Harvesting Tahere Farm Forest – a case study

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Abstract

Detailed data are presented from the harvest (over 10 years) of six small plantations on a Northland farm property. These data show that with innovative harvesting techniques, sensibly located small plantations – even on very steep, broken country – can be a profitable investment. Small plantations also present environmental advantages, encourage appropriate land use and lessen the aesthetic impact of logging on the landscape. Spreading planting in time as well as spatially, by lowering annual cash and/or labour requirements, places quite substantial forest estates within reach of many hill country family farms. It is argued that the results support that smaller plantations carefully sited on a large number of rural properties, and established over extended periods, are a valid way to achieve our afforestation goals. They also have additional environmental, land use and scenic advantages that are likely to be increasingly important to our industry's social licence to operate.

Introduction

Much is made of the economies of scale in harvesting plantation forests. The perception has developed that small areas of plantation forest may not be worth the effort. Of course, some unitised fixed harvest costs are going to be higher for small plantations, but they need not be overwhelming. They can be minimised by good planning and may be compensated by other values.

This paper presents a case study of small-scale plantation forestry on a Northland property which is now halfway through its first harvest cycle. The financial results presented here show that small-scale plantation forestry can be a very profitable exercise on the right real estate and given good planning.

Background

The property is 160 ha of mixed topography hill country 15 km east of Whangarei. Primarily yellow-brown earths derived from Greywacke, the soils are highly erodible and skeletal on the steeper slopes. They are considered of poor-to-medium quality for pasture and of medium-to-good suitability for radiata pine. Mean annual increments in excess of 20 m^3/ha/yr can be achieved.

Periods of intense rainfall in the winter and summer droughts are characteristic of the east coast of Northland. Pre-European, the land was little used by Māori. Pakeha use commenced in 1886 and for three generations the Jones family milked 90 cows and ran 300 wethers. The fourth generation were not interested in farming and the farm was put on the market. When we took over in 1978 the farm consisted of:

- Approximately 60 ha of secondary kauri/podocarp/broadleaf forest on the very steep northern part of the farm
- Approximately 100 ha of mixed quality grassland on slopes ranging from flat (10%) to rolling (40%) to steep (40%) to very steep (10%).

A maximum carrying capacity of around 1,000 stock units was insufficient to support a heavily mortgaged family and, even if it had been, a couple of dry summers in a row soon convinced us that maintaining this maximum was very high risk financially and environmentally. As a result, off-farm work was necessary.

Approximately 40 ha in small blocks scattered across the farm were identified as being more suited to plantation forestry than to pastoral farming. These blocks were steep and erosion-prone. What little grass did manage to grow in the winter often turned to 'cornflakes' during summer. Pasture weeds, both exotic (such as gorse and blackberry) and native (such as mānuka and kanuka) were invading and hard to control on the steep terrain. We did not expect that taking these areas out of the pasture rotation would significantly reduce the carrying capacity of the farm, and in this we were proved right.

It was never envisaged that the 40 ha would be planted in one year. Radiata pine forestry in New Zealand provides the opportunity to create something approaching a normal forest in far less than a working lifetime. As we were less than 40 years old when we started, we could see a spread of plantation ages providing a relatively steady income supplement as our off-farm earning capacity declined. That was the philosophy. The reality was that, being self-employed both on and off-farm, future income was going to be irregular as would be the necessary surplus cash for plantation establishment and silviculture.

The plantation estate

Planting commenced in 1983. Initially boundary lines were decided on considerations such as steepness, erosion risk, existing fences and ease of moving stock. As planting progressed, a pragmatic harvesting ethic was given increasing weight, primarily in the form of ensuring that each plantation was located adjacent to the main ridge running through the farm that would provide the easiest and cheapest access at harvest.

By 2001, 43 ha had been planted and 38 ha were in radiata pine from an average annual planting programme

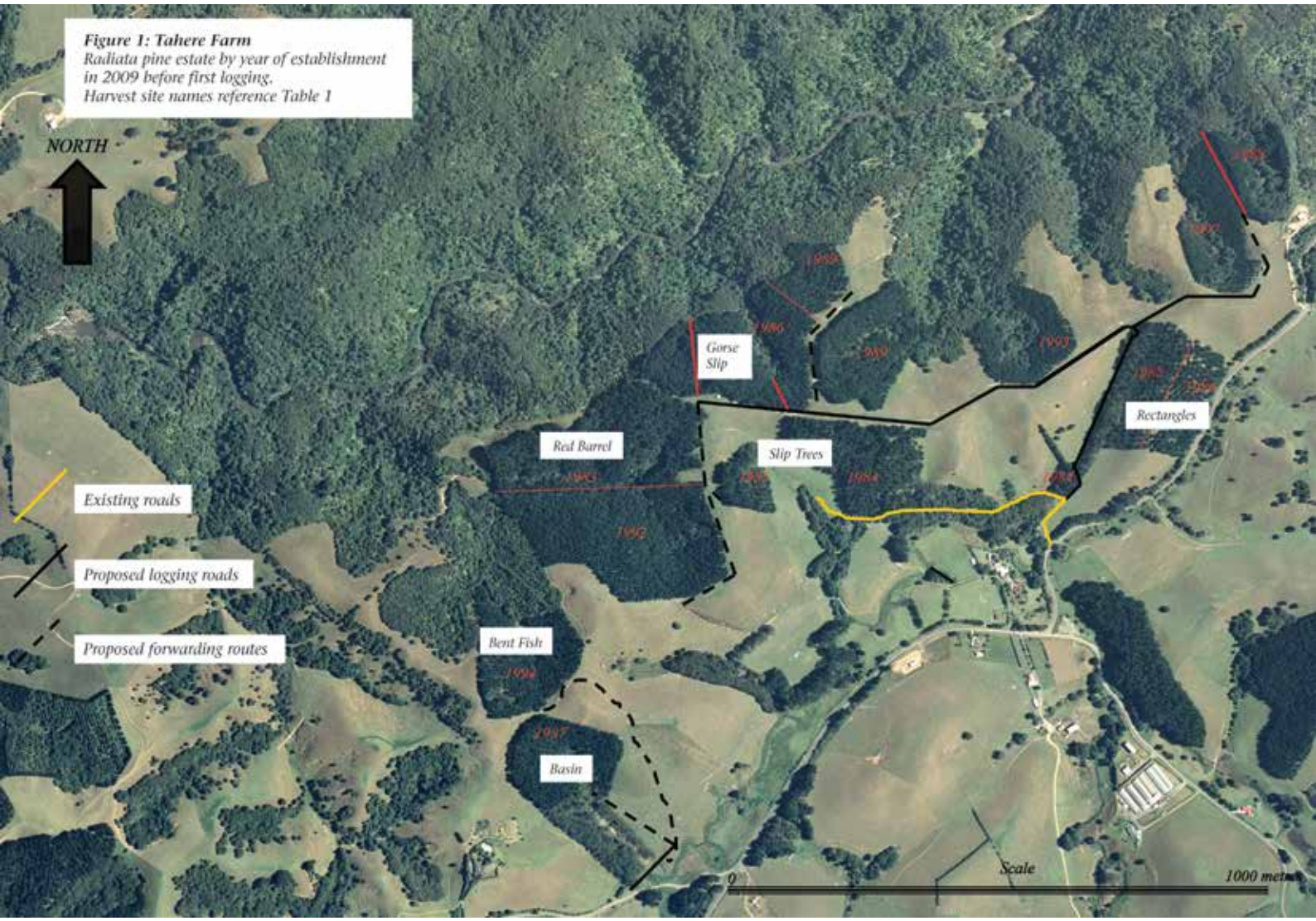

Figure 1: Tahere Farm

of 2.1 ha (range 0 to 7 ha). The small blocks generally allowed planting and subsequent silvicultural operations to be the work of family. In periods when off-farm work was plentiful and family time scarce, the additional income being earned allowed the use of contractors.

Figure 1 shows the pine estate in 2009 (before logging) and the location of planned extraction routes.

Harvest

Harvesting began in 2010, and by 2019 just under half of the pine estate had been logged in six operations carried out over the 10 years, with the oldest stand being 32. Details of this harvest history are set out in Table 1.

Stand details

The average operational area was 3.1 ha, with a range of 1.3 to 5.9 ha. There were several reasons for logging the first two-year areas that were not the oldest in the estate:

- The plantations were agroforestry areas standing at 111 and 200 stems per ha (SPH), respectively. Many of the pruned butts already had a large end diameter in excess of 1 m; leaving them any longer would have made for difficulties in log extraction and processing at local mills
- The stands were located close to the farm's entrance to public roads and required minimal expenditure on roading
- The returns gave us more than enough funds to establish the main harvesting roads to serve the rest of estate
- The returns also allowed a four-year delay before the next harvest which:
  - allowed the newly built roads to consolidate
  - gave a better matching of harvest returns to reducing other incomes as retirement approached
  - enabled us to take advantage of rapid log value accretion as stands aged, but before wind damage became a problem.

Table 1. Tahere Farm case study – harvest running summary (all dollar figures are dollars of the day)

Year of harvest	2010	2011	2015	2018		2019	Totals & means
Stand name	**Rectangles**	**Slip Trees**	**Red Barrel**	**Gorse Slip**	**Basin**	**Bent Fish**	
Stand details							
Area (ha)	3.7	3.1	5.9	1.3	2.3	2.4	**18.7**
Age at harvest (yrs)	24	27	30	32	31	25	Mean = 3.1 ha
Stocking (SPH)	111	200	400	300+	237	450	
Yields (tonnes)							
Total recovered (tonnes)	1,454	1,941	4,124	828	1,461	1,512	**11,319**
Total recovered per ha (tonnes)	393	626	699	637	635	630	Mean = 1,886t
Pruned %	42%	20%	16%	21%	33%	6%	
A grade %	12%	23%	37%	59%	47%	57%	
KI grade %	30%	40%	20%	8%	14%	19%	
Pulp %	17%	17%	12%	12%	7%	19%	
Average JAS conversion (JAS/tonne)	0.80	0.84	0.93	0.98	0.99	0.99	
Market indicators							
Average A grade price received ($/t)	$81	$118	$105	$140	$157	$144	
Average Pruned price received ($/t)	$120	$121	$167	$185	$195	$188	
Gross financial yields							
Gross $ per ha	$33,131	$62,377	$73,782	$95,724	$101,872	$84,237	
Gross $ per tonne	$84.34	$99.61	$105.61	$140.58	$151.35	$133.72	
Costs ($/t)							
Log and load	$34.50	$36.92	$33.95	$43.92	$44.54	$46.02	
Admin. (incl levy, weighbridge, consumables, reporting)	$2.50		$0.70	$5.33	$5.54	$6.73	
Management fee			$3.00				
Transport machinery	$0.39	$0.39	$0.61				
Engineering	$0.00	$0.26	$6.10	$0.19	$0.83	$1.91	Total eng. costs $29,919
Clean-up	$0.69	$0.26	$0.56	$1.45	$0.82	$1.65	
All costs except cartage ($/t)	**$38.08**	**$37.83**	**$44.92**	**$50.89**	**$51.73**	**$56.31**	
Cart logs($/t) (destinations vary between years)	$11.24	$13.77	$13.90	$19.61	$19.73	$15.08	
Total costs for harvest operation ($/t)	**$49.32**	**$51.60**	**$58.82**	**$70.50**	**$71.46**	**$71.39**	
Net returns ($)							
Net return in $/t	$35.02	$48.01	$46.79	$70.08	$79.89	$62.33	Mean = $57.02
Net return in $/ha	$13,763	$30,054	$32,706	$44,641	$50,730	$39,268	Mean = $35,193
Total net return ($)	$50,923	$93,168	$192,967	$58,033	$116,679	$94,243	**$606,013**
Return on investment	N/A	11%	9.1%	N/A	9.5%	N/A	

The last area logged in 2019 (Bent Fish) was also felled young (age 25) because it was suffering ongoing attrition from wind following serious damage in the 2007 storms.

Yields

The average recovered yield by block was 1,886 tonnes with a range of 828 to 4,124 tonnes. The log grade recoveries reflected the wide-ranging silvicultural histories of the stands. At one end of the scale were the agroforestry stands harvested in 2010. Low stocking (111 SPH) and felling age (24 years) gave low total yields (393 tonne/ha) but high pruned percentage (42%). This was countered by the low quality logs above the pruned butts. At the other end of the scale was the Basin harvested in 2018. This stand, grown from GF25 cuttings, was ultra-high pruned to between 6 m and 10 m and held at 237 SPH before harvest at age 31 years. Log grade outturn was excellent, with 33% pruned and 47% Export A grade.

Such variation in stand quality is common in smaller family-owned estates. It reflects, over time, the owner's financial position and their attitudes to plantations – thankfully, our preference for agroforestry was very short-lived.

An interesting part of the yields section (see Table 1) is the JAS (Japanese Agricultural Standard) conversions for each stand. There are explanations for the rather dramatic shift from the start of logging (0.80) to the conversions achieved in the later harvest (0.99).

The stand logged in 2010 (Rectangles) was an agroforestry stand. The enormous pruned butts were sold on the domestic market at a price per tonne so no JAS measurements were taken. The export logs taken from the cabbage-like upper part of the trees had large taper and consequently low JAS conversions. The next two stands – Slip Trees and Red Barrel – were established with seedling stock, with the Red Barrel's greater age and stocking giving the better conversion. The last three stands logged were all established with cuttings and all had noticeably less taper and consequently better conversions. All the pruned butts from the 31-year-old Basin plantation had conversions exceeding 1.00, with the largest achieving 1.08. This had the effect of turning a $185/m JAS export price that year into a return of $201/tonne. Offering those logs to local mills for the equivalent export price per tonne produced some interesting responses!

Market indicators

This section is included to place each year's harvest returns in the context of the market that year (note the range in prices over the decade). Except for the pruned logs in 2010, all logs were exported and sold at wharf gate Marsden Point. The prices quoted for Export A grade and pruned are the average of those prices received for the mix of subgrades produced converted from dollars/m^3 JAS to dollars/tonne. Prices are in dollars of the day. (Inflation over the 10 years, as measured by the Consumers Price Index, has been around 14%.)

Costs and changes made

Costs are also quoted in dollars of the day and all have been calculated as dollars/tonne using the total tonnage harvested in each operation. Over the six operations there have been changes in:

- Topography of areas logged
- Logging methods and machinery used
- Approach to management of logging, cartage and marketing.

The first two operations (Rectangles and Slip Trees) were on easy to occasionally difficult tractor terrain close to public roads. Existing farm roads were adequate for logging trucks after only minimal upgrading. Hence, the low unit engineering costs for these two operations – $0/tonne for Rectangles and $0.26/tonne for Slip Trees.

Management of log and load, health and safety, trucking, marketing and documentation was carried out by a local harvesting organisation, with log and load operations sub-contracted to a two-person operation. No internal tracking was required. Felling was manual with whole trees hauled to temporary landings outside the stump line by a rubber-tyred skidder. Log-making was manual with slash and sloven material stacked for burning by the skidder. Loading was by a 20 tonne digger. In both cases log and load costs were $34/tonne, with administration and management at $2.50/tonne. Transport of machinery onto the site was charged separately and was a modest $0.39/tonne for both operations.

The third operation (Red Barrel) was on slightly more difficult country. Management and marketing for this operation was entrusted to a large national forest management company who charged a basic fee of $3/tonne plus at cost charges for various administrative items and transport of machinery onto the site (these are identified in Table 1). Log and load was contracted to a five-person crew equipped with a rubber-tyred skidder, a bulldozer and towed logging arch and a 30 tonne excavator for loading. Felling and log-making were manual with slash and sloven stacked for burning. Log and load costs were again $34/tonne with administration and management at $3.70/tonne.

Transport of machinery onto the site again was charged separately and was substantially higher (more machines) at $0.61/tonne. Substantial upgrading of approximately 1.2 km of farm track was required to give log trucks access to this site and create a landing for log processing and loading. The total cost of this was $25,156, giving a unit engineering cost for this operation of $6.10/tonne. What is important to the case study is that this engineering asset was utilised by the next operation (Gorse Slip) in 2018 and will be used again in the future for at least two more operations. It is also an asset that greatly facilitates other farm operations and

provides all-weather access for silvicultural operations in the second rotation stands.

A three-year gap in harvesting followed giving time for a radical rethink of harvesting strategy before we began again in 2018. The factors considered from the property's point of view were:

- The farm was now subject to a QE2 National Trust Open Space Covenant. The small scattered logging operations are acceptable under the covenant, but landscape values and the overall aesthetics of logging have risen in importance
- Because of this, as well as for financial reasons, we did not wish to build any more roads and landings and needed to reduce the amount of earthworks within the cutovers
- We were now going to meet much more difficult terrain. Very steep but short slopes were now going to be prevalent. Just a few years ago the choices would have been skidders/tractors with a large amount of now unacceptable access tracking or haulers demanding massive road upgrades and extensions just to get on-site, with very large landings – both unacceptable and very expensive.

We were very fortunate to find the solution in a local four-person harvesting and marketing operation based around tracked excavators and small 4WD off-road trucks. These stripped down 'baby' trucks function as forwarders, but are fast, cheap and fuel efficient compared to what the industry normally calls a forwarder.

Features of this operation were:

- All machinery was easily transported to the farm gate and could then walk cross country to the logging site
- Felling was mainly by a chainsaw felling head on a 30 tonne excavator able to negotiate much of the steeper country and 'shovel' the logs to a convenient processing site. This machine was fitted with a winch and lightweight, but high-breaking, strain rope which allowed machine assist for manual felling of trees the excavator could not reach. The winch could then be used to haul whole trees to within reach of the grapple for subsequent shovelling. The first photo shows this machine in action.

This year, a ridge top, traction assist winch system (T-winch) has been added to this operation, allowing the excavator to safely access more difficult parts of a logging setting and further reducing the need for manual felling and on-site tracking. Shovel logging left a much more even spread of broken slash over the cutover and very little soil disturbance. A distinct advantage of small blocks is that their short haul distances allow shovel logging.

Log-making was by means of a processing head mounted on another 30 tonne excavator. Because finished logs were continuously moved to loading sites by the off-road trucks (see second photo), processing sites could be very small. They required minimal (if any) earthworks and were easily sited to suit shovelling patterns, clean-up operations such as slash pile burning, and landscape values.

30 tonne excavator fitted with a chainsaw felling head and winch. The trees are felled manually with winch assist and are pulled up the hill and picked up by a grapple. The Taheke Scenic Reserve (DOC) is in the background

Off-road truck heading up to load out site

Load out sites too could be smaller and, in the absence of slash and slovens, kept very clean and safe. They are quickly prepared by a small excavator. If topsoil has to be moved it can be stockpiled and easily replaced and re-grassed and the area left as useful grazing until needed again (see third and fourth photos).

The fifth, sixth and seventh photos illustrate the set up at three different locations.

As can be seen in Table 1, the costs of marketing, management and administration and transport of machinery to the site were incorporated into a single charge per tonne negotiated and agreed before start up. No nasty surprises and responsibilities placed where they ought to be. With tracked excavators on-site, investment in an hour or two of machine time before they leave allows immediate tidy up of the site, including clearing lines for replacement fences and consolidation of waste piles in safe locations for subsequent disposal by burning (see eighth photo).

Net returns

Net returns in Table 1 are expressed in dollars/tonne, dollars/ha, and annual and overall totals. As can be expected from a wide variety of stand qualities and a fluctuating log market they are variable year to year. We were fortunate that our best stand (the Basin) was harvested at a time when the market was buoyant. All the pruned logs from that stand returned net values well in excess of $100/tonne.

The mean net return of $35,193/ha translates to more than $1,000/ha/p.a., and that from relatively poor, steep Northland hill country, a wide range of silvicultural treatments and no adjustment for inflation over the 10-year harvest period. Take out the (thankfully) short-lived agroforestry block and the

Load out site on ridge top beside main logging road

The same load out site two years later and ready to be used again to load out mature trees in the background

Bent Fish Gully with the processing machine in the centre. An off-road truck loading machine is temporarily shovelling in the background. The felling machine has been shovelling from the right (out of picture) and is about to load an off-road truck which is reversing into position

At the Basin, a felling machine is in the background and shovelling to feed the processor. A processing machine is in the centre working atop a waste pile. An off-road truck is being loaded in the foreground

Bent Fish Gully site layout. A processing machine, felling machine and one off-road truck can be seem on the ridge (see fourth photo). There is an off-road truck track to the load out site clearly visible. The Basin cutover (see fifth photo) logged one year previously can be seen over the yellow smoko hut. The photo is taken from a public road with a farm gate off to the left

mean net returns are $39,480/ha and $61.42/tonne, respectively. Compare these levels of profitability with the median four-year average of $203/ha/p.a. for sheep and beef farming reported in the June 2019 *ANZ Red Meat Benchmarking Report.* The range in that report was $12 to $451/ha/p.a.

During the development of these plantations, there were times when we meticulously recorded all the costs associated with their establishment and management. We have good data for three of the stands in this case study. To this actual expenditure I have added an annual cost of rates (1.6% of unimproved land value) and an annual cost for use of the land or rent (7% of unimproved land value). Thus, an annual outgoing cashflow is created culminating at harvest in a single net return. From this cashflow can be calculated a percentage return on the monies invested, which is shown in the last line of Table 1. The returns range from 9% to 11%. The analysis is crude, but accurate enough to demonstrate that plantation farm/forestry with small-scale blocks can be a very satisfactory investment. Again, it is salutary to compare these returns on investment with those for sheep and beef farming. The June 2019 *ANZ Red Meat Benchmarking Report* reported a median return on assets of 2.2%, with a range of 0.3% to 4.1%.

Discussion

This case study shows that plantations on farms can be a very good investment even when the average setting size is only 3 ha. With all other factors held constant it is very probable that larger areas would have produced improvements in financial returns, but the difference is much less than is often claimed.

There are many compensating advantages for small blocks:

- Erosion and the risk of downstream damage are much reduced
- Land use can be much better matched to land capability
- Spreading plantings over space and time lowers the annual cash requirements for the establishment and management of plantations and such spending can be better matched to fluctuating incomes from other sources. This is particularly important for those contemplating intensive management such as pruning. Pruning and thinning are expensive, and their timing window is tiny and critical. If sufficient cash (or owner's labour) is not available during that window, the opportunity is lost
- Spreading forest planting on a property over a number of years also makes it easier to spread harvest, which mitigates market risk
- Forest harvest makes a mess – spreading the visual impact over smaller areas and over time can be scenically important.

Gorse harvest complete with fence re-established. Processing waste is accumulated into a safe area for burning

Successful harvesting of the increasingly steep and broken country encountered in this case study was made possible by innovative harvest technology. It would have been physically and financially ridiculous to use haulers on these areas.

As mentioned above, Tahere Farm is now subject to a QE2 National Trust Open Space Covenant. Registered on the title, this covenant is binding on all future owners. With respect to future options for the land, the covenant opens some opportunities and closes others, and the financial implications may be substantial. This case study does demonstrate that the establishment of what is close to a normal forest estate has created for the property a useful income that will be ongoing for as long as there is a forest industry in New Zealand. For instance, my partner Sandy and I now live comfortably on the ongoing harvest of a small plantation estate, universal super and the pastoral farming of beef – in that order of annual value.

The data presented here counters the myth that small-scale forestry is not financially worthwhile. It shows that small scale can be very profitable and has other benefits that are compensatory to any additional costs that do occur. Those compensating benefits are important; they point towards a future for plantation forestry in New Zealand that is coming whether we plan it or not. For instance, I question:

- For how much longer is our society going to tolerate vast areas of rolling hill country logged so that they are reminiscent of World War 1 battlefields?
- For how much longer are we going to be allowed to harvest the protective forest cover from whole catchments with the consequent downstream risks?
- For how much longer are we going to ignore the wide range of site and soil qualities that exist on almost all rural properties and cover the whole lot with a forest of only one species in one year?

Our social licence to operate will be eroded if we carry on this way. All over the developed world the size of logging coupes is shrinking and the pressure will be on to do the same here. Our excuse that we have planted large contiguous areas in the same year – whole properties, whole catchments in one age class – will not cut the mustard with our critics. The pain and technical difficulty of trying to spread over time the harvest of huge even-aged monocultures will be intense. So let's not encourage big investors' plans to plant these suffocating blankets. A billion trees is a great and necessary target, but we should be encouraging their planting over thousands of properties. Let's really put the right trees in the right place.

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