ANZ RESEARCH

AGRI INSIGHT

JUNE 2019

THE ROLE OF FORESTRY IN MEETING NEW ZEALAND'S CLIMATE CHANGE OBLIGATIONS

ANZ

This is not personal advice. It does not consider your objectives or circumstances. Please refer to the Important Notice.

INSIDE

CONTRIBUTORS

Susan Kilsby
Agriculture Economist
Telephone: +64 4 382 1992
Susan.Kilsby@anz.com

Sharon Zollner
Chief Economist NZ
Telephone: +64 9 3574094
Sharon.Zollner@anz.com

Publication date: 7 June 2019

SUMMARY

Land use change in New Zealand will be required to achieve improved sustainability. Sustainability requires a balance between economic, environmental and social needs. Planting additional trees can help achieve environmental goals but this will only be truly sustainable if it is done in a way that also meets the social and economic needs of our rural communities.

Forestry is being promoted by the Government as a tool to help it meet its climate change obligations. Planting additional trees will act as a carbon soak, mitigating greenhouse gas emissions from other sectors. Planting more forests is considered a bridge; a way to buy time until we find effective and efficient ways to reduce New Zealand's carbon dioxide (CO_2) emissions.

New Zealand's greenhouse gas profile differs considerably from other nations, as agricultural emissions make up nearly half of the total. In addition, livestock emit considerable levels of the greenhouse gas methane, whereas emissions in most other countries are mainly CO_2, this being the greenhouse gas produced by the use of fossil fuels.

The Climate Change Response (Zero Carbon) Amendment Bill introduces long-term targets for reducing gas emissions. Under the bill, short-lived gases such as methane will be treated differently to long-term gases like CO_2 and nitrous oxide. The 2050 methane emission reduction target is more ambitious than may actually be required to stabilise climate change to the degree targeted, and there has therefore been push-back from the primary sectors.

The targets for methane emissions are still somewhat ambiguous, as they will be revised by the newly established Climate Change Commission in 2024. By that time, development in scientific research and modelling capability should mean that emissions can be evaluated at the individual farm level. In the interim, emissions costs are likely to be met at the processor level, with costs then allocated to farmers through levies. This will reduce farm income levels, but provides no direct incentive to reduce on-farm emissions.

While the optimal treatment of agricultural emissions remains so challenging there are clear incentives to increase the quantity of trees being planted to reduce the required fall in emissions. Policy changes, grants towards planting costs, and the opportunity to gain revenue from carbon credits will all incentivise more trees to be planted.

Support from farmers is required to switch some land currently used for grazing to forestry. Ideally this would occur through pockets of plantings on grazing properties, rather than complete conversion of farms to forestry, which could have negative economic and social impacts for rural communities.

GREENHOUSE GAS EMISSIONS

SUMMARY

New Zealand has three greenhouse gas (GHG) emission reduction targets. They are:

- 2020 target to reduce emissions to 5% below 1990 levels
- 2030 target to reduce emissions to 30% below 2005 levels
- 2050 target to reduce emissions to 50% below 1990 levels.

At this stage New Zealand is on track to meet the 2020 target, but achieving the later-dated targets will require a significant reduction in emissions and/or a significant increase in carbon sinks, ie land in forestry.

The 2030 target was part of the Paris Agreement, which New Zealand ratified in October 2016. The Paris Agreement came into force in November 2016 and will take effect from 2020. Ratifying the agreement means New Zealand is committed to having a reduction target and regularly reporting on how we are tracking against this target.

The 2050 target to reduce emissions by 50% was initially declared in March 2011.

The Zero Carbon Bill was introduced to Parliament on 8 May 2019 and is expected to become law later in 2019. The Zero Carbon Act has separate targets for long- and short-lived gases.

Methane (CH_4) is a more potent but shorter-lived gas than carbon dioxide. One tonne of CH_4 is equivalent to 25 tonnes of CO_2 based on global warming potential over 100 years. However, methane lasts in the atmosphere for approximately 12 years, versus 100 years for CO_2. Therefore most of the methane being produced is simply replacing gas that has already dissipated. For this reason CH_4 emissions do not have to be reduced to zero to stabilise global temperatures.

The long-term (2050) targets for greenhouse gas reduction are:

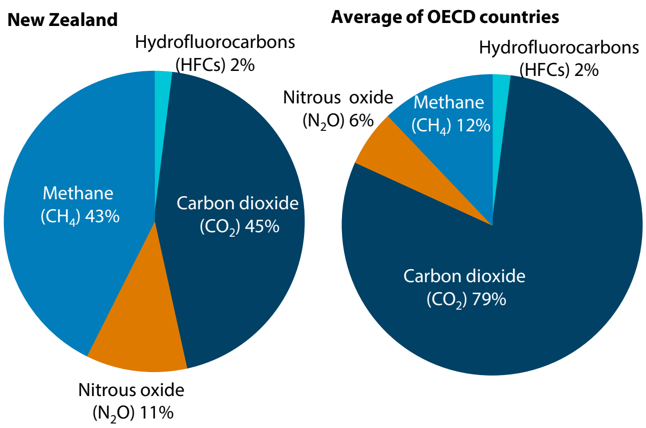
- Reduce all GHG except methane to zero by 2050 (accounting for offsetting from carbon sinks such as forests)
- Reduce methane (from agriculture) by 24 to 47% by 2050.

Because of the uncertainty about the future scientific progress regarding methane monitoring and reduction technology, the methane reduction target is provisional and will be reviewed by the independent Climate Change Commission in 2024. There is also a shorter-term target of a 10% reduction in biogenic methane by 2030.

Under the Climate Change Response Amendment Act, an independent Climate Change Commission is to be established, consisting of 6-10 experts appointed by Parliament. The two main functions of the Commission are to provide expert advice on targets, policies and climate risks, and to hold the Government of the day to account.

New Zealand's large agriculture sector relative to its population means it has a unique GHG emissions profile. In particular, we emit a relatively high volume of methane relative to carbon dioxide.

GROSS EMISSIONS BY GAS, FOR NEW ZEALAND AND OECD COUNTRIES

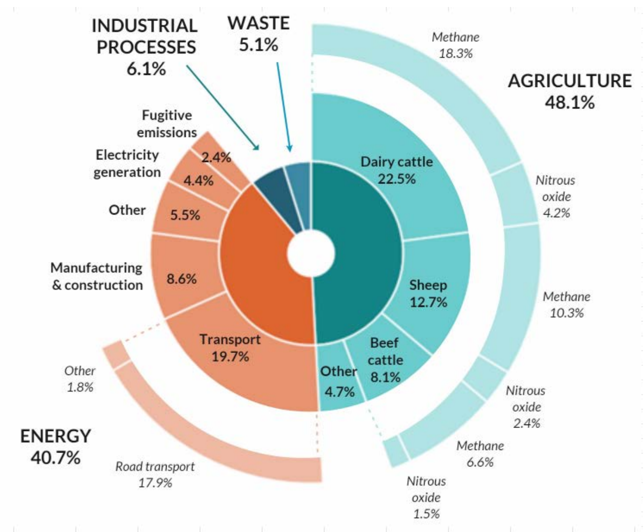


Source: Productivity Commission, OECD

GREENHOUSE GAS EMISSIONS

Agriculture is the main source of New Zealand's methane emissions, and contributes nearly half of New Zealand's total emissions. Without reducing emissions from agriculture it will be near impossible for New Zealand to achieve the targets it has agreed to under the Paris Accord, aimed at limiting temperature increase to 1.5˚C.

BREAKDOWN OF EMISSIONS BY SECTOR

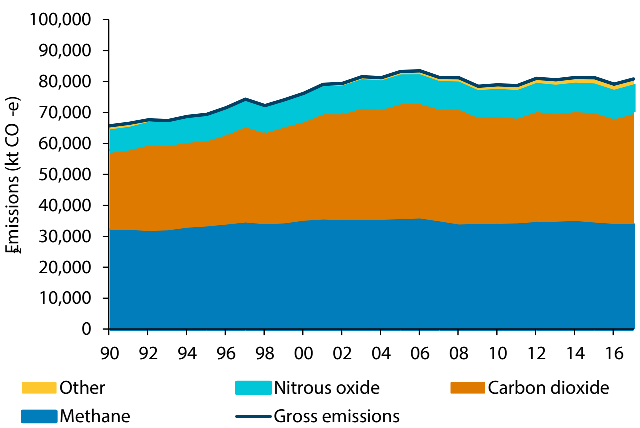


Source: Ministry for the Environment

EMISSIONS BY SECTOR

New Zealand's greenhouse gas emissions have generally stabilised over the past decade. Methane emissions levels haven't changed much since the early 1990s.

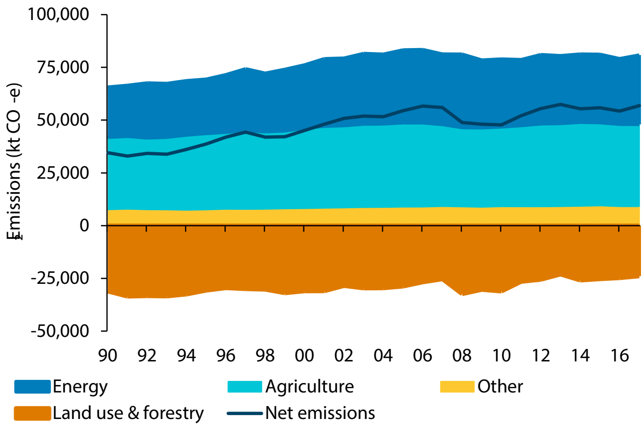
GREENHOUSE GAS EMISSIONS BY TYPE



Source: Ministry for the Environment

The biggest growth in net emissions has come from the energy sector (reflecting population growth) and a reduction in the offset from the forestry sector due to more trees being harvested.

GREENHOUSE GAS EMISSIONS BY SECTOR



Source: Ministry for the Environment

Forestry is currently included in the Emissions Trading Scheme (ETS), but agriculture is not. The forestry sector as a whole offsets emissions from other parts of the economy. Forests that were planted prior to 1990 are automatically included in the ETS scheme. This effectively means that if owners want to clear these forests they must pay the cost of the New Zealand Units (NZUs) associated with the forest.

AGRICULTURAL EMISSIONS

Agriculture is a source of emissions due to the methane that is produced by ruminants and the nitrous oxide that is released from faecal matter.

Methane emissions are caused by enteric fermentation. This is the digestive process by which ruminant animals' process food, from which methane is a by-product. Trial data shows methane emissions vary considerably between individual animals and farms. Further research is needed in this area to define the best ways to reduce emissions, but it is clear methane output varies due to both feed types and genetics.

Increasing productivity through improved individual animal performance to offset a reduction in stocking rates is one way to reduce emissions. Using feeds that have the following characteristics will also help:

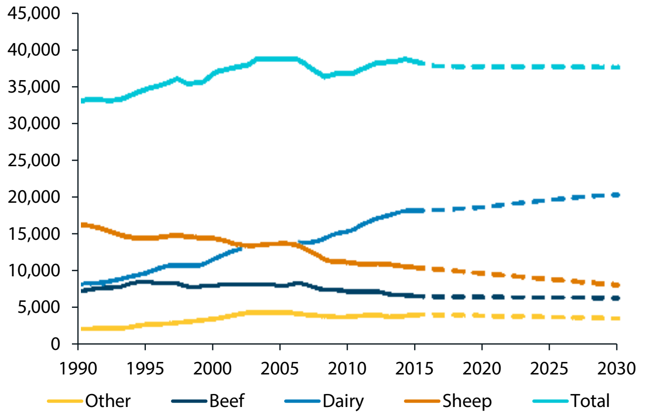
- Low crude protein feed, eg maize, plantain;
- Feed containing higher metabolisable energy (ME) levels, eg fodder beet, grain;
- Feed that produces less methane, eg forage rape.

GREENHOUSE GAS EMISSIONS

Agriculture is not currently included in the ETS, and appears unlikely to be included in the near future, due to long- and short-term gases being accounted for separately. But this does not mean that agriculture won't have to bear its share of the cost of its emissions.

As an initial step, it is expected that emissions from agriculture will be accounted for at the processor level. Accounting for emissions at the individual farm level would be much more effective at encouraging a reduction in emissions, but is also considerably more complex to model and manage, and current technology is not up to the job.

ACTUAL AND PROJECTED AGRICULTURE EMISSIONS BY SECTOR

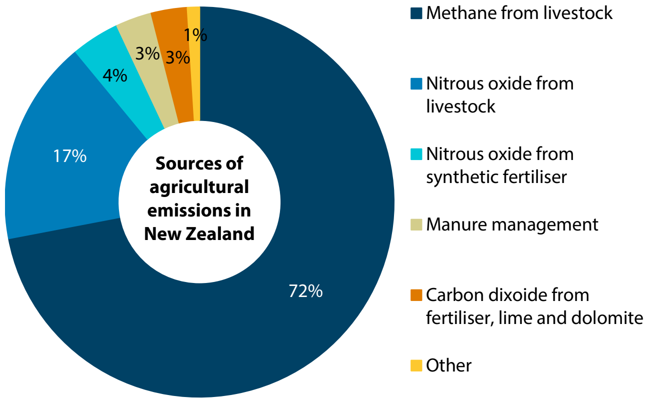


Source: ICCC

Emissions from agriculture have stabilised in recent years and this trend is expected to continue. Over the past 30 years emissions from sheep have fallen, while emissions from dairy have increased. This has been due primarily to a change in land use, but also productivity gains in all agricultural sectors.

Biological GHG emissions vary considerably between land uses and also between individual farms. Dairy farms emit, on average, about 10-11 tonnes CO_2 equivalent (CO_2e) per hectare, compared to 3-5 tonnes CO_2e per hectare for sheep and beef farms.[1] However, there is huge variation between individual stock and farm systems. Therefore, using average data is only useful to obtain ball-park figures and won't necessarily be relevant at the individual farm level. The big disadvantage of processor-level obligations is that all it encourages farmers to do is to lower their production.

BREAKDOWN OF NEW ZEALAND'S AGRICULTURE EMISSIONS 2016



Note: National inventory figures are published two years behind the current calendar year (for example, the 2018 inventory has figures up to 2016).

Source: Ministry for the Environment, ICCC

GREENHOUSE GAS COSTS ALLOCATED TO AGRICULTURE

There are several potential ways by which one could account for agricultural emissions. Two potential methods at the farm level are:

- A land-based method – based on emissions per hectare.
- An output-based method – based on emissions per unit of produce.

A land-based method that measures emissions on a per hectare basis will reward farmers who have low-intensity systems. Farmers with greater than average output per hectare, ie highly productive farms, will incur a greater cost under this method.

The downside of a land-based approach is that it does not encourage high output, and therefore may have negative economic consequences.

An output-based system considers emissions per unit of production, i.e. per kg of milk solids or meat. This system will reward more efficient farms. For example, a farm with a higher lambing percentage will tend to have lower emissions per unit of produce than a farm with a lower lambing percentage.

[1] Interim Climate Change Committee, "Rural Workshop Background Material"

GREENHOUSE GAS EMISSIONS

POTENTIAL COSTS TO AGRICULTURE

The data in the table below is based on trials and shows the huge range in the amount of emissions between farms. Further trial work could result in different results to those below. Figures in the following section should therefore be considered as indicative rather than actual assessments.

GREENHOUSE GAS EMISSION LEVELS BASED ON TRIAL DATA

	Land-based (CO_2e/ha)		Output-based (CO_2e/ kg product)	
	Average (t)	Range (t)	Average (kg)	Range (kg)
Dairy	9.6	3.1 – 18.8	8.8	4.3 – 17.2
Sheep & beef	3.1	0.9 – 5.1	16.0	3.8 – 33.7

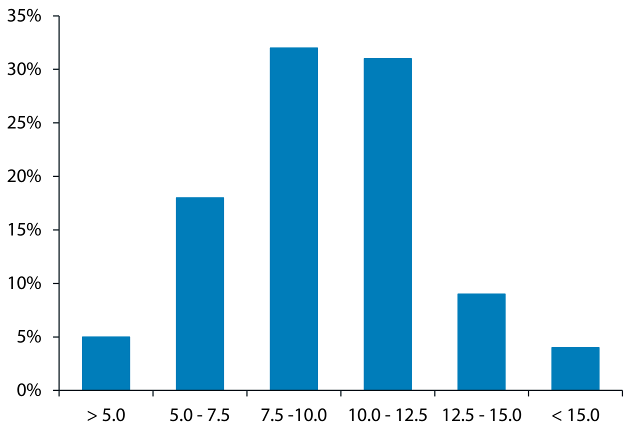
Source: NZ Agricultural Greenhouse Gas Research Centre (NZAGRC)

As there is no practical way to monitor actual emissions levels on farms, allocation will rely on modelling expected outcomes based on trial work. This would need to be done through a tool such as Overseer®, but considerable investment is required to enhance the accuracy of this tool, which was not developed with such a purpose in mind.

Overseer® or a similar type of tool could be used to model both nutrient and GHG emissions. If this could also be used to model the economic implications it would be a much more practical solution than trying to model GHG emissions alone. Research and development work for a tool with the capacity to do this is progressing.

DAIRY FARM EMISSIONS

DAIRY: TONNES OF CO_2E/HA ACROSS 400 FARMS



Source: DairyNZ Economics Group

Initially it is expected that the agriculture sector will be faced with paying for only 5% of the cost of its emissions. At this level the impact on the sector would be relatively minimal, even at a high carbon price. If the sector were faced with the full cost of its emissions then this would make it unprofitable for all but the most efficient farms to operate.

Assuming that just 5% of the cost of emissions is passed on, the costs would range between $4/ha to $94/ha for dairy farmers, with the range depending on emissions levels of individual farms and the carbon price.

DAIRY FARM EMISSIONS LIABILITY ASSESSED ON A LAND-BASED APPROACH ($ PER HECTARE)

Carbon liability: 5%				
CO_2e output per ha	Price of Carbon ($/t/$CO_2$E)			
	$25	$30	$50	$100
3.1	$4	$5	$8	$16
6.4	$8	$10	$16	$32
9.6	**$12**	**$14**	**$24**	**$48**
14.2	$18	$21	$36	$71
18.8	$24	$28	$47	$94

Source: ANZ Research, NZAGRC

If considered on an output basis, costs would range between 1c/kg MS and 9c/kg MS under a 5% obligation. The variation in the range of costs is due to differing emission levels and changes in the carbon price.

DAIRY FARM EMISSIONS LIABILITY ASSESSED ON AN OUTPUT BASED APPROACH – $ PER KG MS

Carbon liability: 5%				
CO_2e output per kg	Price of Carbon ($/t/$CO_2$E)			
	$25	$30	$50	$100
4.3	$0.01	$0.01	$0.01	$0.02
6.6	$0.01	$0.01	$0.02	$0.03
8.8	**$0.01**	**$0.01**	**$0.02**	**$0.04**
13.0	$0.02	$0.02	$0.03	$0.07
17.2	$0.02	$0.03	$0.04	$0.09

Source: ANZ Research, NZAGRC

The assessed impact on dairy farm profits with 5% of the emissions allocated is relatively small, even for high emitters at an elevated carbon price. But if the full cost of the carbon emissions were allocated to farmers, this would have a crippling effect on economic sustainability.

GREENHOUSE GAS EMISSIONS

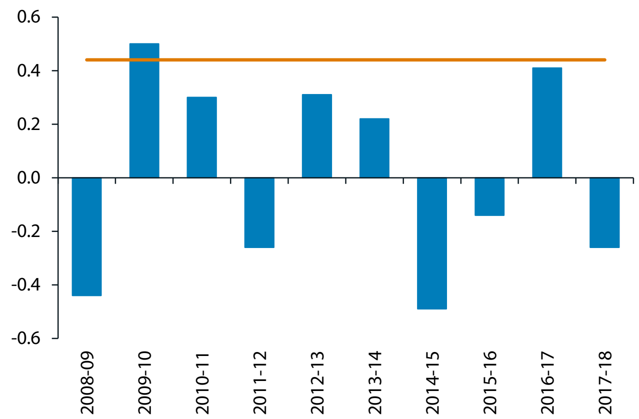
DAIRY FARM COST – $ PER HECTARE ASSUMING AVERAGE EMISSIONS LEVELS (9.6T/HA)

% liability	Price of Carbon ($/t/$CO_2$E)			
	$25	$30	$50	$100
100%	$240	$288	$480	$960
50%	$120	$144	$240	$480
10%	$24	$29	$48	$96
5%	**$12**	**$14**	**$24**	**$48**

Source: ANZ Research, NZAGRC

At full allocation, on a land-based approach, the carbon liability would be $480/ha assuming a $50/t carbon price at an average emission output level. For high emitters these costs would nearly double. On an output basis this would cost the average emitter $0.44/kg MS. As shown in the graph below, the cash surpluses generated from dairy farming would not normally be sufficient to cover the full cost of methane emissions (based on full allocation at a $50/t carbon price).

DAIRY FARM CASH/SURPLUS DEFICIT $/KG MS (AFTER DRAWINGS AND DEBT PAYMENTS)

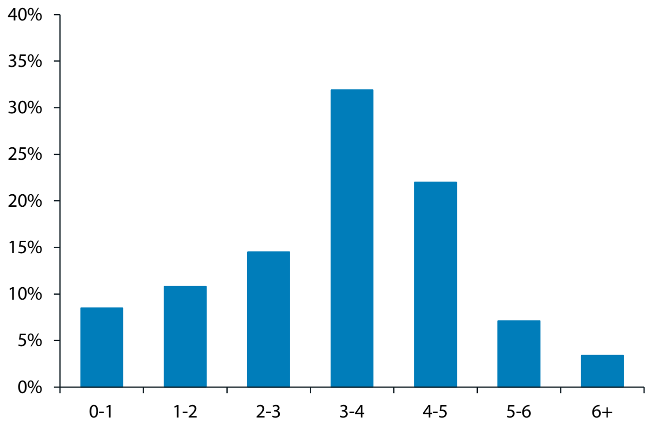


Source: Dairy NZ

SHEEP AND BEEF FARM EMISSIONS

Stocking rates on sheep and beef farms are typically lower than dairy farms; therefore their emissions tend to be lower on a per hectare basis. Trial work thus far shows emissions on the majority of sheep and beef farms are in the range of 3-5t CO_2e per hectare. Emissions will vary considerably due to the wide range of farming systems within the sheep and beef sector.

DRYSTOCK: TONNES OF CO_2E/HA ACROSS 81 FARMS



Source: MPI

The cost to this sector would range from $4-16/ha depending on the carbon price, assuming that just 5% of the emission liability is passed on and an average CO_2e output of 3.1t per hectare. If the full cost of the emissions are assumed then this would increase the cost to between $78 and $310 per hectare.

SHEEP & BEEF FARM – COST PER HECTARE VARIANCE

Carbon liability: 5%				
CO_2e output per ha	Price of Carbon ($/t/$CO_2$E)			
	$25	$30	$50	$100
0.9	$1	$1	$2	$5
2.0	$3	$3	$5	$10
3.1	**$4**	**$5**	**$8**	**$16**
4.1	$5	$6	$10	$21
5.1	$6	$8	$13	$26

Source: ANZ Research, NZAGRC

SHEEP AND BEEF FARM – COST PER HECTARE

% liability	Price of Carbon ($/t/$CO_2$E)			
	$25	$30	$50	$100
100%	$78	$93	$155	$310
50%	$39	$47	$78	$155
10%	$8	$9	$16	$31
5%	**$4**	**$5**	**$8**	**$16**

Source: ANZ Research, NZAGRC

GREENHOUSE GAS EMISSIONS

Emission liability could also be calculated based on the quantity of meat and wool produced. This method would reward farmers who are efficient at producing meat relative to the amount of livestock they are carrying on the farm. Therefore farms with higher lambing percentages, which produce more meat relative the number of ewes carried, and those farms which are able to finish lambs quicker, would benefit under this method.

SHEEP AND BEEF FARM – COST PER KG MEAT & WOOL PRODUCTION OUTPUT VARIANCE

Carbon liability: 5%				
CO_2e output per kg	Price of Carbon ($/t/$CO_2$E)			
	$25	$30	$50	$100
3.8	$0.00	$0.01	$0.01	$0.02
9.9	$0.01	$0.01	$0.02	$0.05
16.0	**$0.02**	**$0.02**	**$0.04**	**$0.08**
24.9	$0.03	$0.04	$0.06	$0.12
33.7	$0.04	$0.05	$0.08	$0.17

Source: ANZ Research, NZAGRC

Variation in productivity levels and farm intensity account for much of the differences in emissions levels within sectors. Across different sectors, the different averages depend a lot on digestive processes, feed types and the quantity of feed available. For example, a dairy cow typically has access to much larger quantities of feed than a beef cow does, and is often a larger animal with the capacity to consume more feed.

Simply cutting stock numbers is one way of tackling emissions. However, if this then results in a larger quantity of feed being available for the remaining stock then this won't necessarily solve the problem, as the emissions levels from the remaining stock has the potential to increase.

Details such as how changes in stocking rates are accounted for in any programmes used to model emissions will be extremely important in giving clear guidance to potential mitigation options.

Animal type	Emissions per animal (kg CO_2e/head/year)	Emission per kg of product (kg CO_2e/kg product ie milksolids or meat)
Dairy cow	2755	10
Beef cow	1812	10
Sheep	379	23
Deer	686	29

Source: Interim Climate Change Committee

As long- and short-term greenhouse gases will be accounted for separately, it won't be possible for farmers to directly offset their methane emissions by planting trees. However, carbon credits can be earned from trees planted that are eligible and entered into the emissions trading scheme. This revenue source can then be used to offset the cost of methane emissions.

Planting trees has the potential to offset the emissions from other sectors. Emissions of various types of gases are typically converted to CO_2 equivalent (CO_2e) for ease of comparison and to enable viewing emissions as a whole.

Under this framework it is theoretically possible to consider how much land needs to be converted to forestry to offset emissions from farm livestock, though in practice the trees are not going to soak up the methane produced by the sheep and cattle.

The area of land required to be planted in trees will depend on assumed methane levels, carbon prices, averaging methodology etc. As policy is yet to be finalised this can't be calculated with a high degree of certainty. While there will be much variation between farms, the following estimates are based on assumed average emissions levels and the amount of CO_2 a growing pinus radiata forest is assumed to be able to soak up during its first 18 years.

As an approximate guide, one hectare planted in trees would offset the emissions of about eight dairy cows or 70 sheep. This would mean the average-sized dairy farm would need to plant approximately 50ha in trees to offset its emissions. A similar area would also offset the emission of approximately 3500 sheep.

GOVERNMENT POLICY

The One Billion Trees Programme (1BT) covers a number of government initiatives designed to encourage more trees to be planted. The purpose of 1BT is to accelerate New Zealand's growth towards a low-emission economy, although the initiatives are focused primarily on finding a way New Zealand can meet its current climate change obligations. 1BT is funded through the Provincial Growth Fund.

The main initiatives under the fund are:

- Direct landowner grants.
- Partnership grants for research/development and workforce initiatives.
- Crown Forestry joint ventures with landowners to plant commercial-sized forests.

The Government has put aside $240m to fund direct land-owner grants and partnerships over the next three years.

The **direct landowner grants** effectively compensate farmers for most of the cost of small-scale planting. Grants are available for up to 300ha under this scheme, with a minimum planted area of one hectare for mixed native trees/scrubs and five hectares for pines/manuka/other exotics. Higher grants are available for planting natives due to the higher establishment costs.

The grants are paid out progressively, with 30% paid when the application is approved, 50% once planting is completed and a final 20% when you are able to prove the trees have been successfully established and are being actively managed. This means as a land-owner you are subject to the financial risk of not receiving your grant should the plantation not be successfully established.

Even with the grants being offered under 1BT, cash-flows for establishing all types of forests will be negative until at least year seven. This is due to planting, pruning and thinning costs, which are incurred early on. Radiata pine plantations with carbon revenue have the potential to deliver a positive cash-flow from about year seven, but this depends on establishment and management costs. Depending on the price of carbon, land-owners planting pines may be better off applying for the government grants, as then they would be eligible to receive carbon credits for the first six years. The value of the credits will depend on the carbon price and the region. For the Waikato/Taupo region a pine tree is assumed to sequest 84t/ha of carbon in its first six years, which at a $25 carbon price is worth $2,100/ha – considerably more than the government planting grant of $1,500/ha.

If you are entitled to a land-owner grant this doesn't mean your forest is automatically entitled to join the ETS scheme. The criteria for ETS approval is separate to the grant scheme.

The **partnership grants** available under 1BT focus on, but are not limited to, the following areas:

GRANTS AVAILABLE FOR PLANTING TREES

Type of planting	Project size (ha)	Grant ($/ha)	Top up available ($/ha)			ETS eligible
			Erosion	Fencing	Ecological Restoration	
Indigenous mix (native trees/shrubs)	1-300	$4000	$500	Up to $500	Up to $2000	Yes
Manuka/Kanuka (erosion control/nurse crop for indigenous forest)	5-300	$1800	$500	N/A	N/A	Yes
Indigenous natural regeneration (retiring land to naturally return to trees)	5-300	$1000	$500	Up to $500	N/A	Yes
Exotics (eucalypts, redwoods or pinus radiata)	5-300	$1500	$500s	N/A	N/A	Yes, but not for first 6 years for Radiata pine

Source: MPI, PF Olsen

GOVERNMENT POLICY

- Labour and workforce development.
- Advice and information for landowners.
- Catchment-based tree planting and restoration to improve environmental outcomes relating to erosion, water quality and biodiversity.
- Science and research including land-use support decision tools.
- Seedling and nursery production.

Crown forestry joint ventures provide an opportunity for land-owners to lease land to the crown, or enter in a joint venture, to develop a commercial-scale forest. This scheme aims to stimulate new planting by providing the upfront funding for a forest development, which is considered a barrier stopping landowners directly investing in forestry.

A minimum land area of 200ha is required, and the land must be commercially viable. Under the scheme land owners can either be paid an annual rental for use of the land or a share of profit at harvest, or a mix of both. If the land is eligible for carbon credits, these will belong to the land-owner.

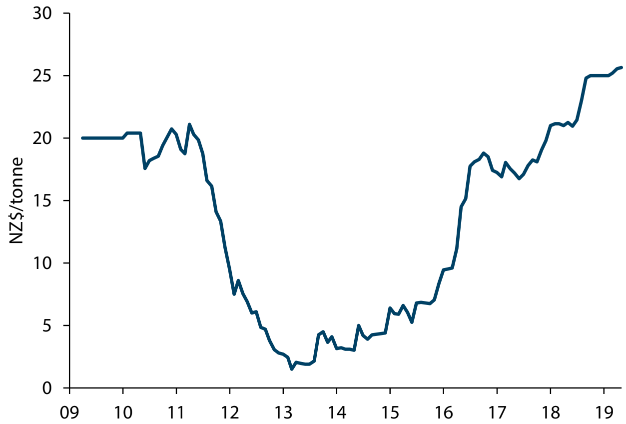
EMISSIONS TRADING SCHEME

The Emissions Trading Scheme (ETS) puts a price on greenhouse gas (GHG) emissions, providing an incentive to reduce them. Planting more land in forests effectively buys New Zealand more time to find ways to reduce GHG emissions. Adding trees soaks up carbon from the atmosphere while they are growing. But once a forest reaches maturity it is considered to be carbon neutral, ie the amount of carbon being soaked up is equal to the amount being released through the decay of fallen trees.

Planting trees provides a one-off opportunity to generate carbon credits. Realising revenue now through the sale of carbon credits puts an obligation on future generations to maintain land in forestry or pay the cost associated with buying back carbon credits at a later date. The value of carbon credits has the potential to rise (and fall) significantly. How the carbon price moves will depend on future government policy and economic factors, which will determine the demand and supply for carbon. At present the carbon price is capped at NZ$25 per New Zealand Unit (NZU). One NZU equates to one tonne of CO_2 equivalent.

Under the current ETS review the cap on the NZU price is expected to change, which would allow the price to rise. New Zealand's ETS scheme was once linked to international schemes, meaning that NZUs and international units could be exchanged. However, the New Zealand scheme was uncoupled from the international scheme when the international carbon price collapsed due to oversupply of units from schemes that lacked integrity. Outside of the ETS scheme carbon has traded above $25/t within New Zealand. This has occurred as companies who are not yet able to join the ETS scheme secure carbon credits now as they perceive there is a risk the price of carbon will rise with changes in government policy.

NEW ZEALAND CARBON PRICE



Source: Bloomberg

Increasing New Zealand's carbon sink, or ability to offset GHG emissions, through planting more forests is considered a bridge or way to buy time until we find effective and efficient ways to reduce our emissions.

HOW DOES THE ETS WORK FOR INDIVIDUAL FOREST OWNERS?

Joining the ETS scheme is voluntary for owners of post-1989 forest land. Once you are part of the scheme you are entitled to receive (or give up) NZUs, also referred to as carbon credits, for changes in the carbon stocks in your forest. You can join the scheme at any time, but can only claim units for the period which you are registered. Forests can be added or removed from the scheme at any time.

If you own land with pre-1990 forest you automatically become an ETS participant if you deforest this land. There are some exemptions, including the ability to remove up to two hectares of land in each five year period, but generally land that contains pre-1990 forest must remain in forest or a carbon liability must be paid.

ETS members must submit returns at least every five years that account for the changes in carbon stocks.

To be included in the ETS scheme a forest must be at least one hectare in size, contain tree species that will grow to at least five metres high, and have a canopy cover of at least 30% of the land area, and the forest must be at least 30 metres wide. This means most shelter belts, riparian plantings and pole plantings on farms are not currently eligible to be registered in the ETS.

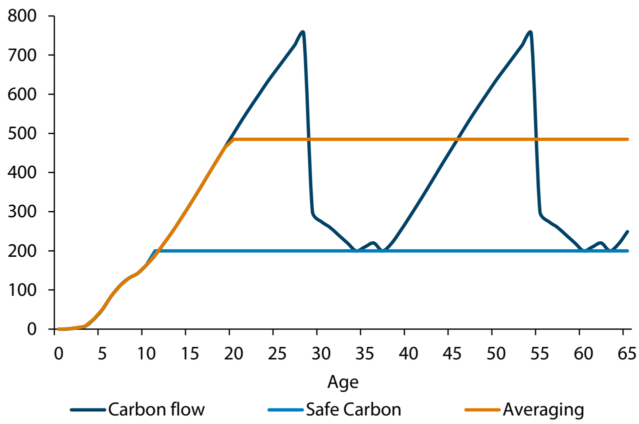
GOVERNMENT POLICY

AVERAGING TO INCREASE LIQUIDITY

Recent changes to the ETS have simplified the way carbon is accounted for by averaging the peaks and troughs in the assumed carbon sequestration and release rates. Averaging aims to reduce the cost and complexity for forest owners and is expected to increase trading in carbon credits as forest owners won't be so concerned about their potential carbon liability at harvest.

Under the new averaging accounting approach you receive fewer carbon credits (NZUs) as your forest grows, but you no longer have to repay any NZUs at harvest, assuming the land is replanted within four years of harvesting. If replanting doesn't occur then you will be required to relinquish NZUs earned beyond the 'safe carbon' level.

RADIATA PINE CARBON SEQUESTRATION SCENARIOS (NZUs/hectare)



Source: PF Olsen

'Safe carbon' refers to the portion of the carbon that is assumed to be retained in the roots of the tree after harvest. In practice this carbon is gradually released, but for the purpose of the ETS it is assumed to be locked up. The safe carbon level is approximately 25% of the total amount of carbon the forest is expected to soak up over its lifetime.

Using the new 'averaging' methodology will be compulsory from 1 January 2021, and optional for forests registered before then.

Averaging eliminates the risk land-owners currently face of carbon liabilities at harvest. The 'averaging' methodology does mean that forests still need to be replanted, but it takes away the cash flow ebbs and flows associated with receiving and then repaying carbon credits, assuming the potential income has been realised.

The exact time period up to which you will be able to earn carbon credits under the new 'averaging' methodology is yet to be decided. Where it should be set really depends on how long you plan to grow your forest before harvesting. The Government may decide on a set time period as this would simplify the process, which is really the overall objective of introducing the 'averaging' methodology. Details will be set in regulation following a period of consultation in late 2019.

The quantity of carbon stocks in a forest at any given time can either be calculated by a detailed forest assessment of yields or one can simply assume standardised levels. Carbon stocks in forests under 100ha are assumed to occur at standard rates, which are set out in the government-produced 'Carbon Look-up tables'. Larger forests are required to use a participant specific Field Measured Approach, which is basically an assessment of how quickly that particular forest is growing and how dense the plantings are.

Carbon Look-up Tables cover the five following types of forests:

- Pinus radiata
- Douglas fir
- Exotic softwoods
- Exotic hardwoods
- Indigenous forest

Pinus radiata has considerably higher ability to soak up carbon than other tree varieties due to being a fast-growing tree (in New Zealand conditions).

For pines there are also specific rates for each region, due to the regional difference in growth rates. Gisborne, Hawke's Bay and Auckland (including Northland) are assumed to be superior regions for growing pines, whereas Canterbury has the poorest growth rates.

VALUE OF PINUS RADIATA CARBON SEQUESTRATION AT YEAR 18

		Auckland	Waikato/ Taupo	Bay of Plenty	Gisborne	Hawke's Bay/ Southern NI	Nelson/ Marlborough	Canterbury/ West Coast	Otago	Southland
NZU's/ha (t CO_2/ha)		473	428	401	485	473	322	249	298	367
$/t	25	11,825	10,700	10,025	12,125	11,825	8,050	6,225	7,450	9,175
	50	23,650	21,400	20,050	24,250	23,650	16,100	12,450	14,900	18,350
	100	47,300	42,800	40,100	48,500	47,300	32,200	24,900	29,800	36,700

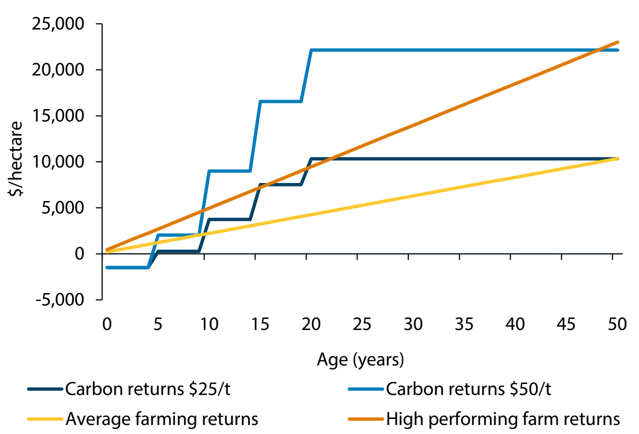
Source: MPI, ANZ Research

GOVERNMENT POLICY

The previous table shows the standard quantity of carbon that a pine forest is assumed to be able to sequest at certain ages. It is assumed that under the new 'averaging' methodology, carbon credits would be able to be sold up to approximately year 18 without incurring future liabilities at harvest (providing replanting occurs). However, the exact time period under the 'averaging' methodology is yet to be set, so this should only be considered indicative.

Returns from farming for carbon stack up relatively well compared to average returns from sheep and beef farms. Assuming farming returns $203/ha before interest and tax, then carbon returns from planting pinus radiata would provide a similar return to farming over a 50 year period, at a $25/t carbon price. There are a lot of variables to consider therefore this should only be taken as an indicative guide. If the carbon price is higher than $25, and/or it is also viable to harvest and replant the trees then returns from trees would outperform the average return from farming. However if considered over a longer time period then farming could potentially outperform forestry due to the limited period for which carbon revenue would be obtained. Slower growing species such as natives have the potential to generate carbon returns over a longer period of time, but overall returns would be lower than for pines. Higher returning farms will generate returns competitive with carbon returns over a 50 year period, and outperform over a longer period of time assuming the carbon price doesn't exceed $50/t. Poorer performing farms, or areas of farms which are lower performing will tend to generate stronger returns from carbon than from farming. In all cases planting trees tends to generate negative returns in the first six years which will have cashflow implications.

RETURNS FROM SHEEP & BEEF FARMING AND CARBON



Source: ANZ Research, MPI

HOW MANY TREES DO WE NEED?

One billion trees is an arbitrary number that doesn't necessarily equate to New Zealand meeting its Paris Accord obligations.

The Government estimates the 1BT programme will result in an additional 500 million trees being planted over and above the 500 million trees already expected to be planted to replace forests being harvested.

Assuming trees are planted at rate of one tree per 10m2 or 1000 trees per hectare this means an additional 500,000ha of land would need to be planted in new forest to achieve the planting of 1BT. Counting the planting needed to replace forests harvested, that would mean 100,000ha of trees planted every year for the next 10 years, or 1 million ha of plantings.

Planting at this scale has occurred only once previously, in 1994. It will be a challenge for the forestry industry to find the capacity to continuously plant this number of trees over the next decade. Labour availability is expected to be a key constraint.

While the desire of the government is to see small areas of trees planted on less productive areas of land, we are already seeing whole farm conversions to forestry. In some cases this may be the best use for the land, but rural communities fear that if large areas of land are converted to forestry this will have a negative impact on the sustainability of rural communities, due to a decrease in the number of farming families residing in the area. It is estimated that farming provides six times the number of sustainable jobs that forestry does. Forestry provides a surge of activity at planting and harvesting, but typically does not provide permanent roles located within rural communities.

For example, land use change from agriculture to forestry was evident in the Lake Taupo catchment following policy changes designed to reduce nitrogen levels in the lake. The social implication for farms stranded within blocks of forestry was a reduction in the support they had previously received from neighbours in both a practical farming sense and a social sense. Any major land use change could also reduce the services within certain rural communities such as schools.

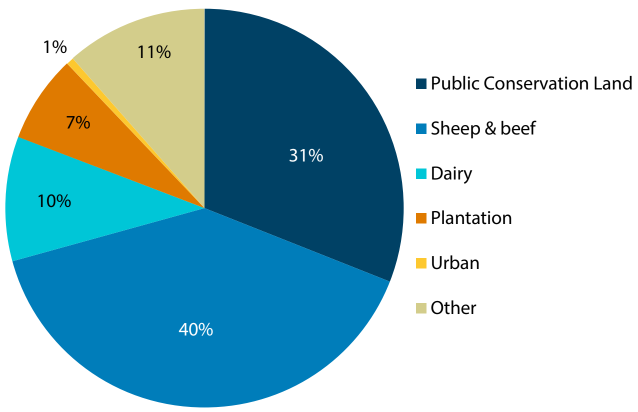
The Productivity Commission last year assessed that a further 1.3 to 2.8 million hectares would need to be planted to get the economy to net-zero carbon by 2050. Net-zero carbon is a more ambitious target than that to which New Zealand is currently committed.

GOVERNMENT POLICY

CURRENT LAND USE

Land currently used for pastoral farming is the most likely category where we will see expansion of plantation forestry. There is currently 10.6 million hectares of land used for sheep & beef farming and a further 2.7 million hectares used for dairying. Combined, these two categories account for 50% of total land use. At present plantation forestry accounts for 7% of total land use.

LAND USE IN NEW ZEALAND



Source: MPI

Dairy land typically occupies higher quality land than sheep and beef farms, meaning growth in plantation forestry is most likely to occur on land currently used for sheep and beef farming. Of the land used for sheep and beef, approximately one quarter (2.8m ha) of it is already covered in some form of native vegetation.[2] This indicates that approximately 20% of the land used for sheep and beef farming is not effectively being grazed and is probably not ideal for pasture production. This land containing native vegetation is either land that was never cleared or land that has reverted or is reverting to scrub. Depending on the coverage of scrub, this land may be more suited to revert to native forest than for planting an exotic forest, which would require the existing scrub to be cleared.

Whether this land can be entered into the ETS and revenue sourced from carbon will depend on how long this land has been covered in vegetation. Land that was in pasture in 1990 would be eligible to enter into the ETS. Beef + Lamb NZ estimate that 1.4 million hectares containing native vegetation is potentially eligible for the ETS.

[2] Norton, D. & Pannell J. 2018 Desk-top assessment of native vegetation on New Zealand sheep and beef farms, University of Canterbury School of Forestry and Auckland University of Technology Institute for Applied Ecology.

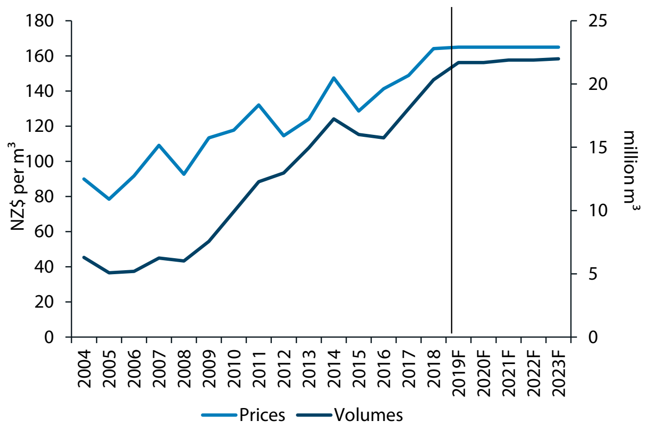
FORESTRY'S PLACE IN NEW ZEALAND'S ECONOMY

Forestry is New Zealand's third-largest export industry behind dairy and meat. Forestry is expected to return approximately $6.8bn in 2019 in export revenue from the sale of logs and lumber.

Forestry currently contributes $1.74bn to New Zealand's Gross Domestic Product (GDP), which is 0.6% of our economy. This compares to the returns from agriculture of $11.3bn or 4.2% of GDP.

Returns from forestry have doubled in the past decade, driven by both higher returns for logs and an increase in the volume of timber harvested.

LOG EXPORT PRICES AND VOLUMES



Source: MPI, Stats NZ

Export returns for logs are expected to remain near current levels in the coming years as harvest volumes stabilise near the current elevated levels.

Planting activity was very high in the early 1990s and these trees are now reaching maturity; hence the increase in harvesting activity. This additional planting activity was primarily by small-scale owners, as opposed to forestry companies.

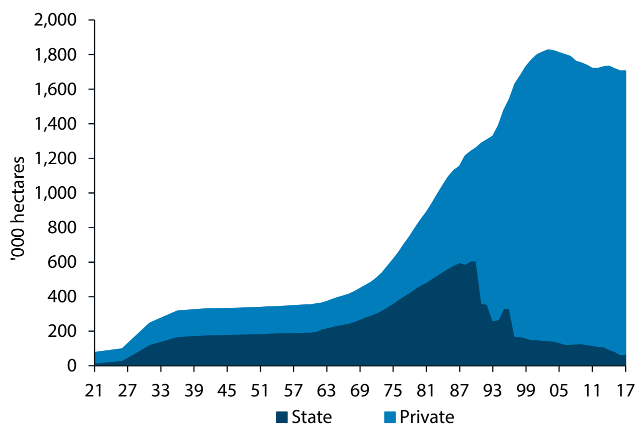
If extra land is planted in trees now, then there will be a lag of about 28 years before these trees are ready to harvest and thereby bolster export earnings. In the interim if planting extra trees displaces livestock, then this will hinder export returns. A 10% reduction in livestock units would effectively carve $3bn a year from export returns.

The volume of timber available to harvest from large-scale plantation forests is forecast to be relatively stable from now out to 2050. Small-scale forests of mature age are expected to peak in 2022. This assumes trees are ready to harvest at 28 years. In practice not all trees will be harvested at exactly 28 years, but harvesting will generally occur between 26 and 30 years.

PLANTED AREA

Planted forests are currently estimated to cover 1.71m hectares.[3] The volume of timber standing is estimated to be 519 million cubic metres.

FOREST OWNERSHIP IN NEW ZEALAND



Source: MPI

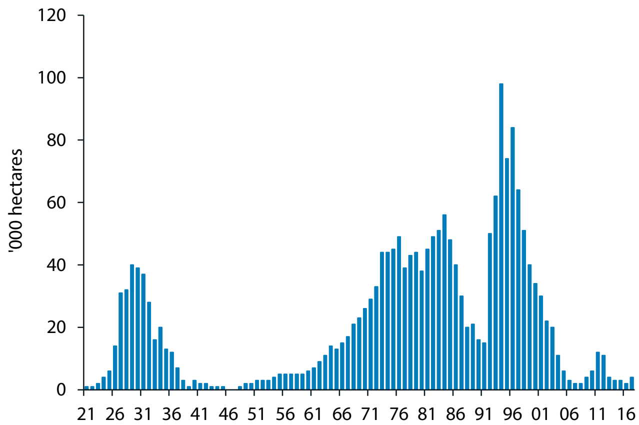
[3] MPI National Exotic Forest Description at 1 April 2017

FORESTRY'S PLACE IN NEW ZEALAND'S ECONOMY

From the 1930s until the late 1980s, more than half of New Zealand's plantation forests were state owned. In 1987 the Forest Service was disestablished and the sale of government-owned forests commenced soon after.

The area in planted forests has decreased by 5% over the past decade as harvested forests were not replanted. Due to changes in market prices and government policy the financial incentive is now to convert land to forestry rather than away from it.

NEW FORESTRY PLANTINGS



Source: MPI

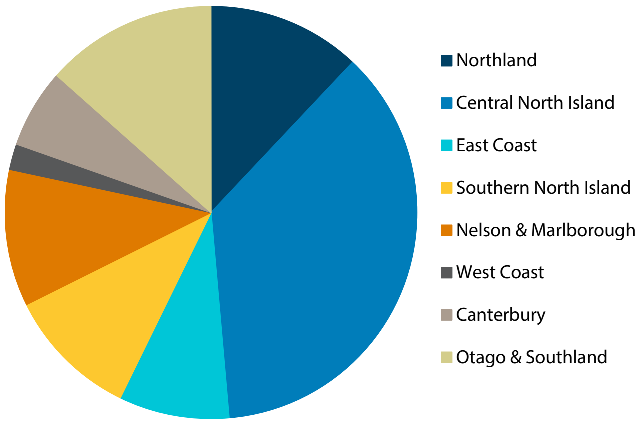
New plantings of exotic forests peaked in the early 1990s due to forestry returns being particularly high at that time. In recent years there has been very little additional land planted in forestry, with the majority of the planting simply replacing trees as forests are harvested. New plantings are estimated to have ticked up slightly in 2018 to 9,000 ha.

REGIONAL PLANTING

The central North Island contains a third of New Zealand's plantation forest, with 567,500ha in trees. The rest of the plantation forests are relatively evenly distributed throughout New Zealand.

The quantity of forests now reaching maturity is rapidly increasing due to the high volume of trees planted in the early 1990s. The quantity of timber that will be available to harvest in 2022 is forecast to be more than double that in 2017.

FOREST AREA BY REGION

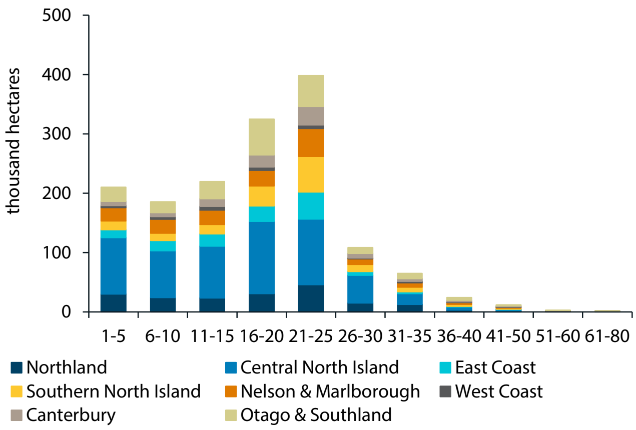


Source: MPI

This means there is a significant increase in demand for harvesting, which is putting pressure on resources. While the central North Island will continue to produce the most timber, the lift in the quantity of timber ready to harvest in some regions is significant. The two regions with the largest percentage increase in harvesting requirements are Hawke's Bay and Tararua/Wairarapa. Other regions where demand for harvesting will increase significantly are Southland, Otago, Nelson/Marlborough, and Manawatu/Whanganui.

In practice this additional harvesting has already commenced as some forests are being harvested slightly earlier due to favourable market conditions, and superior genetics mean trees are reaching maturity slightly earlier. Harvest volumes are expected to remain elevated for the next decade.

AGE OF FORESTS BY REGION



Source: MPI

FORESTRY'S PLACE IN NEW ZEALAND'S ECONOMY

INCOME STREAMS FROM TREES

Aside from the environmental reasons for planting trees, there are sound economic reasons to plant forests on some types of land.

There are several potential income streams associated with planting trees:

- Logs harvested
- Carbon credits
- Honey revenue (from Manuka plantings)
- Forestry rights
- Lease of land for planting in trees

The average rate of return for timber from radiata plantations is in the vicinity of 5-7%, whereas including carbon returns could bolster returns a further 1-3%. However, returns do vary considerably from location to location.

RETURNS FROM HARVESTING PINE PLANTATIONS

Returns from harvesting logs will depend on the market for logs at the time of harvest, and the quality and quantity of timber that is available for harvest. There will also be costs associated with harvesting such as upgrading access tracks and landing zones.

It is very difficult to forecast what the price of logs will be when you are planting a forest, as a lot can happen in 25-30 years. It is, however, worth considering what the log price would need to be in order to make it worthwhile harvesting the trees after all costs are accounted for. It can be possible to delay harvesting trees if log prices are particularly low.

Costs will vary considerably from site to site. There are two main types of costs:

Harvesting costs

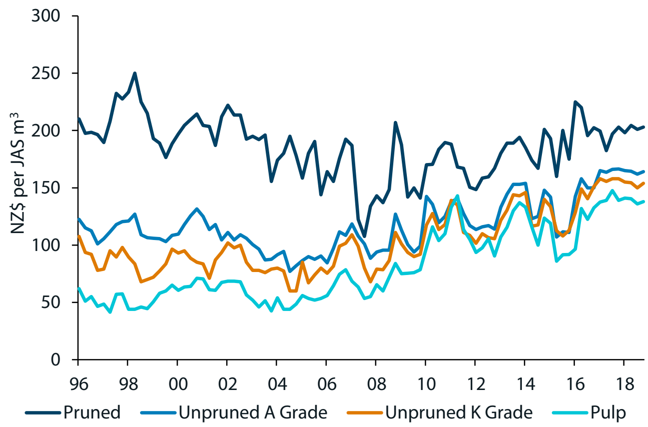
- Location – the further from a port or mill the site is the more costly it is to harvest. Planting a forest for the purpose of harvesting trees on sites further than 160km from a port or mill is likely to be unfeasible unless log prices are exceptionally high.
- Slope of the land – steep land will be more difficult and therefore costly to harvest. There are limitations under the Resource Management Act to harvesting trees on steep slopes due to erosion problems.
- Access on site, eg roading and landing zones – if the site can only be accessed through farm land there will be significant costs associated with upgrading tracks and culverts to standards high enough to allow access for trucks and other heavy machinery.

Silviculture costs

Not all pine plantations are thinned and/or pruned.

The value of the timber at harvest will depend on the quantity and quality of the trees. Trees that have been pruned have a greater range of potential uses than trees that haven't and therefore will be more valuable. However pruning does add additional costs. Less than half of the timber harvested from a pruned forest will be the more valuable 'pruned log' grade. In recent years pruned logs have been priced about 33% higher than unpruned logs, whereas earlier this decade the difference was more substantial.

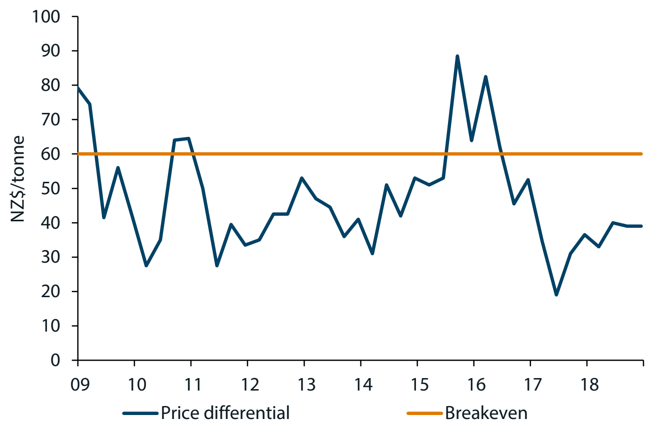
LOG RETURNS BY GRADE



Source: MPI

Only the lower portion of a pruned tree produces the higher-quality pruned timber, so the difference in returns on a per hectare basis is considerably smaller than the difference in the price of the various grades of logs.

LOG PRICE DIFFERENTIAL – PRUNED VERSUS UNPRUNED



Source: ANZ Research, MPI

FORESTRY'S PLACE IN NEW ZEALAND'S ECONOMY

Pruning costs about $4-6 per tree. Trees that are to be thinned won't be pruned, so typically you would be looking at a lower number of stems than was initially planted. For example, you may initially plant 1000 stems/ha but then thin this back to 300 stems/ha so just the 300 trees would need pruning. Therefore pruning costs are likely to be in the range of $1200-$2000/ha.

Whether it is worth pruning logs or not does depend on the relative performance of the various grades of logs at the time of harvest. At present the differential between the two is minimal.

What is definitely clear is that if the forest is not being well managed then pruning is likely to be a waste of money. A poor pruning job will also be a waste of money. At present about half of the pine forests in New Zealand are unpruned.

DIRECT SAWLOG REGIME

Pruned and thinned. Final crop stocking 228 stems per hectare

	Length	Volume	Value
Waste	8m	0.18m³	0%
Industrial grade logs	8m	0.31m³	7%
Sawlogs	15m	1.15m³	43%
Pruned logs	5m	0.64m³	50%
Stump	0.2m	0.03m³	0%
Total	**36m**	**2.3m³**	**100%**

STRUCTURAL REGIME

Pruned and thinned. Final crop stocking 487 stems per hectare

	Length	Volume	Value
Waste	8m	0.24m³	0%
Industrial grade logs	8m	0.41m³	20%
Sawlogs	19m	0.95m³	80%
Pruned logs	0m	0.00m³	0%
Stump	0.2m	0.01m³	0%
Total	**35m**	**1.61m³**	**100%**

Source: FOA (Forest Owners Association Facts and Figures 2017/18)

Planting costs

There are several costs associated with initially planting a forest.

- Seedling trees – costs range from 50c to $4/tree for exotics (eg pines), whereas natives can cost up to $7/tree. Planting good seedlings will pay off in the longer term.
- Planting – contractors typically charge 40-70c/tree.
- Weed control (spraying prior to planting) is likely to cost 25-30c per tree.
- Tree protectors used to prevent hares or rabbits damaging young plants, particularly natives, will cost $1-$3/tree.

The best time to plant trees depends on the species and the region they are being planted in, but the optimal planting window for most regions is relatively short. Planting of pinus radiata trees typically takes place in July or August when the trees are dormant, but in some regions planting outside of these winter months is preferable.

Fencing costs and benefits

Fencing costs will depend on whether an electric fencing is an option or whether a traditional post and batten fence will be required. The terrain will also dictate costs. Costs will range from $9 to $25/m for traditional 8-wire post and batten fences, whereas electric fencing is likely to be in the range of $3 to $14/m depending on whether they need to exclude sheep or just cattle, and the terrain involved.

Fencing areas for trees may also have other environmental benefits, such as reducing the potential for erosion, eliminating stock from entering waterways and minimising nutrient runoff. Other benefits include improved pasture management when the unproductive parts of the paddocks are fenced for trees rather than grazed. Fencing off steep gullies can also make it easier to muster stock.

The ability to access trees that are intended to be harvested is also an important consideration. This may involve extensive costs associated with adding access roads and landing areas in order to maintain and harvest the trees. Proper provisions were not made for a lot of the trees established on farms in the early 1990s, which now means the costs of accessing some sites outweighs the harvest returns.

Costs of establishing a forest and returns differ greatly and therefore the merits of each site must be considered carefully before planting occurs.

FORESTRY'S PLACE IN NEW ZEALAND'S ECONOMY

ALTERNATIVE SPECIES

When considered on an economic return basis, with revenue from either harvesting trees or from carbon, or a combination, returns from pine trees are far superior to other species. However pine may not be suitable for all areas, or landowners may not want to plant pines. There is a risk that tightening environmental standards when it comes to both harvesting and treating pine logs will reduce the long-term viability of this species.

Other popular exotics that are still relatively fast-growing and have the potential to be harvested include redwoods, Douglas fir, and eucalypts. The quantity of carbon that these species are assumed to sequest is considerably lower than pines. For example, a eucalypt will sequest only about half the amount of carbon that a pine tree will when planted in a favourable growing region. Natives sequest only about 15% of what a pine tree does during its first 30 years of its life. However natives will continue to sequest carbon for a longer period of time, as they take a lot longer to reach maturity.

There is a lack of expertise in alternative species for plantation forests and sourcing trees and finding end markets for the timber is more difficult. Despite these challenges there is plenty of research being done in this area and alternative species are gradually expected to become more popular, but are never likely to displace the dominance that pines have in plantation forestry.

There is a desire at the national level for more natives to be planted in New Zealand. Approximately two thirds of the $240m that has been set aside by the Government for grants is likely to be directed into native plantings. But it will be a challenge to significantly increase the amount of land being planted in natives due to the much lower returns from natives relative to a plantation forests.

The grants available for natives are higher than other species but the cost of establishing natives is also considerably higher and they are more difficult to establish than a pine tree.

Fruit and nut trees and scrubs are not currently eligible for the ETS programme and likewise renewable crops are also excluded from the programme.

IMPACT ON ECONOMY

New Zealand has signed up to ambitious targets under the Paris Agreement to reduce its greenhouse gas emissions. Given the unique challenges we face due to the size of the agricultural sector relative to our population, planting carbon sinks is a crucial part of the transition while new technologies are developed to improve the very real economic trade-offs that climate change mitigation involves.

The impact on the export returns from planting additional trees will depend on how much productive land is taken away from sheep and beef farming resulting in a reduction in production. Ongoing reduction in stock numbers are expected but this will be partially offset by gains in productivity per animal as has been the case.

Should we see 500,000 million hectares of land change use from sheep and beef farming to trees this would reduce the land used for sheep and beef farming by approximately 5%. Export returns will only be impacted if stock numbers are significantly reduced. Should the majority of the planting occur on portions of existing farms then the impact on export returns would be minimal. However if entire farms are converted to forestry this will displace livestock and reduce export returns in the medium term. A 10% reduction in livestock numbers would reduce export earning by about $3bn per year assuming no gain in productivity levels. Over the longer term the reduction in meat exports may be offset by increases in exports of forestry products. But most forests won't reach maturity until 28 years, and depending on the price of carbon may not ever be harvested.

Unintended consequences are inevitable with any policy change, and large-scale forestry planting involves significant land-use change with very real implications for the sustainability of rural communities. All efforts need to be made to ensure that sensible long-run decisions are made for the good of our environment, our economy, and our rural communities.

APPENDIX 1: CARBON LOOKUP TABLES – PINUS RADIATA

MPI: Schedule 6: Tables of Carbon Stock per Hectare for Post-1989 Forest Land Carbon stock per hectare for Pinus radiata by region (expressed as tonnes of carbon dioxide per hectare)									
Age (yrs)	Auckland	Waikato/ Taupo	Bay of Plenty	Gisborne	Hawke's Bay/ Southern NI	Nelson/ Marlborough	Canterbury/ West Coast	Otago	Southland
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

Age (yrs)	Auckland	Waikato/ Taupo	Bay of Plenty	Gisborne	Hawke's Bay/ Southern NI	Nelson/ Marlborough	Canterbury/ West Coast	Otago	Southland
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

Source: MPI "A Guide to Carbon Look-up Tables for Forestry in the Emissions Trading Scheme"

APPENDIX 2: CARBON LOOKUP TABLES – OTHER SPECIES

MPI: Schedule 6: Tables of Carbon Stock Per Hectare for Post-1989 Forest Land
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
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
26	436	344	633	224.6
27	445	359	648	233.7
28	468	373	661	242.2
29	493	387	674	250.1

Age (yrs)	Douglas-fir	Exotic softwoods	Exotic hardwoods	Indigenous Forest
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	737	290.9
37	704	489	745	295
38	730	501	753	298.7
39	730	512	761	302
40	751	524	769	305.1
41	772	536	777	307.8
42	794	547	785	310.4
43	815	559	793	312.6
44	836	570	801	314.7
45	857	582	809	316.5
46	878	593	817	318.2
47	898	605	825	319.7
48	918	617	833	321.1
49	938	629	841	322.3
50	957	641	849	323.4

Source: MPI "A Guide to Carbon Look-up Tables for Forestry in the Emissions Trading Scheme"

IMPORTANT NOTICE

This document is intended for ANZ's institutional, professional or wholesale clients, and not for individuals or retail persons. It should not be forwarded, copied or distributed. The information in this document is general in nature, and does not constitute personal financial product advice or take into account your objectives, financial situation or needs.

This document may be restricted by law in certain jurisdictions. Persons who receive this document must inform themselves about and observe all relevant restrictions.

Disclaimer for all jurisdictions: This document is prepared and distributed in your country/region by either: Australia and New Zealand Banking Group Limited (ABN11 005 357 522) (**ANZ**); or its relevant subsidiary or branch (each, an **Affiliate**), as appropriate or as set out below.

This document is distributed on the basis that it is only for the information of the specified recipient or permitted user of the relevant website (recipients).

This document is solely for informational purposes and nothing contained within is intended to be an invitation, solicitation or offer by ANZ to sell, or buy, receive or provide any product or service, or to participate in a particular trading strategy.

Distribution of this document to you is only as may be permissible by the laws of your jurisdiction, and is not directed to or intended for distribution or use by recipients resident or located in jurisdictions where its use or distribution would be contrary to those laws or regulations, or in jurisdictions where ANZ would be subject to additional licensing or registration requirements. Further, the products and services mentioned in this document may not be available in all countries.

ANZ in no way provides any financial, legal, taxation or investment advice to you in connection with any product or service discussed in this document. Before making any investment decision, recipients should seek independent financial, legal, tax and other relevant advice having regard to their particular circumstances.

Whilst care has been taken in the preparation of this document and the information contained within is believed to be accurate, ANZ does not represent or warrant the accuracy or completeness of the information Further, ANZ does not accept any responsibility to inform you of any matter that subsequently comes to its notice, which may affect the accuracy of the information in this document.

Preparation of this document and the opinions expressed in it may involve material elements of subjective judgement and analysis. Unless specifically stated otherwise: they are current on the date of this document and are subject to change without notice; and, all price information is indicative only. Any opinions expressed in this document are subject to change at any time without notice.

ANZ does not guarantee the performance of any product mentioned in this document. All investments entail a risk and may result in both profits and losses. Past performance is not necessarily an indicator of future performance. The products and services described in this document may not be suitable for all investors, and transacting in these products or services may be considered risky.

ANZ expressly disclaims any responsibility and shall not be liable for any loss, damage, claim, liability, proceedings, cost or expense (Liability) arising directly or indirectly and whether in tort (including negligence), contract, equity or otherwise out of or in connection with this document to the extent permissible under relevant law. Please note, the contents of this document have not been reviewed by any regulatory body or authority in any jurisdiction.

ANZ and its Affiliates may have an interest in the subject matter of this document. They may receive fees from customers for dealing in the products or services described in this document, and their staff and introducers of business may share in such fees or remuneration that may be influenced by total sales, at all times received and/or apportioned in accordance with local regulatory requirements. Further, they or their customers may have or have had interests or long or short positions in the products or services described in this document, and may at any time make purchases and/or sales in them as principal or agent, as well as act (or have acted) as a market maker in such products. This document is published in accordance with ANZ's policies on conflicts of interest and ANZ maintains appropriate information barriers to control the flow of information between businesses within it and its Affiliates.

Your ANZ point of contact can assist with any questions about this document including for further information on these disclosures of interest.

Country/region specific information: Unless stated otherwise, this document is distributed by Australia and New Zealand Banking Group Limited (ANZ).

Australia. ANZ holds an Australian Financial Services licence no. 234527. For a copy of ANZ's Financial Services Guide please click here or request from your ANZ point of contact. If trading strategies or recommendations are included in this document, they are solely for the information of 'wholesale clients' (as defined in section 761G of the Corporations Act 2001 Cth).

Brazil, Brunei, India, Japan, Kuwait, Malaysia, Switzerland, Taiwan. This document is distributed in each of these jurisdictions by ANZ on a cross-border basis.

Cambodia. This document is distributed in Cambodia by ANZ Royal Bank (Cambodia) Limited (ANZ Royal Bank). The recipient acknowledges that although ANZ Royal Bank is a subsidiary of ANZ, it is a separate entity to ANZ and the obligations of ANZ Royal Bank do not constitute deposits or other liabilities of ANZ and ANZ is not required to meet the obligations of ANZ Royal Bank.

European Economic Area (EEA): United Kingdom. ANZ is authorised in the United Kingdom by the Prudential Regulation Authority (**PRA**) and is subject to regulation by the Financial Conduct Authority (**FCA**) and limited regulation by the PRA. Details about the extent of our regulation by the PRA are available from us on request. This document is distributed in the United Kingdom by Australia and New Zealand Banking Group Limited ANZ solely for the information of persons who would come within the FCA definition of "eligible counterparty" or "professional client". It is not intended for and must not be distributed to any person who would come within the FCA definition of "retail client". Nothing here excludes or restricts any duty or liability to a customer which ANZ may have under the UK Financial Services and Markets Act 2000 or under the regulatory system as defined in the Rules of the Prudential Regulation Authority (PRA) and the FCA. ANZ is authorised in the United Kingdom by the PRA and is subject to regulation by the FCA and limited regulation by the PRA. Details about the extent of our regulation by the PRA are available from us on request.

Fiji. For Fiji regulatory purposes, this document and any views and recommendations are not to be deemed as investment advice. Fiji investors must seek licensed professional advice should they wish to make any investment in relation to this document.

Hong Kong. This publication is issued or distributed in Hong Kong by the Hong Kong branch of ANZ, which is registered at the Hong Kong Monetary Authority to conduct Type 1 (dealing in securities), Type 4 (advising on securities) and Type 6 (advising on corporate finance) regulated activities. The contents of this publication have not been reviewed by any regulatory authority in Hong Kong.

India. If this document is received in India, only you (the specified recipient) may print it provided that before doing so, you specify on it your name and place of printing.

Myanmar. This publication is intended to be general and part of ANZ's customer service and marketing activities when implementing its functions as a licensed bank. This publication is not Securities Investment Advice (as that term is defined in the Myanmar Securities Transaction Law 2013).

New Zealand. This document is intended to be of a general nature, does not take into account your financial situation or goals, and is not a personalised adviser service under the Financial Advisers Act 2008 (**FAA**).

Oman. ANZ neither has a registered business presence nor a representative office in Oman and does not undertake banking business or provide financial services in Oman. Consequently ANZ is not regulated by either the Central Bank of Oman or Oman's Capital Market Authority. The information contained in this document is for discussion purposes only and neither constitutes an offer of securities in Oman as contemplated by the Commercial Companies Law of Oman (Royal Decree 4/74) or the Capital Market Law of Oman (Royal Decree 80/98), nor does it constitute an offer to sell, or the solicitation of any offer to buy non-Omani securities in Oman as contemplated by Article 139 of the Executive Regulations to the Capital Market Law (issued vide CMA Decision 1/2009). ANZ does not solicit business in Oman and the only circumstances in which ANZ sends information or material describing financial products or financial services to recipients in Oman, is where such information or material has been requested from ANZ and the recipient understands, acknowledges and agrees that this document has not been approved by the CBO, the CMA or any other regulatory body or authority in Oman. ANZ does not market, offer, sell or distribute any financial or investment products or services in Oman and no subscription to any securities, products or financial services may or will be consummated within Oman. Nothing contained in this document is intended to constitute Omani investment, legal, tax, accounting or other professional advice.

People's Republic of China (PRC). This document may be distributed by either ANZ or Australia and New Zealand Bank (China) Company Limited (**ANZ China**). Recipients must comply with all applicable laws and regulations of PRC, including any prohibitions on speculative transactions and CNY/CNH arbitrage trading. If this document is distributed by ANZ or an Affiliate (other than ANZ China), the following statement and the text below is applicable: No action has been taken by ANZ or any affiliate which would permit a public offering of any products or services of such an entity or distribution or re-distribution of this document in the PRC. Accordingly, the products and services of such entities are not being offered or sold within the PRC by means of this document or any other document. This document may not be distributed, re-distributed or published in the PRC, except under circumstances that will result in compliance with any applicable laws and regulations. If and when the material accompanying this document relates to the products and/or services of ANZ China, the following statement and the text below is applicable: This document is distributed by ANZ China in the Mainland of the PRC.

Qatar. This document has not been, and will not be:

- lodged or registered with, or reviewed or approved by, the Qatar Central Bank (QCB), the Qatar Financial Centre (QFC) Authority, QFC Regulatory Authority or any other authority in the State of Qatar (Qatar); or
- authorised or licensed for distribution in Qatar,

and the information contained in this document does not, and is not intended to, constitute a public offer or other invitation in respect of securities in Qatar or the QFC. The financial products or services described in this document have not been, and will not be:

- registered with the QCB, QFC Authority, QFC Regulatory Authority or any other governmental authority in Qatar; or
- authorised or licensed for offering, marketing, issue or sale, directly or indirectly, in Qatar.

Accordingly, the financial products or services described in this document are not being, and will not be, offered, issued or sold in Qatar, and this document is not being, and will not be, distributed in Qatar. The offering, marketing, issue and sale of the financial products or services described in this document and distribution of this document is being made in, and is subject to the laws, regulations and rules of, jurisdictions outside of Qatar and the QFC. Recipients of this document must abide by this restriction and not distribute this document in breach of this restriction. This document is being sent/issued to a limited number of institutional and/or sophisticated investors (i) upon their request and confirmation that they understand the statements above; and (ii) on the condition that it will not be provided to any person other than the original recipient, and is not for general circulation and may not be reproduced or used for any other purpose.

Singapore. This document is distributed in Singapore by the Singapore branch of ANZ solely for the information of "accredited investors", "expert investors" or (as the case may be) "institutional investors" (each term as defined in the Securities and Futures Act Cap. 289 of Singapore). ANZ is licensed in Singapore under the Banking Act Cap. 19 of Singapore and is exempted from holding a financial adviser's licence under Section 23(1)(a) of the Financial Advisers Act Cap. 100 of Singapore.

United Arab Emirates (UAE). This document is distributed in the UAE or the Dubai International Financial Centre (DIFC) (as applicable) by ANZ. This document does not, and is not intended to constitute: (a) an offer of securities anywhere in the UAE; (b) the carrying on or engagement in banking, financial and/or investment consultation business in the UAE under the rules and regulations made by the Central Bank of the UAE, the Emirates Securities and Commodities Authority or the UAE Ministry of Economy; (c) an offer of securities within the meaning of the Dubai International Financial Centre Markets Law (DIFCML) No. 12 of 2004; and (d) a financial promotion, as defined under the DIFCML No. 1 of 200. ANZ DIFC Branch is regulated by the Dubai Financial Services Authority (DFSA) ANZ DIFC Branch is regulated by the Dubai Financial Services Authority (DFSA). The financial products or services described in this document are only available to persons who qualify as "Professional Clients" or "Market Counterparty" in accordance with the provisions of the DFSA rules. In addition, ANZ has a representative office (ANZ Representative Office) in Abu Dhabi regulated by the Central Bank of the UAE. The ANZ Representative Office is not permitted by the Central Bank of the UAE to provide any banking services to clients in the UAE.

United States. Except where this is a FX- related document, this document is distributed in the United States by ANZ Securities, Inc. (ANZ SI) which is a member of the Financial Regulatory Authority (FINRA) (www.finra.org) and registered with the SEC. ANZSI's address is 277 Park Avenue, 31st Floor, New York, NY 10172, USA (Tel: +1 212 801 9160 Fax: +1 212 801 9163). ANZSI accepts responsibility for its content. Information on any securities referred to in this document may be obtained from ANZSI upon request. This document or material is intended for institutional use only – not retail. If you are an institutional customer wishing to effect transactions in any securities referred to in this document you must contact ANZSI, not its affiliates. ANZSI is authorised as a broker-dealer only for institutional customers, not for US Persons (as "US person" is defined in Regulation S under the US Securities Act of 1933, as amended) who are individuals. If you have registered to use this website or have otherwise received this document and are a US Person who is an individual: to avoid loss, you should cease to use this website by unsubscribing or should notify the sender and you should not act on the contents of this document in any way. Non-U.S. analysts: Non-U.S. analysts may not be associated persons of ANZSI and therefore may not be subject to FINRA Rule 2242 restrictions on communications with the subject company, public appearances and trading securities held by the analysts. Where this is an FX-related document, it is distributed in the United States by ANZ's New York Branch, which is also located at 277 Park Avenue, 31st Floor, New York, NY 10172, USA (Tel: +1 212 801 916 0 Fax: +1 212 801 9163).

Vietnam. This document is distributed in Vietnam by ANZ or ANZ Bank (Vietnam) Limited, a subsidiary of ANZ.

This document has been prepared by ANZ Bank New Zealand Limited, Level 10, 171 Featherston Street, Wellington 6011, New Zealand, Ph 64-4-382 1992, e-mail nzeconomics@anz.com, http://www.anz.co.nz