,187	41,223	28,142	124,551

In Summary:

- The sheep and beef industry contributes 7.4 jobs per 1000 hectares in Wairoa.
- The forestry industry generates 2.2 jobs per 1000 hectares, excluding harvest.
- The forestry industry generates 5.1 jobs per 1000 hectares, including harvest.

As can be seen, although both farming and forestry induce jobs in the region, the transient nature of forestry work often means that the labour force comes from outside the region and therefore are not permanently contributing to rural communities. For example, a farm that employee's staff are there on permanent basis, spending money at the local shop, pub, schooling children and contributing to the community, whereas forestry workers were typically often only in a community for a short time during planting or for silviculture work, and not contributing on a perpetual basis as a farm employee would. In addition, financial out-flow of the money earned by the forestry workers would often be spent outside the region creating financial 'leakage' of funds. This is an important implication when looking at large-scale land use change for landowners in any rural community.

8 Hill Country Farming in Northland Overview

To understand what the implications of change are from status quo, it is first important to ascertain what the existing picture looks like, and why are there drivers to change it? And what are the implications of these changes? The following section seeks to explore the physical and financial context of the current 'Northland Hill Country' sheep and beef industry.

8.1 The Beef & Lamb Economic Survey

The Beef + Lamb New Zealand sheep and beef farm survey began in 1950 and provides a sound base for the Economic Service's forecasts of meat and wool production and trends in the sector, by linking physical production together with financial returns *(B+LNZ, 2021).*

The collection of data is undertaken though annual analysis of financial statements and surveys of over 500 farms across New Zealand of varying scale, stock policies and most importantly for this project, land classes (found below). The annual on-farm survey generates about 2000 pieces of information per farm, covering physical production data, financial returns, and capital structure *(B+LNZ, 2021).* This information is then stratified into geographic regional classes, e.g. Northern North Island (NNI) which captures Northland, Waikato and the Bay of Plenty.

North Island Farm Classes:

Class 3: North Island Hard Hill Country - Steep hill country or low fertility soils with most farms carrying 6 to 10 stock units per hectare. While some stock are finished, a significant proportion are bred on-farm and sold in store condition.

Class 4: North Island Hill Country - Easier hill country or higher fertility soils than Class 3. Mostly carrying between 7 and 13 stock units per hectare. A high proportion of sale stock sold is in forward store or prime condition. Majority of the progeny are bred and finished on-farm or sold store to be finished.

Class 5: North Island Finishing Farms - Easy contour farmland with the potential for high production. Mostly carrying between 10 and 15 stock units per hectare. A high proportion of stock is sent to slaughter and replacements are often bought in.

The focus for this project is - Class 4 Northern North Island Hill Country.

In 2020/21, the average Northland sheep & beef hill country farm, was 354 effective hectares supporting 3355 stock units, compromising a stock policy of 70% cattle and 30% sheep. The historic overview can be seen below.

Figure 15: Summary of the 'Average Northland Hill Country' Sheep & Beef Farm

Physical Indicators	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Effective Area (Hectares)	320	345	334	324	335	344	351	354
Total Stock Units at Open	2957	3385	3116	3029	3184	3124	3143	3355
Stock Units / ha	9.2	9.8	9.3	9.3	9.5	9.1	9.0	9.5

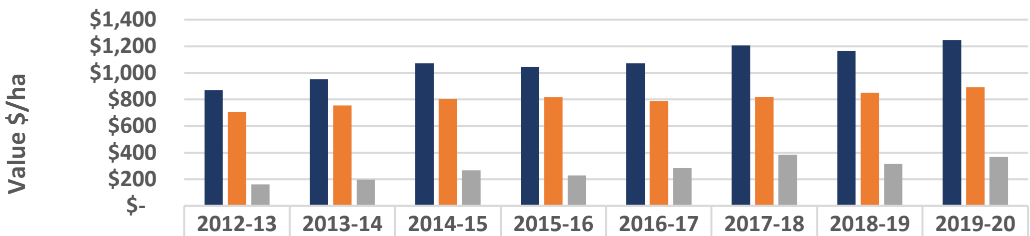
Of note in figure 15 is the 'mean' effective area of the surveyed farms has not significantly changed from 2012-13 to 2019-20 recording an increase of 34 hectares in mean farm size. This is only representative of surveyed farms and may not reflect a macro-trend nationally. Stock units remain relatively consistent with small anomalies in 2013-14 and 2018-19 which may be representative of climatic variation observed in pastoral production systems i.e., reduced stock numbers given reduced supply of feed, or increased stock numbers during a good pasture growth season.

9 The Financials of Farming Northland Hill Country

9.1 Historical Financial Performance

Typically, the primary objective within a farming business is generally no different from that of any other business, to make a profit. The following section looks to lift the bonnet on the economic engine of sheep and beef farming in Northland and analyse the historical trend in financial performance of a NNI Class 4 sheep & beef farming business.

Figure 16: Historical Financial Performance



	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Total Gross Revenue	$869	$952	$1,072	$1,045	$1,071	$1,206	$1,165	$1,247
Total Farm Expenditure	$708	$754	$805	$817	$788	$821	$850	$893
Farm Profit Before Tax	$161	$199	$267	$228	$283	$385	$315	$369

(Information Source: Beef & Lamb NZ Economic Survey, 2021)

Figure 16 displays the financial performance of benchmarked farms on a per hectare basis over a an 8-year period. The analysis discounts any off-farm income and income generated from non-farming related sources (forestry, tourism, honey etc) to validate the benchmark financial performance from exclusive farming activities. Using hectares as the model allows for equal comparison of farm business' which typically vary in scale.

The data shows:

- An almost year-on year increase in gross farm revenue, even with cyclical commodity prices. In 2019-20 this represents a total pre-tax & drawings income of circa $130,626 for the average Northland Hill Country Farm of 354 effective hectares.
- A similar trend in farm expenditure with major farm inputs equally vulnerable to the cyclical nature of commodity prices. This may indicate that these farms are spending more on farm inputs (fertiliser, repairs, fencing, wages) with a 26% increase in expenses.
- Farm Profit Before Tax has generally been increasing which may reflect the major variables that influence profitability, such as: increased management capability, improved genetic worth of livestock *(Parsons. J., 2021)* and a reducing interest rate environment over the observed over the period, 2-year fix rate of 6.2% in 2012 reducing to 3.6% in 2020 *(RBNZ, 2020).*

However, one caveat when looking at this analysis is to be mindful that the capital structure of each business heavily influences the benchmark measure. For example, take two identical farms except one has no debt, while the other spends 15% of its gross revenue on debt servicing. The farm with no debt will report a higher profit than the farm with the moderate debt loading - even though the earning rate of each farm was identical. Thus, the farm's capital structure can heavily influence the variation in reported profit. An alternative measure is using Earnings Before Interest, Tax & Rent (EBITR). This analysis removes business expenses of interest & rent to indicate farm performance before debt servicing and rent/lease. However, this method does not fully disclose *net return* to the business owner. Therefore, it is more useful when looking at productivity performance comparison, as opposed to net financial performance, as is the mandate of this section.

Well-known maths professor Ron DeLegge once said, "*99 percent of all statistics only tell 49 percent of the story*" *(DeLegge.R.,1997).* Therefore, given the heterogeneous nature of farming, it is important to look at the bigger picture to analyse the spread of financial performance when analysing financial data sets. Figure 17 below, illustrates the relative profit distribution spread of the average 2019-20 Farm Profit Before Tax (FBPT) analysis located above *(figure 16).* Performance is ranked in five 20-percentile bands determined by FBPT.

Figure 17: Quintile Analysis Class 4 NNI Hill Country Farm Profit Before Tax 2019-20

NNI Class 4 Hill Country	Unit	Q1 low 2019-20	Q2 2019-20	Q3 2019-20	Q4 2019-20	Q5 high 2019-20
Gross Farm Revenue	$/ha	$ 964	$ 878	$ 1,101	$ 1,037	$ 1,419
Total Expenditure	$/ha	$ 908	$ 608	$ 797	$ 669	$ 847
Farm Profit Before Tax	$/ha	$ 56	$ 270	$ 304	$ 367	$ 571

Most apparent is the significant variation of relative profitability among farms categorised in the same 'class' of farm, i.e., a big difference between 'average' and 'great' farming performance. Influences of this may include:

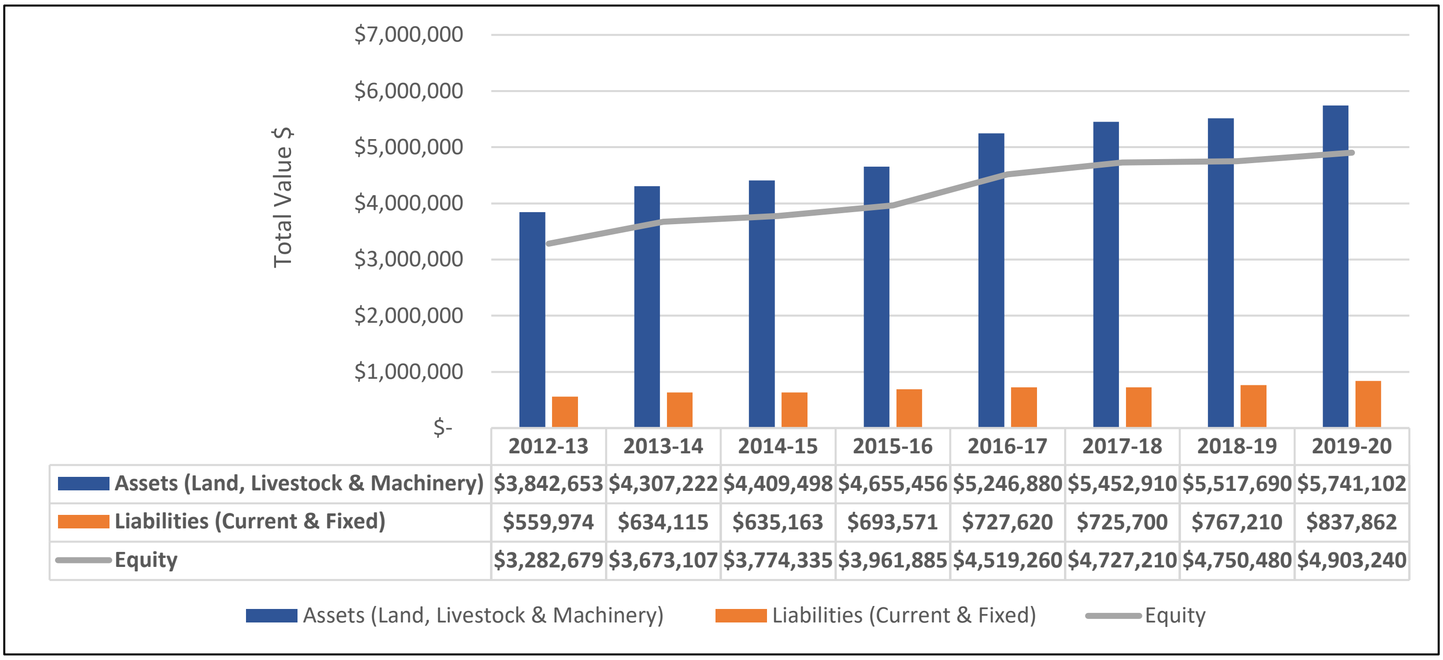
- Management capability – Degree of financial acumen may result in better business decisions.
- Pasture species and pasture management - more desirable pasture species have a higher metabolisable energy component and increased utilisation of pasture grown.
- Genetics of livestock – Superior genetics may result in higher lambing percentages and liveweight production "we use Coopworth genetics which significantly improves our livestock performance on hill country' – *(Parsons. J, 2021*)
- Debt-servicing commitment – a highly leveraged business will have greater debt serving requirement and therefore a direct correlation with profit.
- Seasonal variation of micro-climates – variational distribution of rainfall and sunshine hours, these differ between geographic locations.
- Timing of financial year-end with stock sales in the observed financial year – may have stock on hand to sell but financial proceeds will not be realised in the reported financial year.

Farmers who successfully implement good pasture and animal husbandry, business principles, and configure and manage their farming systems according to the available resources and market opportunities, tend to be at the most profitable end of the distribution spread.

9.2 The Capital Value of a Hill Country Farming Business

The profit earned from a farming business gives perspective of the annual financial return expected from the operational aspect, but what does the capital structure of a NNI Class 4 Hill Country Farming business look like?

Figure 18: NNI Class 4 Hill Country - Assets, Liabilities and Equity Trend 2012 - 2020



	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Assets (Land, Livestock & Machinery)	$3,842,653	$4,307,222	$4,409,498	$4,655,456	$5,246,880	$5,452,910	$5,517,690	$5,741,102
Liabilities (Current & Fixed)	$559,974	$634,115	$635,163	$693,571	$727,620	$725,700	$767,210	$837,862
Equity	$3,282,679	$3,673,107	$3,774,335	$3,961,885	$4,519,260	$4,727,210	$4,750,480	$4,903,240

(Source: Data sourced from B+LNZ Economic Survey, 2021)

Observations of '*The 49's':*

- The appreciation of assets (land & buildings, machinery, and livestock) has experienced a 49% increase in value from 2012 to 2020*).* Underpinning this value, is believed to be land value increase driven competition of land use from forestry and dairy support farming *(Drivers for Land Use Change, MPI, 2016)* given that stock numbers on surveyed farms have remained relatively static over this period.
- Interestingly, liabilities have also increased by 49% from 2012 to 2020, even with a 2.6% drop-in interest rates *(RBNZ, 2021)* which may indicate that these farms are investing into capital development & purchases such as additional fencing, capital fertiliser and land acquisition facilitated by taking on additional debt with lower interest rates.
- Coincidently, the third 49% increase is equity, with the average surveyed farm business balance sheet now net of $4.9 million, a $1.7 million increase (49%) from $3.2 million in 2012. This implies that the appreciation of land value is for the most part, driving the balance sheet growth of these farms and not profit, retained as equity.

9.3 Relationship of Land Value, Profit and Return

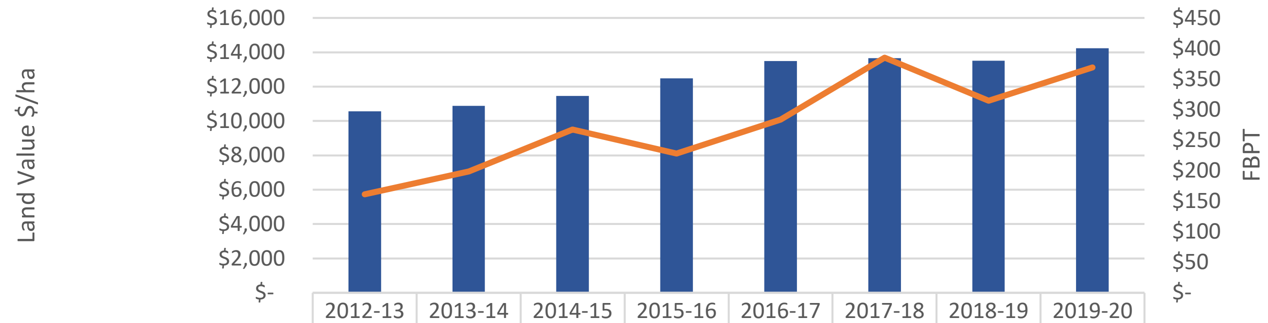
A research report (*The Effect of Environmental Constraints on Land Prices, Journeaux.P, 2015*) undertaken by AgFirst agricultural economist Phil Journeaux in 2015, defined that:

Fundamental drivers of land value are a combination of three things:

1. **Productive value** – the value relative to the rent, or profits, obtainable from the land.
2. **Consumptive value** – this includes amenity factors such as recreational opportunities and scenery, plus intangibles such as the countryside is a nice place to live, a great place to bring up kids, you're your own boss, and farming is a great lifestyle.
3. **Speculative value** – the ability of an asset to retain its value/the return on the asset as an investment.

Using this framework, analysis of the relationship of land value, profit and return has been undertaken to see if any of these drivers are an influence of NNI class 4 hill country fits this framework theory.

Figure 19: Relationship of Land Value Vs. Farm Profit Before Tax



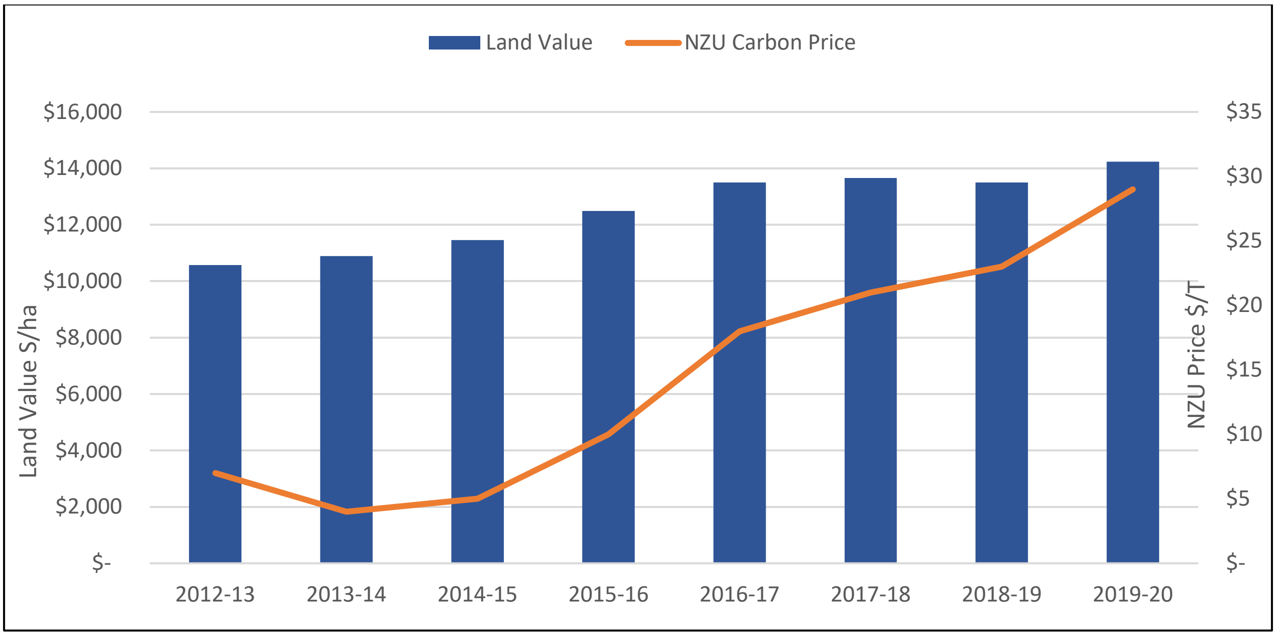
	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Land Value	$10,569	$10,889	$11,460	$12,492	$13,499	$13,654	$13,500	$14,234
Farm Profit Before Tax	$161	$199	$267	$228	$283	$385	$315	$369

(Source: Data sourced from B+LNZ,2021)

Observations from this relationship indicate that relative farm profit may be a contributing influence of a 'productive driver' in land value growth given the distinct nearly linear correlation between FPBT and land value growth.

Digging a little deeper, there may also be an indication of 'speculative value' as a higher profit will drive a better year-end financial result and potentially generate new land acquisition from investors or current landowners. In addition, externalities outside of pastoral farming may also be contributing to this growth in land value. An example of such 'policy' driven externality influence, is the addition of the Emissions Trading Scheme and the value of carbon credits. What role does this play in driving land value? Figure 20 below displays a similar relationship between hill country land value appreciation and carbon price.

Figure 20: Relationship of NNI Class 4 Land Value and NZU Carbon Price

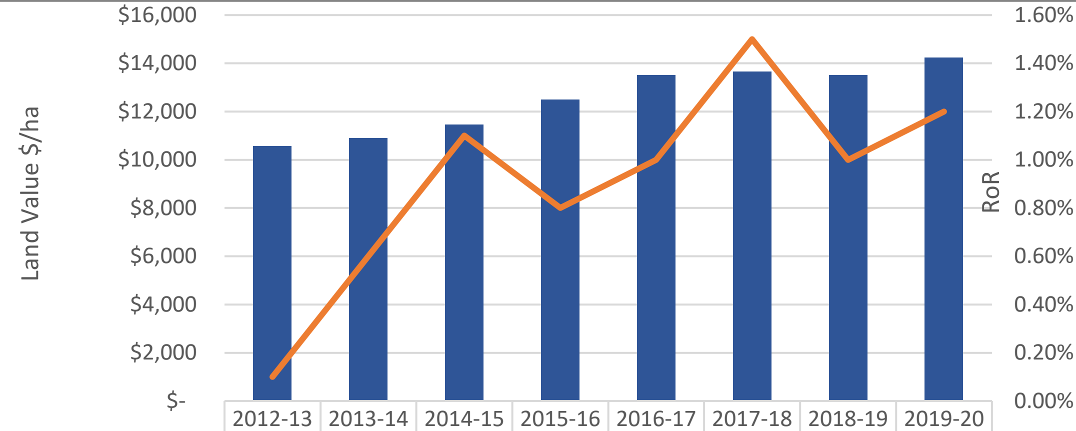


(*Source: Information from B+LNZ & Carbon Trade NZ, 2022*)

This relationship shows that there is a strong indication NNI Hill Country land prices may also being influenced by 'speculative value' from investors looking to purchase green field farmland for plantation forestry and capitalise on the growing carbon market. However, the implication of this for landowners, is highlighted within research undertaken (*Endless Shades Of Green, MacGillivray & Tither,* 2020) that found 'cut-over' land (land that is second rotation forestry) experiences a significant reduction in value, with evidence to suggest market value decreases to between $2000-$3000 per hectare after the first rotation. This means for a landowner looking to plant a forest, after the first rotation and carbon credits have been claimed, there will be a significant reduction in asset value and subsequent impact on balance sheet which they must consider in the process, in addition to the carbon liability associated with the land from accrued credits.

The increasing value of farmland as an asset appears rosy at face value; however, the unintended consequence of this, is that the appreciation can be viewed in assessing Return on Capital (ROC) (a measure of profit vs. asset value).

Figure 21: Relationship of Land Value and Return on Farm Assets



	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Land Value	$10,569	$10,889	$11,460	$12,492	$13,499	$13,654	$13,500	$14,234
Rate Of Return on Farm Assets	0.10%	0.60%	1.10%	0.80%	1.00%	1.50%	1.00%	1.20%

As evident, the metric of RoA has fluctuated between 0.1% and 1.5% over the last 8 years. The implication of this, is that it may drive the more commercially minded operators to look for a better return from their farm/asset on this metric if they deem this RoC too low vs. total asset value. This is largely up to the individual's risk appetite and the value they place on return vs. asset deemed appropriate, if any.

10 So, What Are the Drivers for Change?

The following section seeks to understand why, if, at first glance, Northland sheep and beef farm business'; appear profitable, with growth in asset appreciation, produce cash surpluses and possess many 'consumptive value' benefits, is there a desire to change?

If you read a newspaper or read a rural news website, there is evidence that there is a compounding, and overwhelming sense of compliance and legislative pressure felt by farmers, not only in Northland but nationally. The following section looks at a selection of the relevant polies facing farming and afforestation.

10.1 Environmental Policy Facing Hill Country Farmers

Depicted below, is a visual representation of organisations and industries talking about environmental change with farmers. It provides an oversight into the complexity that the environmental narrative imposes on agriculture at farm level.

Figure 22: Illustration of Organisations Talking About Environmental Farm Practices

(Source: AgFirst, 2021)

National Fresh Water Policy Statement - Te Mana O Te Wai

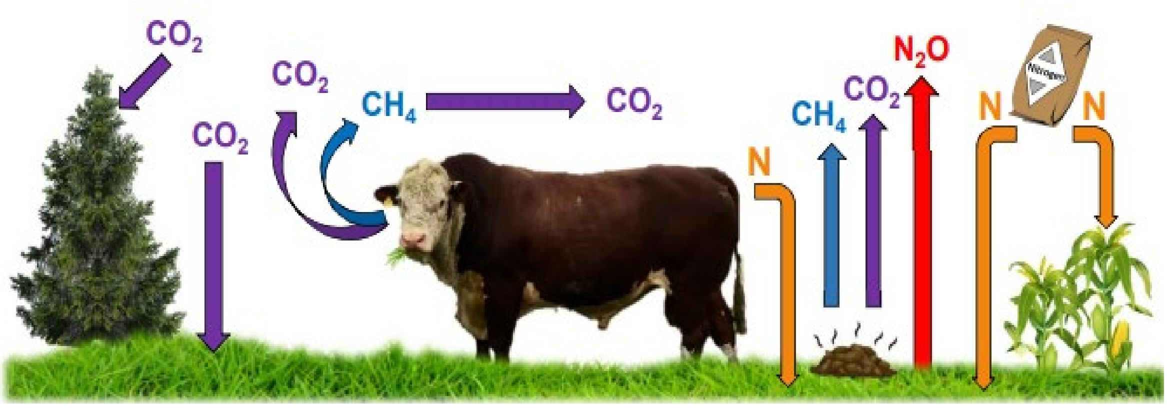
Freshwater farm plans are a new legal framework established under the Resource Management Act 1991 (*MFE, 2021).* The policy has been established by central government and will be regulated by Local Regional Council's. The objectives of the policy are to improve freshwater quality by reducing nutrient and sedimentation impact from rural and urban sources. The policy applies to farms with 20 hectares or more in arable or pastoral use. The proposed timeframe for this is mid-2022. The main points of the policy that will impact farmers are:

- Apply regulations on water take and metering
- Apply low-slope rules for excluding stock from waterways under 10 degrees.
- Nitrogen-cap policy on individual farms.

He Waka Eke Noa – Primary Sector Climate Action Partnership

He Waka Eke Noa is the primary sector, Māori and Government working together on climate change and agricultural greenhouse gas emissions *(He Waka Eke Noa, 2021).* Major sources of on-farm greenhouse gas emissions are from livestock ruminant animals, such as cattle & sheep producing methane (CH4) and synthetic fertiliser containing nitrogen (N2O) (*Journeaux. et al, 2021*).

Figure 22: Sources of On-Farm Green House Gases



(Source: New Zealand Agricultural Greenhouse Gas Research Centre, 2019)

The sheep and beef sector comprises 40% of New Zealand's land area and is currently responsible for about 20% of New Zealand's total, and 45% of its agricultural, gross emissions *(Case.B., 2020).*

Instead of a tax on farm emissions through the Emissions Trading Scheme, the collective body have agreed to work together with farmers and growers to design a mechanism to manage the emissions produced from livestock farming. By 2025, the partnership will develop and implement a framework to empower farmers and growers to measure, manage and reduce on-farm emissions; recognise, maintain, or increase integrated sequestration on farms; and adapt to a changing climate (*He Waka Eke Noa, 2021)*. This will include an appropriate on-farm pricing system identifying on-farm emissions and carbon sequestration. *(He Waka Eke Noa, 2021).*

Objectives for He Waka Eke Noa:

1. Recommendations for an appropriate farm level emissions pricing system from 2025 as an alternative to the Emissions Trading Scheme.

2. Recognition and measurement of on-farm sequestration that composes part of the pricing mechanism.

Two options currently being promoted by this collective to reduce GHG emissions on farm, are to:

1. To reduce stocking rate & optimisation of stock classes into more efficient converters of pasture to live weight gain to reduce overall feed eaten (there is a direct relationship between pasture eaten and GHG output)
2. To reduce the input of soil nutrients such as Nitrogen & Phosphate.

However, when looking at these options, the implication is that any change in a farm system need to be explained within the context of the system as a whole. For example, one potential farm management mitigation strategy is to reduce stock numbers and increase per animal performance (with the same amount of feed eaten). For many farmers this would represent a significant change in their farming system, and they would be looking for information and advice around implications such as the degree of de-stocking and how this would affect grazing management, other changes in farm management e.g. calving dates, replacement rates, changes in stock types, changes in breeding strategies. Plus, of course, the impact on profitability.

The implication of this for hill country farmers is seen in the results of a research report (Journeaux, Reisinger, & Clark, 2017) where they found one of the main drivers of pasture production on hill farms is Nitrogen (N), phosphorus (P), and sulphur (S) fertiliser inputs to the legume-based pastures. Suppose these inputs are reduced in line with lower product output. The result is, pasture production will decline over time because of reduced symbiotic N fixation, pasture composition will revert to less desirable species, and pasture vigour is reduced. This means that 'depowering' hill country farms in this way, would in many instances, re-introduce historical management issues, such as more marked differences in seasonal growth exacerbating feed supply/demand imbalances, reduced feed quality, the in-ability to maintain performance of both breeding and finishing stock, and increased difficulty in keeping shrubby weeds under control.

In addition to the scientific implications, there is a human-capital implication. For example, there may not be the skill-set present or desire in an individual to drastically change stock policies, i.e. a specialist breeder may not want to convert into a more efficient class of stock, such as bull farming (which have a higher pasture conversion efficiency) and the topography may not accommodate the live weight gains necessitated to make this profitable. This is supported by *Parks (1995*), who suggests that a barrier to land use change is in the human capital of the land management decision-maker, in that they may not have the skills to run a new type of farm. Therefore, before any mitigation strategies to reduce GHG output are undertaken, there needs to be consideration as to the capability of the individual farmer to change systems, and if the farm can support these changes by way of land class.

Zero Carbon Act

New Zealand has a goal of becoming carbon neutral by 2050 (*Ministry for Environment, 2021*). The Climate Change Response (Zero Carbon) Amendment Act 2019 provides a framework by which New Zealand can develop and implement clear and stable climate change policies that are designed to:

- Contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5° Celsius above pre-industrial levels
- Allow New Zealand to prepare for, and adapt to, the effects of climate change.

The Climate Change Commission (CCC) states that, 'the policy is designed to achieve four key things:

1. Reduce net emissions of all greenhouse gases (except biogenic methane) to zero by 2050
2. Reduce emissions of biogenic methane to 24–47 per cent below 2017 levels by 2050, including to 10 per cent below 2017 levels by 2030.
3. Establish a system of emissions budgets to act as steppingstones towards the long-term target.
4. Require the Government to develop and implement policies for climate change adaptation and mitigation'.

(*Climate Change Commission, 2021).*

The policy also states that, 'Efforts to mitigate climate change should not come at the expense of food production'. The context for this, is that there needs to be significant consideration given before establishing policy mechanisms that drive environmental benefit which have implications on food production. An example of this is seen though the ETS and large scale-plantation forestry for carbon incentives competing for land that is the foundation for food production (meat and milk) typically observed in hill country.

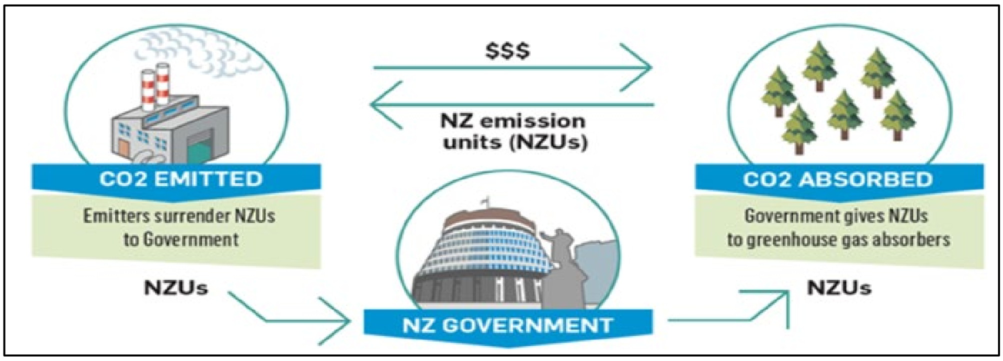
The Emissions Trading Scheme (ETS)

In 2016, New Zealand ratified the Paris Agreement on climate change. This policy commits New Zealand to reduce national GHG emissions to 30% below 2005 levels by 2030. As agriculture makes up 49% of New Zealand's emission profile, it is very likely, agriculture will be involved to some extent should the *He Waka Eke Noa* collective initiate fail in its objectives *(Journeaux et al. 2019).*

The purpose of the Emissions Trading Scheme (ETS) is to assist a country's ability to meet its agreed emission reduction targets. The New Zealand emission unit is the NZU. 1 NZU = 1 tonne CO2. As at 30/08/2021, NZUs were currently trading at $50/tonne (*Jardern, 2021*) and are expected to move significantly higher over the coming years driven by the uptake of 'speculative' investors looking to cash in on the financial instrument as an investment. (*Woodford.K, 2021*).

Under the ETS, participants acquire NZUs by; earning them by removal activities (such as carbon sequestration storage in forests) receiving them for free (e.g. government allocation) or buying them from other participants (incentivising others to reduce their emissions and sell surplus units), buying them at auction (generating government revenue that can be returned to the economy), buying them from external offset mechanisms (domestic or international) or through international trading.

Figure 23: New Zealand Unit Circular Accounting Allocation Framework



(Source: MPI, 2020)

When looking at the ETS as a farming business, objectives under He Waka Eke Noa include establishing an emissions pricing system. Essentially, this is a 'tax' on emissions (as outlined in under He Waka Eke Noa) from the farming operations to drive the change in behaviour in reducing GHG footprint.

Initially, this pricing system has been proposed to have a discounted rate on GHG emissions, with consequent gradual increases if the objectives are not met, for example, a 5% emissions tax on the total GHG output of the farm initially. The financial impact of the implementation this policy would have on the ‘average Northland Hill country farm' can be seen in a sensitivity analysis below. It has been prepared using the Beef + Lamb NZ GHG calculator, which is a tool accessible to sheep and beef farmers though B+LNZ, to ascertain the net emissions at a farm level along with potential emissions offset vis carbon sequestration from forests (native or exotic). The observed range of absolute GHG emissions on a Northland sheep and beef farm can be from 0.9 to 5.1 T/GHG/ha per year. This is largely dependent on the level of intensity of farming (e.g., stocking rate, amount of feed purchased in, nitrogen use); generally, the more intense the farming system the higher the absolute emissions.

The sensitivity analysis assumes no other management strategies have taken place to reduce GHG emissions, for example reducing stocking rate or reduced fertiliser inputs, and that no carbon off-set sequestration is accounted for on-farm. The key number was the gross emission of 2.6 T/GHG/ha/yr. or, approximately a total of 920 T/GHG emission output per year based on the average Northland Hill country effective area of 354 hectares and the typical stock policy implemented.

Figure 24: Summary of Potential Emission Tax Liability under the ETS

	Total Cost of GHG Emssion / Year				
Emssion Liability	**NZU Price**				
	$ 50.00	**$ 75.00**	**$ 100.00**	**$ 125.00**	**$ 150.00**
5%	$ 2,301	$ 3,452	$ 4,602	$ 5,753	$ 6,903
10%	$ 4,602	$ 6,903	$ 9,204	$ 11,505	$ 13,806
25%	$ 11,505	$ 17,258	$ 23,010	$ 28,763	$ 34,515
50%	$ 23,010	$ 34,515	$ 46,020	$ 57,525	$ 69,030
75%	$ 34,515	$ 51,773	$ 69,030	$ 86,288	$ 103,545
100%	$ 46,020	$ 69,030	$ 92,040	$ 115,050	$ 138,060

(Source: *GHG Info sourced from: https://beeflambnz.com/ghg-calculator-info*)

What is observed, is that there is a significant financial impact at the farm-gate level based on the varying levels of imposed tax emissions as the proportion of liability increases with the carbon emissions price. What this means for the average Northland hill country farm, is that a 100% emission liability tax at a price of $150/T of GHG output, would result in an annual net profit loss to the business based on annual NBPT of $130,626 the 2019/20 season. Therefore, this may present a significant motivation for hill country farming business' to look at either; reducing absolute GHG emissions as a result of their farming operation, or, by capitalising on the ability to offset GHG emissions via afforestation. It is important to note however, that off-set via afforestation is of terminal length, meaning that the carbon sequestration will only be accounted for based on economic life of the forests, as dictated by MPI. Thereafter, the options are to either plant more trees, or actively reduce emissions through management decisions, such as choice of stock policy or farm inputs.

Te Uru Rakau / One Billion Trees

The Government developed the One Billion Trees Programme (1BT) to increase tree planting across New Zealand. The initial goal was to double the current planting rate to reach one billion trees planted by 2028 *(MPI, 2020).* The policy provided funding to encourage planting of both exotic and native species of forests. The initiative set three key objectives:

1. **Right tree** - Encourage both permanent and plantation forests made up of exotic and native tree species. The programme encourages the planting of native species to improve biodiversity.

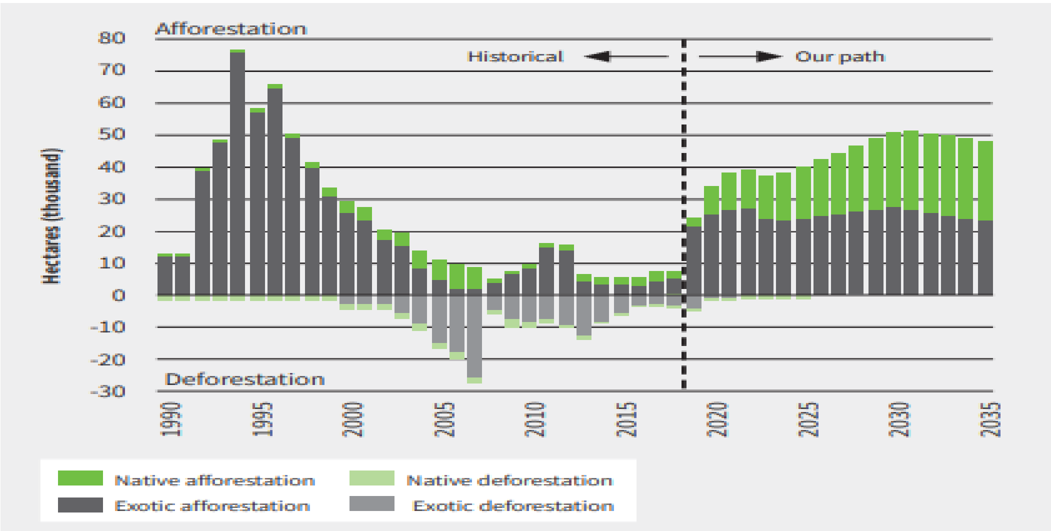
2. **Right place -** To see trees integrated into the landscape to complement and diversify our existing land uses, rather than see large-scale land conversion to forestry. To see

the trees planted to be suitable for the site and their intended use. To do this 1BT needed to align tree planting with local land-use and planting priorities and strategies.

3. **Right purpose -** To make sure tree planting is well planned and considers the long-term maintenance and end-use of the trees. Commercial viability for production forests and protection for permanent forests should be thought through before planting. To make sure plantings take local social, environmental, cultural, and economic priorities into account.

To entice landowners to plant, government grants were made available. For indigenous natural regeneration, such as retiring land or managing a natural return to trees, $1000/ha was available for areas between 5ha and 300ha. Exotic planting, such as eucalypts, Redwood or Pinus Radiata to stabilise erosion-prone land attracted a base rate of $1500/ha. Uptake of the programme was so successful, that it exhausted the quotas for exotic species in less than 12 months after the implementation of the programme. In response, 1BT shifted the mandate to encouraging plantation of indigenous species and no longer provided grants for afforestation of Pinus Radiata. As at 31 December 2020, $154.5 million of the $200.3 million of available funding had been allocated to grants and partnerships projects. Below is a summary of the future objectives by 1BT for afforestation in New Zealand.

Figure 24: Future Objectives for One Billion Trees



(Source: NZ Farm Forestry Association, 2021)

11 Afforestation & The Emissions Trading Scheme

New Zealand has a goal of becoming carbon neutral by 2050 (*Zero Carbon Act, 2019*). To help achieve this goal, modelling undertaken for the Productivity Commission (Dorner, et al., 2018), indicates that land-use change, in particular the conversion of sheep and beef land into forestry, is likely, to be a key-way New Zealand can achieve low-emissions targets by 2050. In contrast to this, the Climate Council Commission (CCC) has raised concerns that the ETS over-incentivises forestry offsets and doesn't do enough to encourage actual reductions in emissions. The Commission stated that the current NZ ETS settings may incentivise more large-scale pine plantations than is desired to meet 2050 targets and could lead to forestry displacing gross emissions reductions. The commission also stated that, excessive planting of Pinus radiata, is not considered sustainable, as it provides only a temporary offset to emissions, meaning land planted today in pines today, won't generate any offsets by 2050.

Modelling undertaken by the CCC demonstrates, 1.3 to 2.8 million ha of land could move into forestry in response to carbon price policies (such as the ETS), with the additional carbon being sequestered in new forests making up a substantial part of New Zealand's overall (net) emission reductions. Accumulation of carbon using exotic plantation forests is likely to provide a major component, but there will also be a focus on establishing forests of native trees, either by planting or through natural regeneration. The Commission recommends that 300,000 hectares of new native forests and 380,000 hectares of new exotic forests are established between 2021 and 2035 (*Climate Change Commission, 2021*).

MPI reports that, when looking at afforestation for inclusion into the ETS, the criteria for eligibility must meet the following:

- Trees planted or established after December 31st, 1989 (including those planted as recently as 2021) and that have not previously been entered into the scheme.
- Land that has not previously been forested post 31st December 1989.
- Potential to grow over 5 meters in height and the potential to reach over 30% tree canopy cover.
- Eligible tree species (i.e. not fruit or nut crops etc).
- Minimum size of one hectare, with an average width of 30+ meters.

This means that for farms with significant areas of re-generated bush that is older than 32 years as-at 2021, it would not meet the criteria, nor would second rotation forestry as it was not 'clear-land' post 1989. An example of this is found from Beef + Lamb New Zealand's research report (*Analysis of carbon stocks and net carbon position for New Zealand sheep and beef farmland*, 2020) where it estimated that there is an existing 1.4 million hectares of native forest on sheep and beef farmland. Some of these forests may be storing additional carbon that would contribute to offsetting agricultural emissions; however, in the context of the ETS, this forest would be ineligible for both off-set function and economic recognition (accrual of NZU's) as it is pre-1990, even though it may be positively contributing to the overall sequestration balance. The implication of this, is that much of this land is already retired, so in order to be eligible for economic recognition, or, recognition for sequestration for off-set purposes, a landowner would need to plant new 'green-field' pastoral area with eligible species, which may not necessarily be the best or most profitable use for that land or logistically work within the farming business.

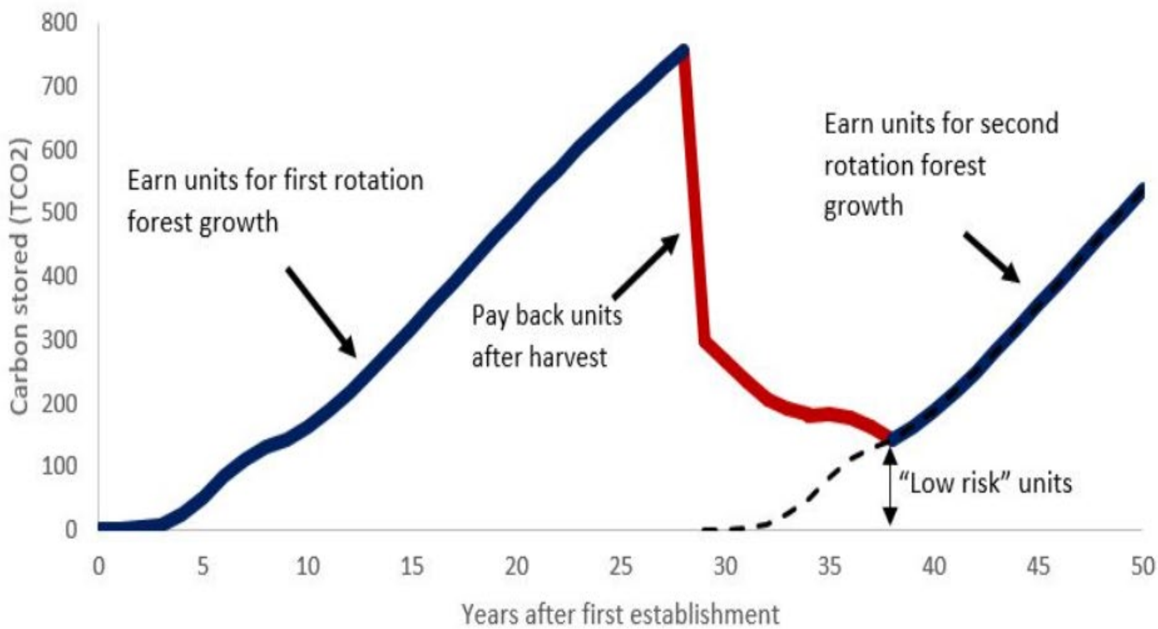
11.1 Emissions Trading Scheme Pricing Mechanisms

Entering new or existing forests into the ETS is not compulsory. However, if a landowner wishes to participate in the ETS, as at August 2021, there are two pricing mechanisms available. The pricing schemes represent implications for landowners with significant variation in liquidity and potential harvest liabilities which necessitates a long-term view on current and future land use opportunities associated with inclusion into the ETS policy. The two pricing mechanisms are summarised below.

Stock Change Accounting

Stock change accounting concentrates on short-term increases and decreases in carbon storage in your forest.

Figure 25: Total Stock Change Accounting Mechanism



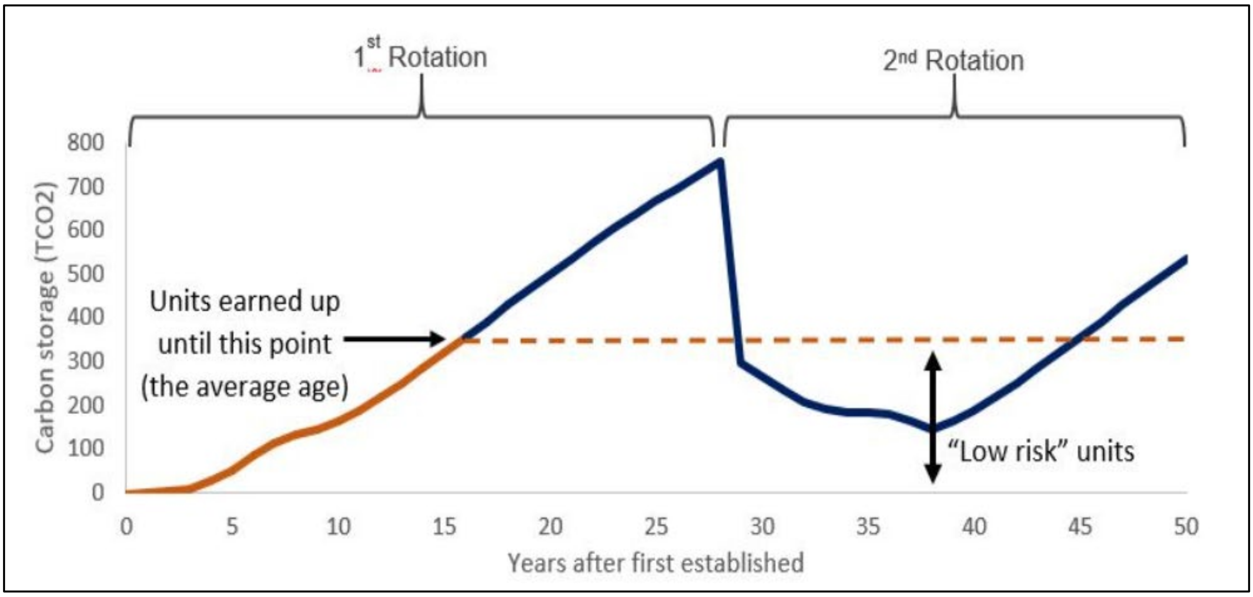
(Source: MPI, 2021)

As your forest grows it stores carbon, and you will earn units for that carbon storage. Under the stock-change accounting mechanism, you will keep earning units so long as the change in carbon stock is positive when you submit emissions return every 5 years. If you have a permanent forest, you will keep earning units until the forest reaches a 'steady state' as dictated by the MPI look-up carbon sequestration tables *(*appendix C*)* for forests under 100 hectares. If the forest is over 100 hectares, the Field Measurement Approach (FMA) must be undertaken by a forestry consultant to measure its carbon biomass (Ministry for Primary Industries, 2015). If you have a rotational forest, you'll earn units while the forest is growing but will need to pay units back after harvest. Harvesting is the most common reason for needing to pay back units (*MPI, 2021*).

Key Points:

- Typically used in forests of perpetuity, such as natives and indigenous species.
- Units are required to be repaid if the forest is harvested.
- The forest will earn units up until the economic life allocated by Ministry of Primary Industries look up tables, there is a 50-year limit on all species at present.

Figure 26: Averaging Carbon Accounting



(*Source: MPI, 2021)*

Forests under averaging, earn units for growth and carbon storage in the first rotation up until the forest reaches its "average age". Carbon submissions are returned every 5-years. The average age of a forest is the age at which it reaches the average level of carbon it is expected to store over several rotations of growth and harvest. The average age of a forest will depend on the forest type and the typical age of harvest for that forest type. For example, a radiata pine forest is usually harvested at around age 28. The average assessment of carbon stored by a radiata pine forest over multiple rotations is equivalent to the amount of carbon it stores at around age 16.

Key Points:

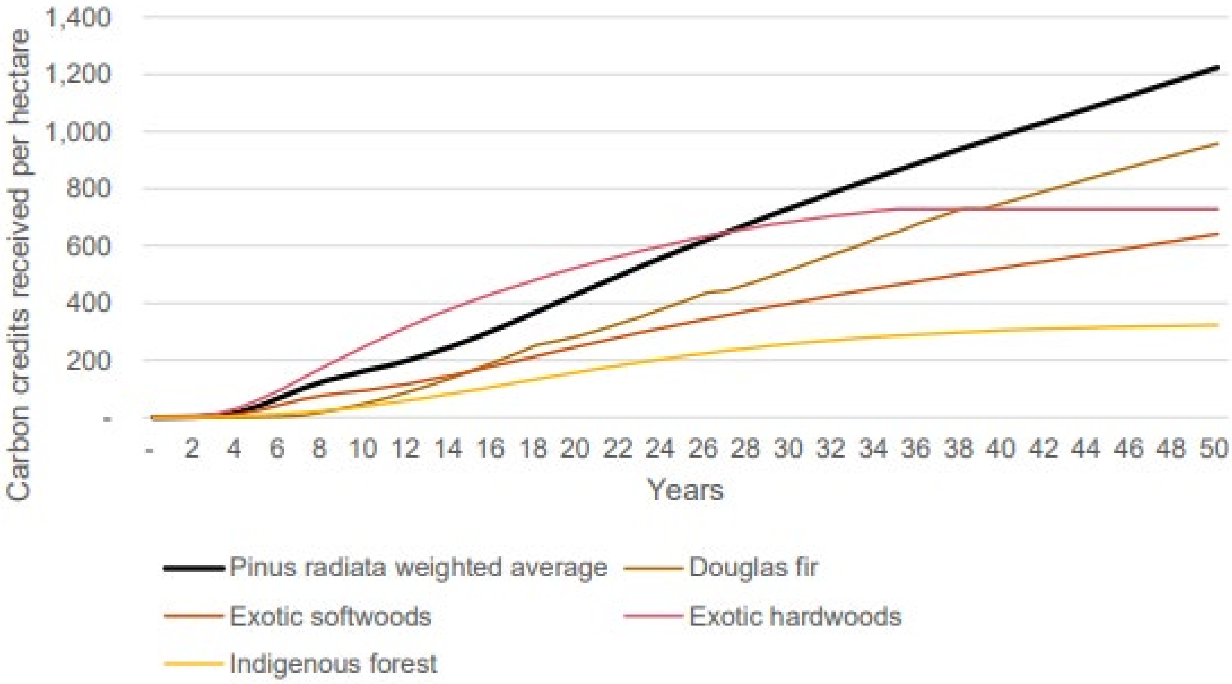
- Units are not repaid at harvest, but there is a requirement to replant.
- Accrues NZU's until 'average age' in years, but no further allocated from that point.
- Typically used for forests intended for harvest.
- This is the compulsory pricing mechanism for forests intended for harvest from December 2022 onward.

Carbon trading is complex. Post-1989 ETS eligibility is a variable that will vary from site to site and is a key economic contributor to returns when looking at afforestation opportunities vs timber-only regimes, i.e. harvest for timber-only and no-carbon allocation. The policy is regularly changing and requires expert advice to keep up-to date with latest amendments.

11.2 Carbon Sequestration by Tree Type

The number of carbon units received, and therefore allocation of NZU's, varies by tree species and will significantly impact the allocation of NZU's when looking at the function of emission off-set or selling units. Below, figure 27 depicts the various allocation rate of NZU's from common tree species found in New Zealand forestry regimes.

Figure 27: Indicative Carbon Sequestration Rates - By Tree Species



(Source: MPI, 2021)

MPI report that in Northland, *Pinus Radiata* will sequester approximately 800 tonnes of CO2 / ha over a 28-year period, or approximately 435 tonnes of CO2 / ha (average of 25.5 T /CO2/ha/year) over the 16-year averaging period. However, this fast growth and allocation of NZU's has a finite life of under averaging accounting, then no further allocation or economic contribution is recognised. In contrast, research undertaken in Northland by Tane's Tree Trust (*Rates of carbon sequestration in planted and re-generating New Zealand native forest, 2021*) found that native tree species such as Totara and Manuka /Kanuka sequester carbon for a significantly longer period and therefore provide a much longer-term allocation of NZU's, albeit at a lower accrual rate as seen above. A summary of their research found that:

- Re-generating manuka/kanuka forest sequesters carbon at a rate of 10 t CO2 ha / yr. for the first two or three decades of regeneration, but plateaus once its stock reaches about 260 t CO2 / ha at around 80 years of age.
- Re-generating totara-dominated forest can sequester carbon at a steady rate of 9-10 t CO2 ha / yr. over many decades, at least for the 120 years covered by the available data in the study.

These results show, that when looking at a long-term approach (>30 years) for NZU accrual, or potential offset of GHG emissions, native species can be a preferable choice for landowners given the longevity of carbon sequestration vs. the relatively short sequestration life of exotic species and not being bound to the requirement of harvesting. However, if short-term financial gain from trading NZU's is the mandate of the landowner, then this could be a more attractive option given the superior cash-flow liquidity. This may be a determining factor when looking at forestry species for carbon credit revenue.

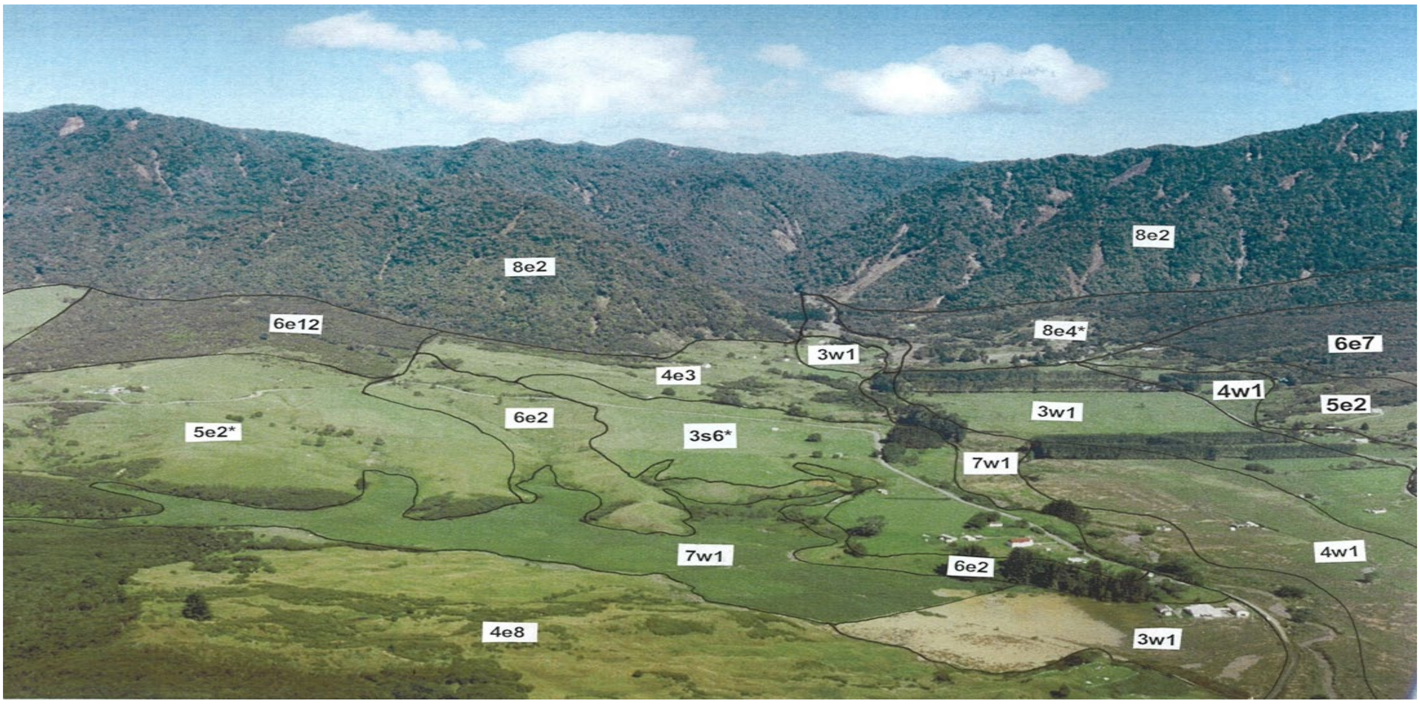
12 The Importance of Understanding Your Resources – Case Studies

The following section is a review of previous case studies that are relevant to encouraging the thought process behind viewing the farm as a 'whole system' in respect of an integrated approach to afforestation.

12.1 Case Study 1 - Identifying Land Strengths & Limitations

Understanding your farm as a land resource is critical to identifying specific limitations (*Cathcart, 20210).* The Land Use Capability (LUC) farm map, produced by Bob Cathcart from AgFirst in figure 28 below, gives an example of farm mapping to understand the specific limitations of a Northland Hill Country sheep and beef farm and overlaying the LUC framework to classify at a farm paddock level using classification systems such as wetness denoted with 'w' and erosion denoted with 'e'. In addition, this classification system also takes into account base soil structure, soil classification, and climate which helps landowners identify the scale and location of poor and high-performing areas.

Figure 28: Example of Land Use Capability Mapping on a Northland Farm



(Source: Cathcart.B., AgFirst, 2010)

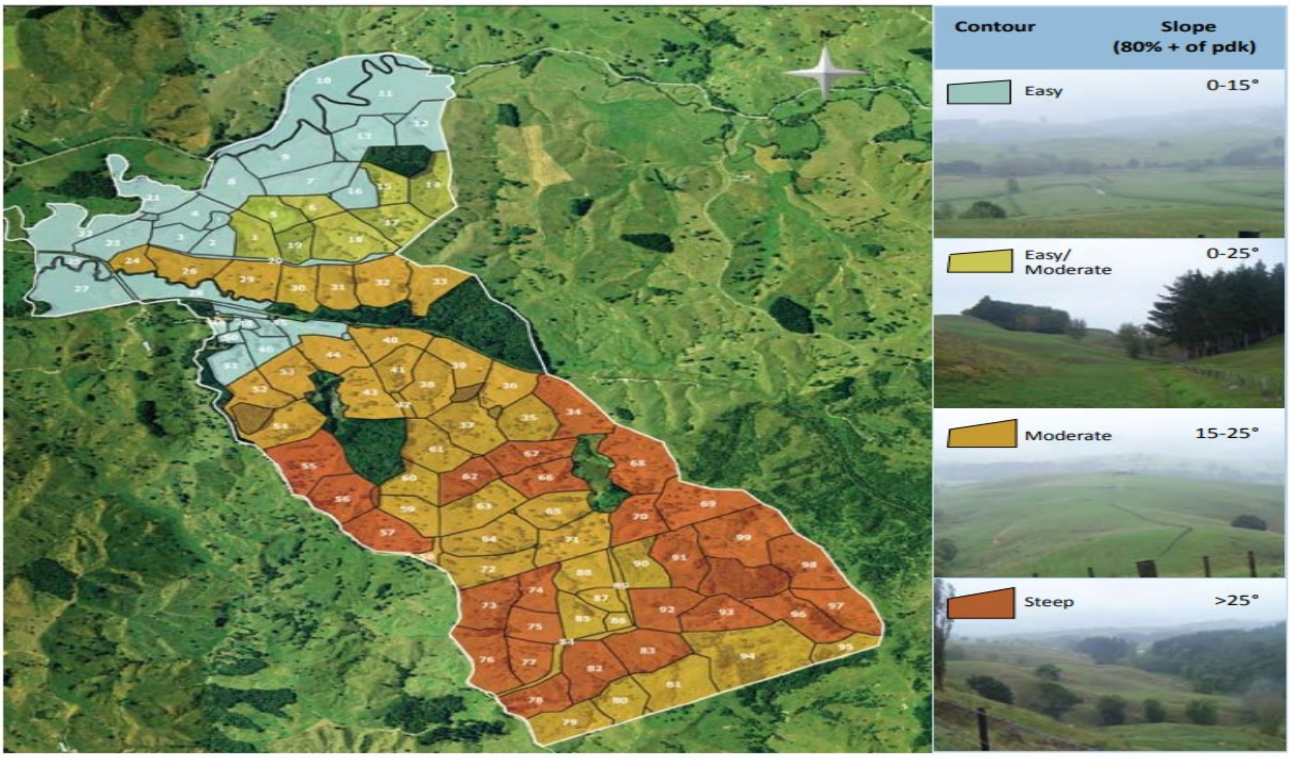
Application of the LUC map enables the landowner to make informed decisions based on specific physical characteristics of land. An example of such decision, may present in retiring marginal land use classes and consider integrating alternative land use options away from status quo, e.g., retiring '8e4' from pastoral farming and consider afforestation of native or exotic forests given the erosion susceptibility, resulting in sediment loss from this class of land.

12.2 Case Study 2- Farming by Land Type

The following section details research undertaken in 2011 by PA Handford and Associates and AgFirst Northland. The research project (*Towards Resilient Farm Businesses in Northland*, *Handford.PH. et al, 2011*) was commissioned by NZ Landcare Trust's Sustainable Farming Fund project.

The research project took an approach to understanding how farm profitability is influenced by land slope on a privately owned commercial sheep and beef farm in Waiotira, Northland. The farm encompasses a suite of land types in one contiguous farm parcel which grazes 4000 Stock Units (SU) on a 376ha effective platform, and therefore presents an excellent subject property for comparison against the 'typical Northland hill country farm'. The objective of the project was to ascertain if there is a relationship between topography, livestock production and profitability. For context, commodity prices for output products (meat and fibre) are taken from 2013-14 data, however the message remains the same around the importance of understanding your farm as a whole-system approach.

Figure 29: Analysis of Topography - Land Slope Map



(Source: NZ Landcare Trust, 2011)

Seen above, the farm has been overlayed using Geographic Information Software (GIS) to ascertain the slope profile. It is then categorised into four classes, being; easy, easy/moderate, moderate and steep based on relative degree of slope identified on the map legend.

To ascertain if there is a relationship between slope, production and profitability, the findings of this analysis can be summarised below in figure 30.

Figure 30: Effect of Slope on Pasture Growth, Production & Profit

Contour	Area (ha)	Pasture Production (kgDM/ha/yr)	Adjust to 85% Utilisation (kgDM/ha/yr)	SU/ha	Product cw/ ha (kg)	Gross Margin c/kgDM	Gross Margin $/ha	Farm Working Expenses $/ha	Net Profit ($/ha)
Easy	88	9425	8011	14	325	14	$ 1,122	$ 450	$ 672
Easy/Moderate	27	8338	7087	12	288	13	$ 921	$ 425	$ 496
Moderate	146	7250	6193	11	175	12	$ 740	$ 400	$ 340
Steep	115	4350	3698	6	100	10	$ 370	$ 350	$ 20

(Source: NZ Landcare Trust). Assumptions located in appendices – appendix B)

The biggest source of energy on a farm for livestock is the pasture grown *(B.Thompson, 2011).* The annual output of pasture growth can be measured as kilo's of dry matter per hectare per year (KgDM/ha/yr). The research that found annual pasture production ranges on typical hill country farms from 4,350 to 9,425 kgDM/ha/yr depending on fertility, pasture type, and slope.

Interpretation of this data suggests that slope is the most influential determinant of annual pasture production on hill country. Regarding profitability, there is direct relationship between pasture grown, stock performance and net profit with the easier contour producing more than threefold meat production per hectare and thirty-three-fold higher profit per hectare i.e., 98% of the profit comes from 70% of the farm. Therefore, the message is, that it is essential to understand where the most and least profitable components of the farm are, and the role that these respective classes of land play to the whole business in regard to production and profitability. For example, a beef breeding operation that utilises hill country to winter breeding cows to free up the easier contour for higher priority younger stock, may not require the same level of pasture growth for liveweight gain when compared to an intensive finishing operation that requires high levels or pasture-growth and liveweight gain for profitability. This needs to be considered under the whole farm system approach framework.

12.3 Case Study 3 - Opportunity for Integration of Forestry

Ground truth forestry consultants (*Praat.JP et al, 2021)* report that the integration of trees and forests though exotic and native species on farms, can provide multiple benefits to compliment a hill country farming business. This can be achieved through:

- **Income diversification** – by providing alternative sources of revenue away from meat and fibre commodity cycles through timber and carbon.

- **Erosion control –** By stabilising erosion prone soils and hillsides through the tree rooting structure and assist in preventing erosion. Though the harvest process of pines does can still contribute to sedimentation of waterways and must be managed carefully.

- **Climate resilience –** Having the ability to sequester carbon from the atmosphere and potentially provide farm operation emissions off-set.

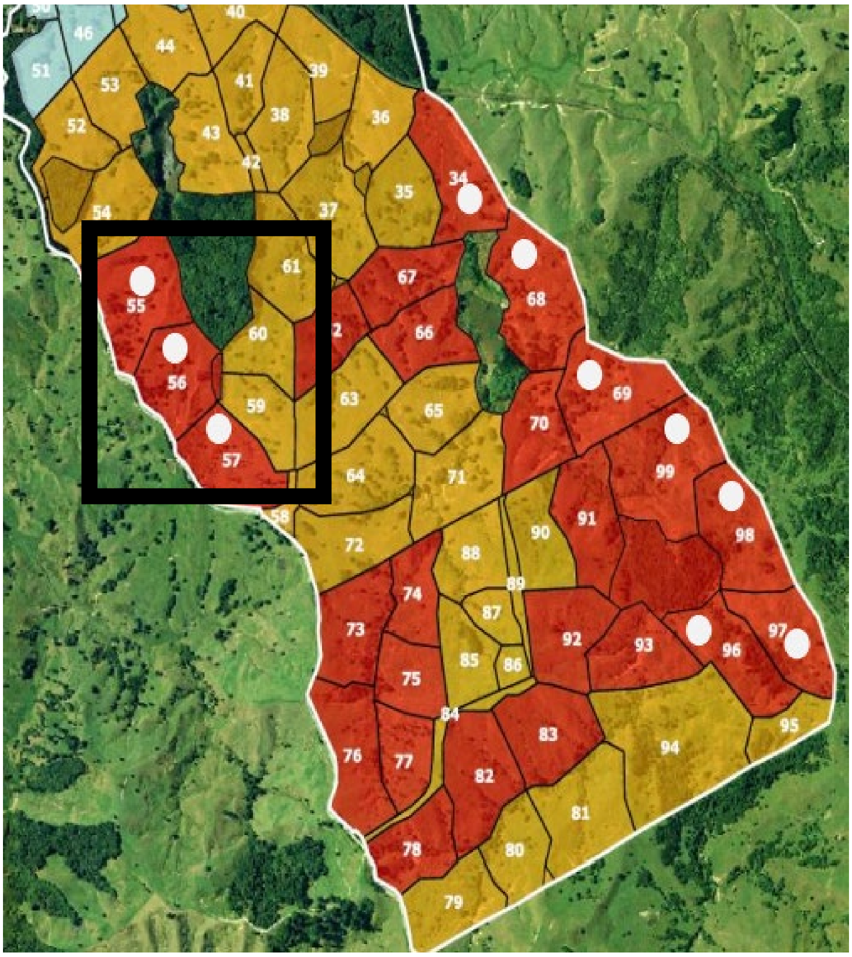
- **Increase Biodiversity –** Natives and Indigenous species attract flora and fauna and provide a habitat for plants and animals and possess many aesthetic benefits.

When deciding on what farming system best suits an individual business, they should consider several factors, including their production goals, attitudes, skills and knowledge, environmental considerations, and regulatory constraints (*Thorbury, 2010*). In considering these factors, a holistic and risk-weighted approach should be evaluated, assessing the business' individual strengths and opportunities, and to look at how a change in one enterprise, or individual enterprise of the farm, will have a resulting impact on the entire business. Utilising expert knowledge and advice, embracing software tools and careful planning is essential.

Utilising the same framework from the LUC mapping (case-study one above), an example of how an integrated afforestation opportunity may work for a hill country farming business targeting the lowest performing areas of the farm and considering the implications of this integration is provided below.

There are 115 hectares of 'steep land' paddocks on the subject property. With the criterion of assessing the relative productivity and profitability of the whole farm, a series of paddocks were identified (shown with white dots in figure 31) for potential conversion to forestry. These paddocks were chosen as they are either close to the road, or were contiguous in an area, which if retired, would have minimal impact on stock movement and maximise the value from the roading infrastructure required during harvest, which is a major variable when looking at net stumpage return under a harvest model. In this example, paddocks 55, 56 & 57 were chosen, given the close proximity to the road. The paddocks combined, total 15.6 hectares (4% of total effective farm area) and would accommodate approximately 94 stock units (6 S.U. / ha) under the pastoral grazing scenario.

Figure 31: Identification of Afforestation Opportunity



Two afforestation options have been considered for economic analysis: Pinus Radiata (Pine Tree) and planted permanent (non-harvest) indigenous species mix of Manuka/Kanuka & Totara for the identified area. There are other regimes available to landowners, such as spaced planted poplars, sustainable harvest native timber, eucalypts and exotic hardwoods, however given the limited availability of data and large economic disparity between these, they are not included in the analysis.

The analysis uses Net Present Value (NPV) methodology, which put simply, is the present-day value of a future income stream, and it recognises the fact that income is worth more today, than it is tomorrow due to inflation and there is an opportunity cost of money. This opportunity cost is called a "discount rate". A discount rate of 6% is used to represent the cost of funds required to finance these investment options. The NPV value is then converted to an annuity, or the average yearly income the landowner would expect to receive. It is assumed the pines are entered into the 'averaging' scheme and the indigenous stand is nominated into permanent stock exchange accounting with an economic life of 50 years, as per MPI look-up tables. Assumed carbon price of $50/T and selling units at each 5-year return period over 17 years. An Internal Rate of Return metric (IRR) has also been applied to indicate profitability (the higher an internal rate of return, the more desirable an investment is to undertake). The following assumes that the NZU value will remain static in price over the 17- & 50-year period for the respective calculations. The assumptions for the below analysis are in appendix B.

Figure 32: **Indicative Financial Summary - Per Hectare**

Indicator	Pine - Timber Only	Pine – With Carbon	Native/Indigenous
Establishment Cost	$1900	$1900	$10,000
Silviculture	$950	$950	$20
Net Harvest Return (28 years)	$21,837	$21,837	-
Discounted Annuity (average annual income)	$537	$1859	$318
IRR	9.1%	34%	3.9%
Ave T/CO2 Seq/Yr	0	25.5	6.5

(Values sourced from various case studies)

Analysis of the above regimes is intended to provide insight, not a forecast. Given the large economic disparity represented within individual forests, influenced by: harvesting method, roading infrastructure, location to port, forest management & commodity prices, it is strongly recommended that a landowner engage a reputable forestry consultant before considering any afforestation opportunities.

Key Findings and Implications

Pine tree income provides superior overall profitability and liquidity benefit over both the farming and indigenous species regime, accruing a total of 6762 NZU's over the total 15.6 hectares over 17 years. This represents a value of $338,100 at $50/NZU or, $1859 when annualised with carbon. However, this is only for the first rotation and thereafter, is limited to the timber-only regime which when annualised, would return approximately $537 per hectare, which is comparable to the top 20% of NNI Hill Country farming performance as identified in section XX

The native blend of Manuka and Totara will accrue a total of 5070 NZU's over the 15.6 hectares over a 50-year period, representing total income of $253,500 at $50/NZU or $318 per year when annualised over 50 years. Thereafter, MPI do not recognise any economic contribution, which would mean no further economic contribution to the business.

Additional potential sources of revenue for native/indigenous include honey revenue from Manuka. This has the potential to add an additional $300-$800 revenue / hectare / year, however these have not been modelled due to complexity and variation in quality of flowering Manuka and subsequent honey quality.

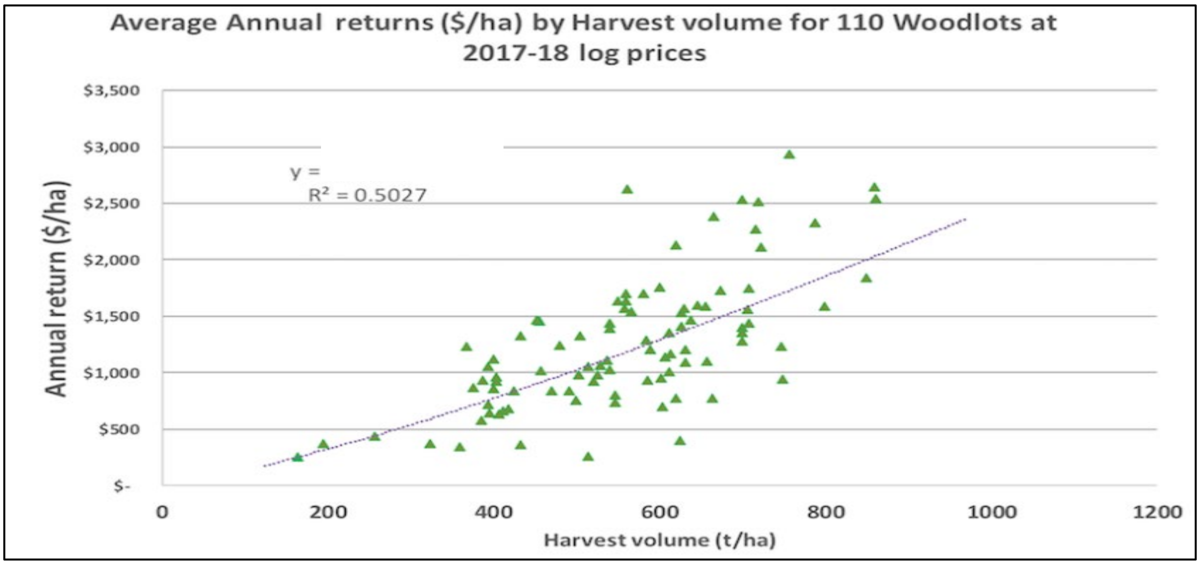
Upfront capital costs are significantly more for indigenous at $10,000 per hectare compared to pine at $2850 per hectare. However on-going silviculture costs are lower for indigenous than the pine regime, so the financial position of the individual needs to be considered before planting, i.e for a highly in-debited business this may be a significant challenge to fund up-front, so thought needs to be given as to how the integration will be funded, i.e though debt, or though cashflow. This decision will also be guided by land status and tenure, for example Māori land title would provide significant challenges to borrow against the land as security, so this will either need to be funded via cashflow, afforestation grant, introduced outside capital, or as a joint venture with a forestry company. The implication is, that this may impact on returns for the landowner or commit them to terms and conditions they are not necessarily comfortable with.

A less capital-intensive option is observed in letting Manuka & Kanuka re-generate naturally after fencing off. However, the carbon sequestration benefits may not be realised as quickly due to lower stocking rates of trees and negatively impacting liquidity from carbon. It would also require greater management of undesirable weeds, such as gorse to be controlled until the natives mature which requires labour and financial input.

The impact on land value needs to be considered and the implication of attached liabilities from participating in the ETS mechanism. If the accrued credits are sold as they are earned, this becomes an attached liability, i.e. if a change of land use away from trees is considered or the forest is harvested and not replanted, the NZU's will need to be repaid at the spot market rate at the time. The implication is, that the value of carbon could be significantly higher (or lower) than the value they sold at, potentially resulting in economic burden attached to the land and the long-term ability to change the land use may be prevented.

It is critical for any landowner looking to integrate forestry into the farming enterprise to assess the potential profitability before the land-use change occurs. Like farming, forestry is a heterogeneous enterprise and as such, displays a similar relationship of comparable financial performance as pastoral farming, as displayed below in figure 33. This data is taken from various real scenarios and illustrates a profit distribution from $3000 per hectare to $250 per hectare under a timber-only regime. This highlights the impact that key variable costs play in the profitability of the pine regime.

Figure 33: Financial distribution Spread of Harvest Foresty Plantations



(Source: NZ Farm Forestry Association, 2018)

The message is, it is important to keep a holistic view of the total benefit that a shift in land use will bring. If a landowner places higher virtue on environmental benefits over and above the economic metric, then this may be a determining factor in deciding on what the best use of land may be, i.e. the consumptive value of remaining in farming, or deciding on the species of forest to plant.

12.4 Case Study 4 – Impact on Residual Farming Operation

It is important to understand, that the impact of afforestation integration with farming, needs to be considered at the whole farm system level, and that any integration will have a resultant impact for the rest of the business. For example, what impact would retiring a portion of the farm out of pasture for integration of forestry, have on the logistical or profitability component of the business.

Journeaux et.al, *2020* reports that, up to a certain point, enterprises obtain cost advantages because of the scale of the operation. The cost per unit of output decreases with the rate that they are produced, because the fixed costs are spread out. In addition, operational efficiency usually becomes greater with increasing scale, which reduces unit costs further. Put simply, the bigger a farm is, the more effective hectares there are to spread the fixed costs (such as interest, insurance, and rates) because these costs will remain the same even if the farm area changes. It is also referred to as the 'scale of efficiency'.

This can theory be partially mitigated as highlighted in a case-study (*Endless Shades Of Green, MacGillivray & Tither, 2020*) undertaken by AgFirst in the Hawkes Bay. This case study identified the opportunity to maintain profitability through a focus on applying more productive/profitable systems on the better land and freeing up more difficult land that can be allocated to a longer-term forestry investment. The summary of the study concluded that, the subject farm would be able to generate a very similar EBIT from concentrating on the most productive 750 ha of the farm, compared to the currently more extensively farmed 1,250 ha operation. In addition, the 500-ha integrated into forestry would produce significant carbon income and eventually timber returns, which are not included in the summary table below.

Figure 34: Comparison of Financial Performance Variance

	Ha in pasture	EBIT per ha	Total EBIT
Current farm area & performance	1,250	$300	$375,000
All pasture – best practice performance	1,250	$430	$537,500
Best 750 ha @ improved performance	750	$525	$393,750

(Source: *Endless Shades Of Green, MacGillivray & Tither, 2020*)

The key findings found that by removing the least profitable area out of the pastoral production system and focusing on the easier contour, the resulting gross profitability was very similar (within 5%) to the existing larger farmed area. However the implication is, that for many farmers this would represent a significant change in their farming system, for example looking at a change in class of stock or policy to more intensive farming, for which the landowner would be looking for information and advice around such matters as; the degree of de-stocking, how this would affect grazing management, other changes in farm management e.g. calving dates, replacement rates, changes in stock types, changes in breeding strategies. Plus, of course, the impact on profitability. This highlights the need for sound advice and planning when looking at integrating forestry and what resultant impact the integration would have on the residual farming operation. For farms of existing marginal economic scale, this may be a determining factor not to integrate forestry.

The socio-economic implications also need to be weighted in the system change. For example, the landowner needs to consider if the residual farming operation following afforestation is of sufficient economic scale to continue to support the staff employed (if any) within the business and adopting the methodology of *Harrison, E & Bruce, H., 2019*, what will the land-use change impact have on the local community. To think more broadly, when the impact is compounded over multiple farms, the implication is significantly bigger.

13 Summary - What Are the Implications of Change?

What is apparent, is that the implications of change to a Northland hill country farm should not be generically applied across the board. The logic for this, is that implication measures such as increased land use competition, environmental regulation, financial performance, and socio-economic outputs are inherently individualistic to each farm business. Evidence of this this is seen in the wide disparity of financial performance among individual business, the individual policy regulations impacting each farm based on geography & topography or stock policy, and the inherent strengths and limitations that individual farms present under the LUC framework.

The implications for individual business' will be largely dependent on a variety of factors, these being:

Pressure to change – Fiscal policies such as the Emissions Trading Act and environmental policies such as the Freshwater Policy Statement and Zero Carbon Act imposing changes on the way farms operate and making landowners consciously aware of their environmental obligations and fulfilment of Kaitiakitanga (guardianship and protection). Or the social stigmatism associated with a change typically seen with afforestation.

Appetite for change - There may be a conscious bias to keep the land in its current use due to consumptive values or personal feeling toward a change of land use or change in stock policy.

Understanding to change – Landowners' may not understand there is opportunity to allow change on the farm, either through not-knowing what other opportunities are present, or that they they're unsure where to start on the journey.

Financial capacity to change - The capital costs may present as too significant to allow any change or may not identify appropriate funding strategies to support the change.

Land resources to allow change – The farm may not be suitable to accommodate any change through specific limitations or proximity to a port for harvest afforestation to be profitable.

Skillset to change – There may not be the skill-set present or the desire to learn a new skill set to drive changes on-farm. For example, a traditional breeding operation may not have the understanding or desired skill set to run a profitable finishing operation or understand how to make them more accessible contour land more profitable so more marginal land can be retired.

Individual landowners need to regularly and holistically evaluate their individual position and assess what potential implications may come from the change and, understand such benefits or potential consequences that will come from the change.

14 Key Findings

- Northland presents many opportunities for land use, and some are in direct competition with one another, such as horticulture competing for land use with dairy farms, urban sprawl competing with rural land use, and forestry competing with sheep and beef for land. Much of this, is driven by intrinsic behaviour including financial motivation and fulfilment of environmental obligations.

- There is an overwhelming sense of legislative and compliance pressure on the primary industry that will directly influence land use and land use decisions. These need to be well-thought out and that the implications of any change may be long-term, or even permanent. Future considerations need to incorporate an inter-generational view and a holistic thought process, so as, not to financially burden the following generation.

- The integration of exotic or native forestry regimes on hill country farms can provide improved financial resilience, profitability, and environmental benefits with well-planned and well-executed management.

- Understanding the relative profitability of various land uses provides the economic context, however more holistic views such as environmental and socio-economic impacts should be considered.

- Short-term economic incentives from policy financial instruments such as the ETS could result in economic burden for landowners and communities through attached perpetual liabilities from carbon.

- The addition of pricing mechanisms such as the ETS have dangled the financial carrot and challenged the historical land-use philosophy that forestry is only for the steepest of marginal country. However, the high performing hill country businesses are still competitive with timber-only regimes.

15 Recommendations

- Landowners need to understand their whole farm system, including specific strengths and limitations and relative profitability of all land classes on their property in addition to the logistical role each hectare of land on their farm plays.

- It is imperative that any landowner considering land-use use engages industry expert advice to understand what the implications of land-use change may present, including financial, environmental, logistical, and socio-economic.

- Hill Country Farmers must continue to adapt and become more financially and environmentally resilient through continuous improvement in productivity achieved with improvements in areas such as the genetic merit of livestock, stock class & policies, as well as adaptation to policy implementation and awareness of their environmental footprint.

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17 Appendix A - Key Inputs for Forestry

Forestry Costs

- Forest cost is based on establishing 1000 radiata pine/ ha
- Pruning twice (years 5 and 8) and thinning (year 8)
- An annual management and insurance fee of $60/ ha.
- Total cost in first 8 years is $2,850/ha.
- Gross income at harvest in 30 years is estimated to be $46,862/ha based on conservative yield of 550 m3/ha and three-year average log prices.
- The net income or "stumpage" is estimated to be $21,837/ha once roading, logging, management, RMA and transport costs are taken care of.
- Returning approximately $40/m3 of timber.
- A distance of 60km from port was used. Every additional 10km distance reduces stumpage by about $1100/ha.
- Where carbon value was included, the value of an NZU was assumed to be the same at harvest and during the growth of the crop.
- For the 15.6ha project, after annual management and insurance fees and establishment costs are paid for, the net return at 30 years is $241,837 or $537/ha/yr.

Returns at 30 years

	$/m3
Road & skid construction	$4.00
Logging & loading	$25.00
Management	$3.50
Contingency / RMA	$1.00
Total harvest costs	$33.50

Log grades	Yield (m3/ha)	Log price	Harvest cost	Transport cost			Net Stumpage ($/ha)	
				km	$/m3/km	$/m3		
Pruned	115.5	$125.00	$33.50	60	$0.20	$12.00	$9,182.25	
A Export - S1/S2 Domestic	100	$95.00	$33.50	60	$0.20	$12.00	$4,950.00	
K export	80	$90.00	$33.50	60	$0.20	$12.00	$3,560.00	
L/R Domestic	75	$65.00	$33.50	60	$0.20	$12.00	$1,462.50	
KI export	75	$75.00	$33.50	60	$0.20	$12.00	$2,212.50	
Pulp	104.5	$50.00	$33.50	60	$0.20	$12.00	$470.25	net $/m3
Total	550						$21,837.50	39.7

(Source, P.A Handford – 2021).

18 Appendix B - Key Inputs For farming

Gross Margin

Enterprise	Cents /kg DM
Breeding Ewes	12 – 14
Breeding Cows	8 – 9
Bull Beef	10 - 14
Average	12

- Gross margin per hectare was calculated from dry matter production per hectare and gross margin per kg dry matter. This ranged from $1,122/ha down to $370/ha.
- Averages of $3.75/kg carcass weight for bull beef, $3.90/ kg Cwt for prime beef, $5.50/kg Cwt for sheep meat and $2.82/kg wool were used for this analysis.
- Fertiliser, which adds about $100/ha to farm working expenses for steep land, has been included in farm working expenses.

19 Appendix C - MPI Look-Up Tables

Schedule 6: Tables of Carbon Stock per Hectare for Post-1989 Forest Land

Table 1: Carbon stock per hectare for *Pinus radiata* by region (expressed as tonnes of carbon dioxide per hectare)

Age (yrs)	Ak	W/T	BOP	Gis	H/SNI	N/M	C/W	O	S
0	0	0	0	0	0	0	0	0	0
1	0.5	0.4	0.4	0.6	0.5	0.2	0.2	0.3	0.2
2	3	3	2	4	3	1	1	2	1
3	8	7	6	10	9	3	2	5	3
4	29	25	24	37	34	12	5	9	14
5	59	50	51	77	71	28	15	26	35
6	98	84	84	121	113	48	31	49	65
7	131	111	118	162	155	73	53	72	99
8	153	130	143	190	185	100	76	94	134
9	166	142	155	201	197	117	101	124	160
10	188	163	169	219	210	132	125	141	174
11	217	188	188	242	233	144	139	146	181
12	249	218	212	270	260	161	150	156	198
13	283	249	239	302	291	182	158	172	219
14	320	283	269	336	325	206	170	192	244
15	357	318	300	372	361	232	186	214	272
16	396	354	333	410	398	260	205	240	302
17	435	391	367	447	436	290	226	268	334
18	473	428	401	485	473	322	249	298	367
19	511	464	435	522	510	353	274	329	401
20	549	500	468	558	547	386	300	361	435
21	585	536	501	594	582	418	326	394	470
22	620	570	533	628	617	450	353	426	504
23	653	603	564	661	650	482	380	458	538
24	685	636	593	692	681	513	408	490	571
25	715	666	622	722	712	543	435	521	604
26	745	696	650	751	741	573	461	552	635
27	773	726	677	779	769	603	488	583	667
28	801	755	704	807	797	632	515	613	698
29	828	783	730	834	825	661	542	644	729
30	855	811	755	861	852	690	569	674	760
31	880	838	780	886	878	718	595	703	790
32	905	865	804	912	903	745	621	732	820
33	930	891	828	937	929	772	647	761	849
34	954	916	851	961	953	799	672	789	878
35	977	941	873	985	978	825	697	817	906
36	1000	965	896	1009	1002	850	722	845	934
37	1022	990	917	1032	1026	875	746	872	962
38	1044	1013	938	1055	1050	900	770	899	989
39	1066	1037	959	1079	1073	924	793	925	1016
40	1088	1060	980	1102	1097	947	816	951	1043
41	1110	1083	1001	1125	1121	971	839	978	1070
42	1132	1106	1021	1148	1144	994	861	1003	1097
43	1154	1130	1042	1172	1168	1016	883	1029	1123
44	1176	1153	1062	1196	1192	1039	905	1054	1149
45	1198	1176	1082	1220	1217	1061	926	1080	1176
46	1220	1199	1103	1244	1242	1083	947	1105	1202
47	1243	1223	1123	1269	1267	1105	967	1130	1229
48	1266	1247	1144	1295	1292	1126	988	1155	1255
49	1289	1272	1165	1321	1319	1148	1008	1181	1282
50	1313	1296	1187	1347	1345	1170	1028	1206	1309

Key:
Ak means Auckland
BOP means Bay of Plenty
C/W means Canterbury/ West Coast
Gis means Gisborne
H/SNI means Hawkes Bay/Southern North Island
N/M means Nelson/ Marlborough
O means Otago
S means Southland
W/T means Waikato/ Taupo

Table 2: Carbon stock per hectare for Douglas-fir, exotic softwoods, exotic hardwoods and indigenous forest (expressed as tonnes of carbon dioxide per hectare)

Age (yrs)	Douglas-fir	Exotic softwoods	Exotic hardwoods	Indigenous forest
0	0	0	0	0
1	0.1	0.2	0.1	0.6
2	0.1	1	3	1.2
3	0.4	3	13	2.5
4	1	12	34	4.6
5	2	26	63	7.8
6	4	45	98	12.1
7	7	63	137	17.5
8	20	77	176	24.0
9	33	87	214	31.6
10	50	95	251	40.2
11	69	106	286	49.8
12	90	118	320	60.3
13	113	132	351	71.5
14	138	147	381	83.3
15	165	163	409	95.5
16	193	180	435	108.1
17	222	197	459	120.8
18	253	214	483	133.6
19	268	232	505	146.3
20	286	249	526	158.7
21	307	266	546	170.9
22	331	283	565	182.6
23	355	299	584	193.9
24	382	315	601	204.7
25	409	330	618	215.0
26	436	344	633	224.6
27	445	359	648	233.7
28	468	373	661	242.2
29	493	387	674	250.1
30	518	400	685	257.5
31	545	414	696	264.3
32	572	427	706	270.6
33	597	440	714	276.3
34	625	452	722	281.6
35	650	465	729	286.5
36	679	477		290.9
37	704	489		295.0
38	730	501		298.7
39	730	512		302.0
40	751	524		305.1
41	772	536		307.8
42	794	547		310.4
43	815	559		312.6
44	836	570		314.7
45	857	582		316.5
46	878	593		318.2
47	898	605		319.7
48	918	617		321.1
49	938	629		322.3
50	957	641		323.4