Specialty Wood Products Research Partnership

FOREST GROWERS RESEARCH

Techno-economic analysis of posts from specialty wood species and radiata pine

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EXECUTIVE SUMMARY

The volume of post and pole grade logs cut from New Zealand plantation forests is in the order of 400,000 cubic metres per annum. Some of this material goes to non-post uses and some volume (up to 28%) is lost during processing. The total volume of wooden posts and poles produced is estimated to be around 270,000 to 310,000 cubic metres per annum.

This study is intended to compare the potential for producing posts from durable eucalypt species with the well-established CCA treated wooden post market, as well as posts made from other materials. There are a wide range of non-wooden posts on the market, made from concrete, steel, recycled plastic and hybrids made from a mix of materials. Generally, these non-wooden posts have retail prices that are higher than the CCA treated wooden posts.

The costs of durable eucalypt posts were estimated to be $890 per cubic metre when the costs of growing and processing, including profit margin were included. CCA treated pine posts and non-wood post retail prices were estimated.

	CCA pine	**Durable Eucalypt***	**Steel**	**Concrete**	**Plastic**	**Wood / plastic**	**Wood / concrete**
Retail price; 1m^3 wooden posts or equivalent number of non-wooden posts	$741	$890	$1,749	$2,029	$1,202	$1,006	$1,470

*estimated

Non-CCA treated posts have the advantage of being acceptable for use on organic farms and orchards and should be easier to recycle or dispose of after their useful life is over. End of life disposal costs for CCA treated posts are likely to be around $75 per cubic metre.

Given the estimates available on the area of organic farming and horticulture, the potential demand for non-CCA treated posts was calculated. In total there could be a demand for up to 17,000m^3 of non-CCA treated wooden post per annum with the bulk of this driven by vineyards, as they have high numbers of posts per hectare and comparatively high breakage / turnover rates. Additionally, the New Zealand wine industry is aiming to achieve zero waste to landfill by 2050 (New Zealand Winegrowers, 2021), which will provide additional demand for non-CCA posts.

Due to the predominance of vineyards in the volume of posts demanded, much of the non-CCA wooden post demand is expected to be in Marlborough, as it has almost 70% of the total national area in vineyards with expansion in recent years being several hundred hectares per annum.

Taking the eucalypt tree crop harvest volumes predicted from a 20-year rotation and the assumed conversion factors likely to be achieved it was estimated that a forest harvest area of 60 ha per annum would be required to meet the post demand from organic growers. This implies a total forest estate dedicated to growing durable eucalypt posts of around 900ha. The Nelson / Marlborough demand is currently around 11 to 12,000 m^3 per annum.

Based on this analysis making durable Eucalyptus posts that are cost competitive with non-wood options is possible.

A further consideration is the green-house gas footprint of the various options. Posts made of concrete and steel will inevitably (due to the high energy intensity fossil fuel (coal) based processes used to make them) have a higher GHG footprint than posts made of wood (which are a medium-term store of carbon). The heat in the form of steam used in a post treatment system will largely come from post peelings which are a low carbon fuel. The ecological footprint of plastics

posts is less clear, they are made from a waste stream and so reduce volume to landfill but will require heat to melt the plastic prior to it being formed into posts. There is the potential to recycle the plastic posts again should they be damaged whilst in service. There is likely to be some end of life disposal of all posts, regardless of type. However, the LCA of the various routes was not a focus of this analysis but may be of merit at a later stage.

INTRODUCTION

The production of posts is a small but significant part of New Zealand forestry and wood products industry.

The volume of posts and pole grade logs harvested has been estimated as being in the order of 400,000 cubic metre per annum consistently for several years (NZFOA, 2020). This figure is an estimate, as there is little hard data publicly available on the post and pole processing industry. This puts the post and pole log market at around 1.2% of the current NZ log harvest of around 36M m^3 per annum. The processing loss from roundwood logs to posts can be up to 30% (industry figure), giving a volume of posts sold of around 290,000 m^3 per annum. For context, the conversion losses from saw logs to sawn lumber can be 40 to 45%.

The Scion Wood Processing database has 35 post and pole yards identified, spread from Northland to Southland. This database is not considered to be 100% complete. However, it does indicate the scale and the wide distribution of the sale and use of posts and poles across New Zealand. Not all of the sites selling wooden post and poles are noted as having a treatment plant.

A recent study (van Bruchem, 2020) has put the post and pole market (agriculture and horticulture) at around 270,000 to 310,000 cubic metres per annum. The difference between the volume of post logs sold from forests and finished post products sold is due to processing losses (breakage and peeling) and some post and pole logs going to CCA treated battens and piles.

There are posts made from a wide range of material sold into the post and pole market, apart from CCA treated radiata pine. These include; steel, concrete, recycled plastic and some hybrids that have a wooden core and plastic or concrete outer.

There is a demand for posts that do not contain CCA chemicals from organic farms and orchards. Further, where posts are prone to breakages (vineyards) there can be issues with accumulation of broken / waste CCA treated wooden posts (Davies, 2016) that are difficult to dispose of. This can be high in vineyards where mechanical harvesting of grapes is practised. The New Zealand wine industry is aiming to achieve zero waste to landfill by 2050 (New Zealand Winegrowers, 2021). Finding alternatives to CCA treated posts is a key aspect of this. New Zealand Winegrowers has a CCA Working Group which developing an industry document outlining alternatives to CCA posts.

The issue of acceptance for use on organic farms does not affect posts made from steel, plastic and concrete, but they tend to be more expensive than CCA pine posts (Organic Aotearoa NZ, 2010). For concrete and steel posts recycling is possible at end of life. The plastic posts should also be recyclable as should the plastic / wood hybrids and the concrete wood hybrids, although the concrete / wood hybrids may present some challenges with separating the wood and concrete completely.

An alternative to be considered is the use of naturally durable Eucalyptus species (*E. bosistoana*, *E. globoidea* and *E. quadrangulata*) as a substitute for CCA treated pine posts (Millen et al 2018).

Objectives

The objectives of this work are to;

- describe the markets for posts and poles (both CCA-treated radiata and durable Eucalypts)
- conduct Techno-economic analysis of production of treated radiata and durable Eucalypt posts using the WoodScape model.

METHODS

The first part of the study involved an online search for post prices. The absence of direct reference to suppliers and manufacturers is deliberate, to avoid issues with prices having changed. Prices were summarised by; size, and the type of materials the posts were made from.

A literature search on the post market was also conducted, a key resource is the thesis published in late 2020 by van Bruchem.

Some of the market for posts is interpreted from areas of land in particular uses (New Zealand Winegrowers Inc., 2018 and 2020), the number of posts estimated to be used per hectare (van Bruchem, 2020 and industry estimates)

Information on CCA treatment costs were also sought from industry sources.

The costs of growing posts using a durable eucalypt species were estimated using some industry growth models and forest crop costs calculator. Harvesting and transport costs were derived using Scions Harvesting and Transport Cost Calculator which is derived from the calculators produced for Forest Growers Research (Blackburn, 2009, Riddle 1994).

Capital and operating costs for post and pole yards were obtained from industry sources and two types of post and pole operations were added to the WoodScape model (Jack et al, 2013);

- Radiata CCA treated posts
- Durable eucalypts

The WoodScape model was used to estimate the financial returns (return on capital employed (ROCE)) for making posts under a range of feedstock and post price scenarios.

RESULTS

Market size

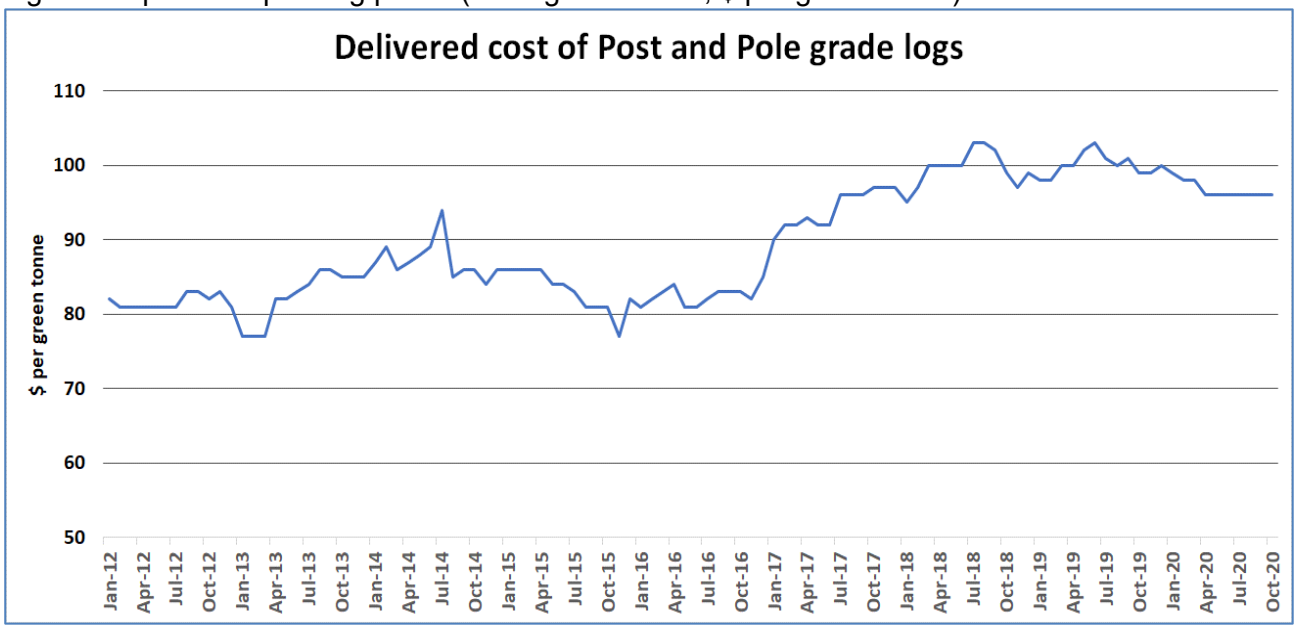
The total market for logs used for posts and poles is in the order of 400,000 cubic metres per annum (NZ FOA, 2020). The size of the post market was estimated at being between 270,000 and 310,000 cubic metres (von Bruchem, 2020). The difference between the volumes sold as post and pole logs and the volume of posts poles produced is due to a number of factors;

- Some of the post and pole grade logs going into piles, battens, sawn material and retaining walls etc.
- Production losses from defects, breakage and rounding the posts with a lathe (up to 30%)
- Debarking losses (which can ~5% of the log volume (excluding bark).

The price paid for posts and poles from *Pinus radiata* forests, delivered to a manufacturing / treatment facility have varied from $77 to $103 per green tonne (delivered to a mill) over the last 8 years (Figure 1).

The average price for the last 12 months has been $97 per green tonne and $99 per green tonne for both 24 and 36-month periods. The 5-year average is $94.

Figure 1 – post and pole log prices (average delivered; $ per green tonne)



*Source data; AgriHQ.

Significant post and pole producing regions are Northland, Central North Island, coastal / western Southern North Island (Santoft etc.) and Nelson. Coastal and sand dune forests are preferred sources due to the higher density wood and small branches often associated with these sites.

The total demand for posts was estimated by van Bruchem as being 290,000 m^3 per annum, with the bulk of this (85%) from the pastoral sector.

Much of this demand is spread widely across New Zealand as it is from pastoral grazing.

Other areas have concentrated demands due to the presence of a particular land use. An example being vineyards in Marlborough. Marlborough has an estimated 27,808 ha of productive vineyards (69% of NZs total vineyard area). The use of posts in vineyards is intensive, estimated at 580 to 600 posts per ha (grazing farmland averages around 20 posts per ha). In vineyards replacement posts are required at a rate of up to 4 to 5% per annum (Davies, 2016) largely due to breakage and some deterioration with age. This gives a demand in Marlborough for around 640,000 posts per

annum or 14,200 m^3 per annum of posts. Nationally the demand for vineyard posts could be 924,000 posts (approximately 20,000 m^3). This does not include posts required for new vineyards. The area of land used for grape growing has been expanding at a rate of around 2.5% (~1,000 ha.) per annum nationally. This level of expansion implies a demand of over 400,000 posts (8,800 m^3 per annum.

Therefore, the national demand just from vineyards for posts could be 1,400,000, or 31,000 m^3. Of this around 1,000,000 posts (23,000 m^3) would be in Marlborough. There is some uncertainty around the ability of the expansion of vineyards to continue to expand at the current rate, simply due to the availability of suitable land.

Given the issues with use and disposal of CCA treated posts there will be some of this total demand that is for non-CCA posts, and this is likely to increase in future, as wine growers aim to reduce, or eliminate their waste to landfill.

Van Bruchem's study estimated that the total demand for posts from organic farms and horticulture was likely to be between 6,000 and 14,000 m^3 per annum.

Organic Winegrowers NZ claim that over 10% of New Zealand wineries hold organic certification, but do not provide figures on the area this represents. If the 10% was applied to the national demand it would imply a demand from wine growers for non-CCA posts of around 140,000 individual posts or 3,100 m^3 of post material.

The area of organic farming and horticulture in New Zealand has been estimated at around 94,000 ha, with 71,800 in grazing land and 22,200 in horticulture. Given these figures and their very different intensity of posts per ha, an estimate of the demand for non-CCA posts can be made (at a national level). The demand for non-CCA posts from organic grazing land is likely to be in the order of 75,000 post per annum (1,600 m^3 per annum) and from organic horticulture it is estimated to be 515,000 posts (11,000 m^3 per annum).

The total market for non-CCA posts is difficult to estimate but a low-end estimate would be in the order of 6,000 to 7,000 cubic metres per annum, with the bulk of this driven by vineyards. A high-end estimate could be 17,000 m^3 per annum. Due to the predominance of vineyards in the volume of posts demanded, much of the non-CCA wooden post demand is expected to be in Marlborough, as it has almost 70% of the total national area in vineyards.

The high-end volume of posts could be produced from an estate of around 1,100 ha of durable Eucalypts, assuming a post yield of around 350 to 400 m^3 per ha per annum and rotation of 20 years and harvesting 55 ha per annum. Due to the dominance of the Nelson Marlborough region is wine growing the demand there could be 11 to 12,000 m^3 per annum, which could be sourced from an estate of around 860 ha at a harvest rate of 42 ha per annum.

Market price

There are several types of posts used for agricultural fencing and horticultural crop trellis systems (plant and crop supports) that are not CCA treated wood. There are a mix of steel, concrete, recycled and hybrid or mixed material posts made from wood / plastic and wood / concrete being produced in New Zealand and Australia.

CCA treated posts are not accepted for use on organic farms and orchards which drives some of the market for non-CCA posts. Another potential issue is the disposal of CCA treated wood after its useful life is over.

A summary of retail prices by size and type is outlined in the following section.

Treated pine posts

The most common type of post sold for farm and orchard fencing and crop supports are CCA treated radiata pine. The prices for these (Table 1) were sourced from price lists obtained from an internet search.

Table 1 - average CCA treated post prices (retail per post with buyer pick-up)

	Length				
Diameter, mm	**1.8m**	**2.1m**	**2.4m**	**2.7m**	**3.0m**
75	$ 8.88	$ 9.56	$ 11.86	$12.68	$ 15.58
100	$ 12.16	$ 12.95	$ 16.91	$16.92	$ 20.30
125	$ 12.05	$ 14.31	$ 16.82	$20.31	$ 23.61
200	$ 33.00	$ 39.00	$ 45.00	$55.37	$ 64.50

Steel posts

There are a few different steel post options available with several being sourced from Australia. A driver for steel posts in Australia is the presence in some areas of termites. Steel posts are typically more expensive than CCA treated posts (Table 2).

Table 2 - average steel post prices (retail per post with buyer pick-up)

	Length			
Diameter, mm	**1.8m**	**2.1m**	**2.4m**	**2.7m**
51	$ 10.10	$ 11.79	$ 13.11	-
63	-	$ 14.60	$ 16.55	-
72	$ 12.37	$ 14.43	$ 16.15	-
72 S	$ 21.56	$ 25.16	-	-
80	$ 16.00	$ 18.70	-	$ 57.20

Recycled plastic posts

There are several different producers of posts made from recycled plastic (polyethylene) in New Zealand and Australia. These posts typically cost more than CCA treated posts (Table 3).

Table 3 - average recycled plastic post prices (retail per post with buyer pick-up)

	Length				
Diameter, mm	1.8m	**2.1m**	**2.4m**	**2.7m**	**3.0m**
75	$ 9.72	$ 10.98	$ 12.55	$ 14.12	$ 15.69
100	$ 16.71	$ 19.43	$ 22.32	$ 25.11	$ 27.90
125	$ 26.11	$ 30.51	$ 34.87	$ 39.23	$ 43.59
200	$ 66.95	$ 78.11	$ 89.27	$ 100.43	$ 111.59

Plastic coated posts

A product made in Australia that meets the requirements of organic farming is an untreated pine post that is encased in a thick layer of polyethylene. This product is called Woodshield (Figure 2). The plastic layer is recycled polyethylene and is around 4 to 6mm thick. The end caps are thicker – allowing some mechanical driving of the posts.

Figure 2 – hybrid wood / plastic (WoodShield) posts

Image source; Stuff.co.nz

The hybrid wood plastic posts (Table 4) are more expensive than CCA treated posts.

Table 4 - average wood / plastic hybrid post prices (retail per post with buyer pick-up)

	Length			
Diameter, mm	**1.8m**	**2.1m**	**2.4m**	**2.7m**
83	$ 8.48	$ 9.79	$ 10.61	$ 12.41
100	$ 16.86	$ 18.99	$ 21.11	-
120	$ 21.25	$ 24.80	$ 28.34	-

Concrete posts

Concrete posts (equivalent strength as opposed to equivalent diameter) are also more expensive than CCA treated posts (Table 5).

Table 5 - average concrete post prices (retail per post with buyer pick-up)

	Length			
Diameter, mm	**1.8m**	**2.1m**	**2.4m**	**2.7m**
70	$ 18.36	$ 21.44	$ 24.64	$ 27.66
90	$ 28.69	$ 33.45	$ 38.29	$ 43.05

Sawn hardwood posts

Sawn hardwood post prices (Table 6) were found, with 100x100mm posts at varying lengths being available in small quantities.

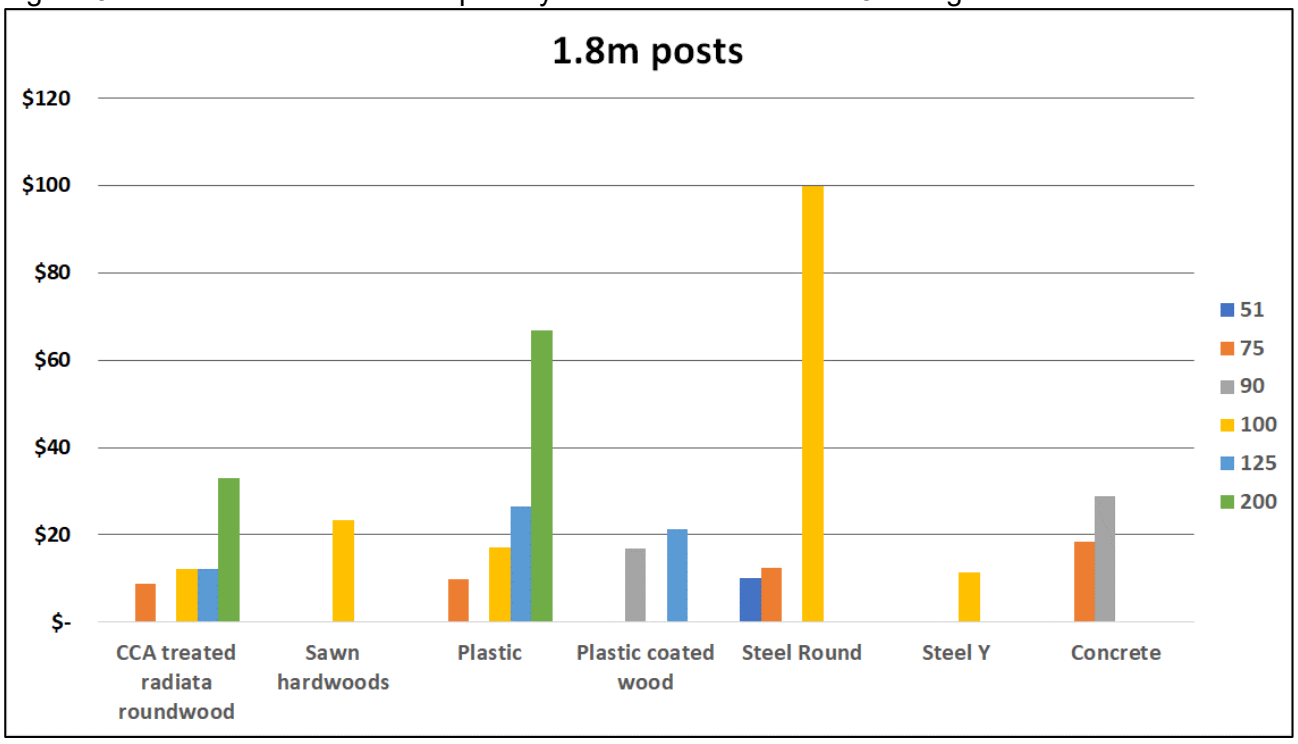
Table 6 – sawn eucalypt post prices

	Length			
Dimension	**1.8m**	**2.1m**	**2.4m**	**2.7m**
100mm x 100mm	$23.25	$27.15	$31.00	$34.87

Summary of posts costs

The approximate average retail costs of posts made from the various materials by length and diameter are shown in Figures 3, 4, 5 and 6.

Figure 3 – estimated retail costs of post by size and material for 1.8m lengths



CCA treated posts are typically the cheapest option. The sawn hardwood posts were typically more expensive than other options, except for steel posts.

Figure 4 - estimated retail costs of post by size and material for 2.1m lengths

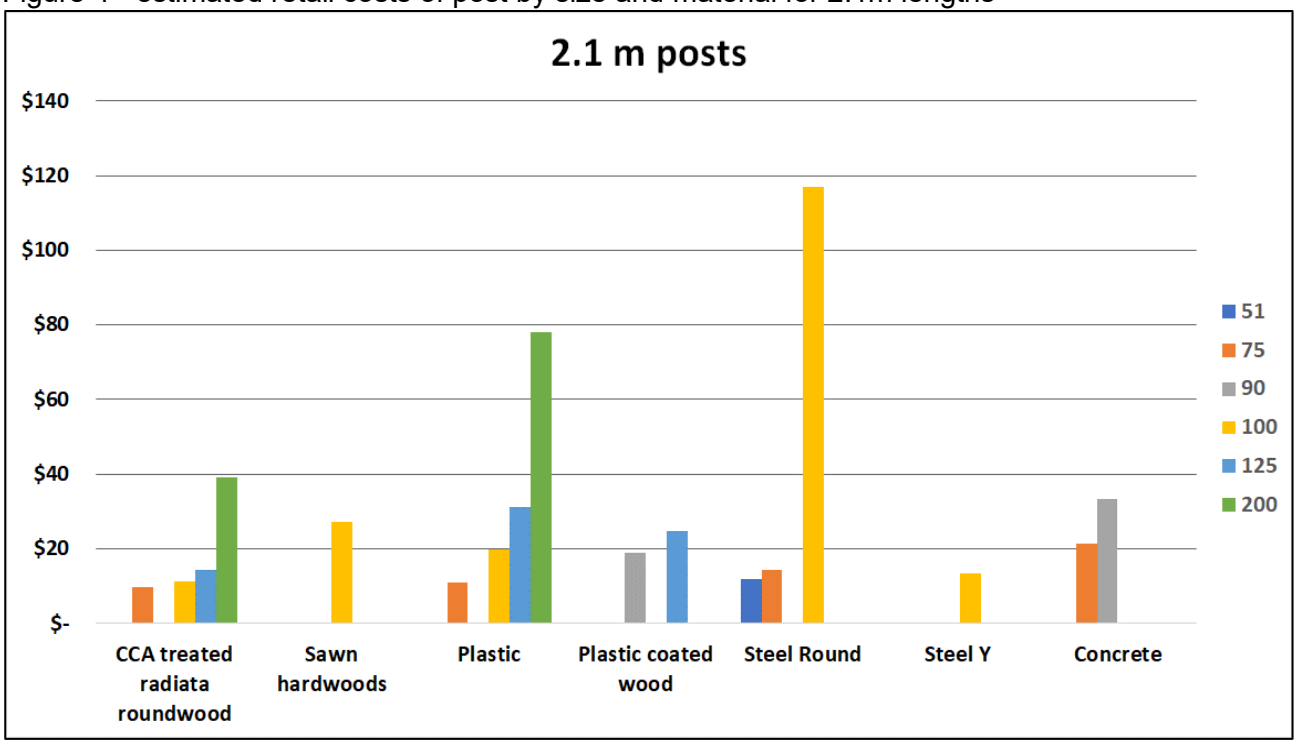


Figure 5 - estimated retail costs of post by size and material for 2.4m lengths

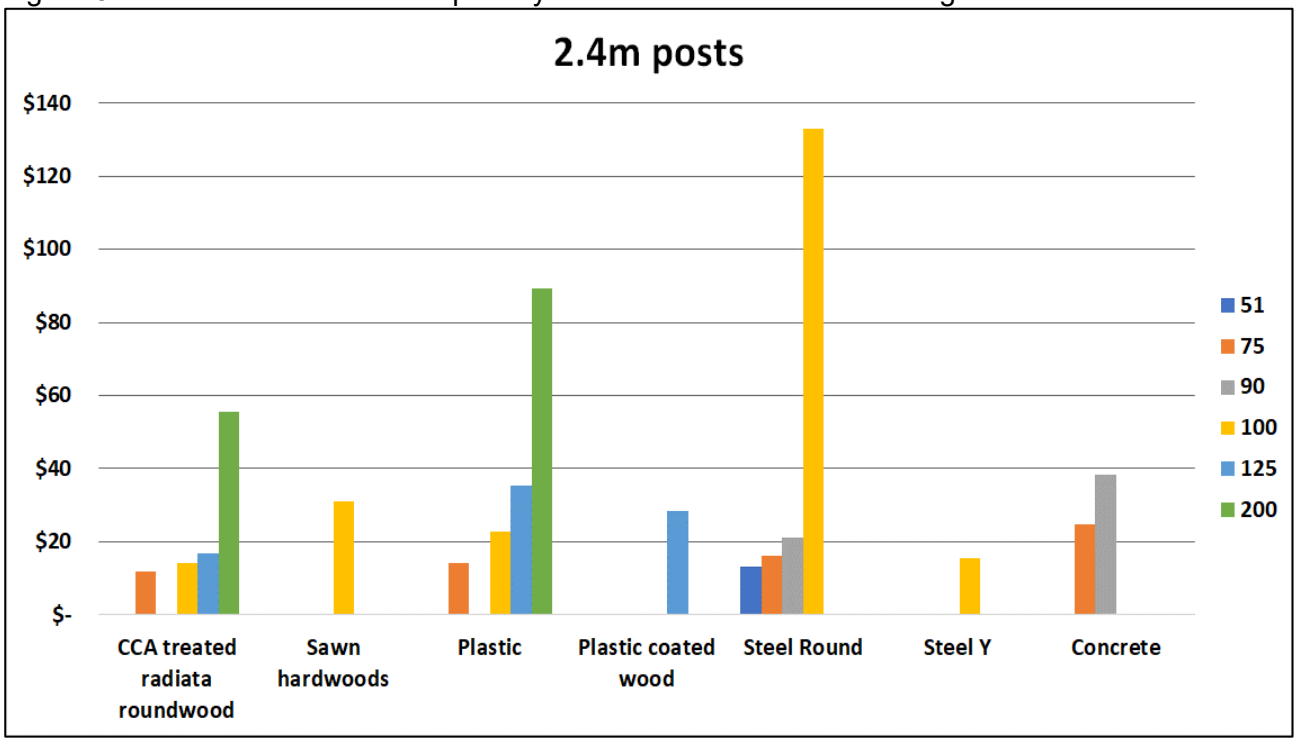
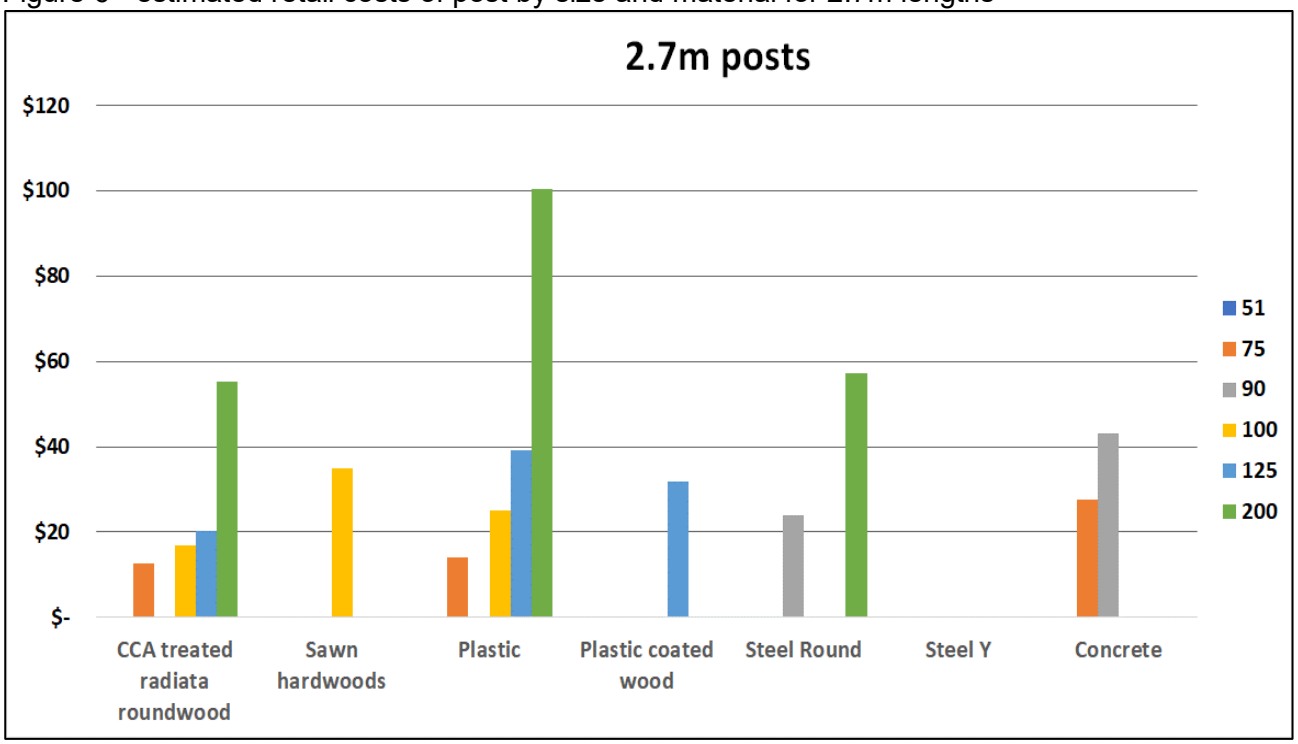


Figure 6 - estimated retail costs of post by size and material for 2.7m lengths



The retail prices of a range of different post and pole options have been summarised (Table 7). These prices are for 1 m^3 of post of 2.4m in length and 100mm in diameter assuming a wooden post, or the equivalent if in a product such as steel or concrete which may have different dimensions for the same strength. One cubic metre of wooden posts of this dimension is the equivalent of 53 posts, so the cost for non-wood posts in Table 6 are for the equivalent number of posts (53).

Table 7 – generalised costs of posts (1m^3 of wooden posts or equivalent number of non-wooden posts)

	CCA pine	Steel	Concrete	Plastic	Wood / plastic	Wood / concrete
Retail price; 1m^3 of posts	$741	$1,749	$2,029	$1,202	$1,006	$1,470

The CCA pine posts are clearly cheaper than any other option, with the recycled plastic post and post with a wooden core covered in recycled plastic being the next cheapest option. These costs do not include any disposal cost.

No prices were found for round durable hardwood posts. Sawn square hardwood posts of 100mm by 100mm and lengths of 1.8, 2.1, 2.4 and 2.7m length were retailing for around $1270 to $1290 per m^3. This makes them cheaper than steel, concrete and concrete hybrids, similar to plastic and more expensive than wood plastic hybrids and CCA pine.

Tecno-economic analysis of wooden post and pole production

The use of durable eucalypts is not necessarily competing with CCA treated posts in some markets as the CCA posts are not acceptable on organic farms and orchards. The plastic steel and concrete posts are acceptable, and so the durable eucalypts posts are competing with the cheapest non-CCA treated product, which has a retail price of around $1,000 per m^3 of 100mm diameter 2.4 m long posts.

Cost analysis

Radiata pine - CCA treated posts

The cost of the raw material going into the radiata pine post and pole processing industry is well documented via the log prices published by grade. The current price averages around $97 per green tonne (approximately $101 per m^3).

This is a key input into the WoodScape modelling of the financial performance of a post and pole treatment operation.

The returns from a CCA post treatment plant (producing 20,000 m^3 of posts per annum), based on the feedstock cost of $101 per m^3 were estimated to be;

- ROCE 11.0%
- IRR 4.7%
- NPV -$4,887,162
- Payback 10.6 years

Durable Eucalypt posts

The cost of producing posts from a durable Eucalypt crop was estimated by first modelling the growth rate of a regime designed to produce posts using a *Eucalyptus fastigata* growth model. The costs of producing the logs from this regime were then estimated using a excel based growing cost calculator.

Key inputs to the growing cost model were;

Land cost	$8,000/ha
Discount rate	6%
Roading costs	$5.20 per m^3
Logging costs	$32.00 per m^3
Transport costs	$19.20/$m^3$ (90km one way)
Site preparation	$840/ha
Planting	$1,060/ha (tree stock $722 / labour $338)
Releasing	$640/ha (2 at $320/ha each)

The growth model assumed a harvest volume (TRV) of 600/m^3 per ha at age 20, with an initial stocking of 1,100 and a thinning at age 4 to 700 spha (Millen et al, 2020).

The crop produced a range of post products per stem (Table 8).

Table 8 – Possible number and size of posts per stem – Eucalyptus post crop

sed, mm	Length, m	Number of posts	Delivered price	Delivered price per post
300	3.0	1	$ 32.64	$32.64
250	2.7	4	$ 91.80	$22.95
200	2.4	1	$ 28.05	$28.05
150	2.4	1	$ 14.79	$14.79
130	1.8	2	$ 9.18	$4.59
Total		**9**		**$103.02**

The IRR of the crop based on the volume and prices assumed above was 8.2%.

The area of land established in durable eucalypts to supply the Marlborough organic producer market was estimated. This was based on a total demand of 5,290 m^3. Eucalypt forest crop modelling estimated it was possible to grow 600m^3/ha with a recovery for post grade logs of 0.85

and a conversion logs to post of 0.7. This gives a volume of post per ha of 357 m^3. This equates to harvest of 15 ha per annum. Using a rotation of 20 years to grow the crop therefore requires a total planted estate of around 300 ha. This would be the minimum area required to supply the estimated current demand. As the crop would not be available for 20 years demand may have changed.

Costs of durable Eucalypt posts

The cost of growing and delivering the Eucalypt post crop to a post processing yard; including roading, logging and transport was estimated to be $115 per cubic metre, including a profit margin to the grower of 4%.

Converting the Eucalypt logs into posts by debarking and peeling of the sapwood whilst producing a smooth outer incurs losses in volume and incurs costs from labour, energy and capital inputs.

The WoodScape model was used to estimate the costs and returns from the processing of the logs into posts. The costs of the posts ex-mill yard were estimated to be in the order of $445 per cubic metre and at this price the return on capital employed (ROCE) of the post manufacturing operation was 11.8%. This is not a high ROCE and may be insufficient to attract an investor, but it does indicate that under the assumptions used the operation would have a modest profit. The results are sensitive to changes in feedstock cost.

The ex-mill price of $445 equates to a retail price (approximately) of $890 per cubic metre. This is slightly more than expensive than CCA treated posts and slightly less than the equivalent non-wood products.

DISCUSSION

Making CCA treated radiata posts based on input log costs of $101 per cubic metre and other labour, capital, energy and chemical costs had a ROCE of 11%. The CCA-radiata post processing is more capital intensive as it requires the posts to be steamed and pressure treated with chemicals which the Eucalypt posts do not require.

Based on this analysis producing durable Eucalyptus posts that are cost competitive with non-wood options is possible.

A further consideration is the green-house gas footprint of the various options. Posts made of concrete and steel will inevitably (due to the high energy intensity fossil fuel (coal) based processes used to make them) have a higher GHG footprint than posts made of wood (which are a medium-term store of carbon). The heat used in a post treatment system will largely come from post peelings and are a low carbon fuel. The environmental footprint of plastics posts is less clear, they are made from a waste stream and reduce volume to landfill but will require heat to melt the plastic prior to it being formed into posts. The LCA of the various routes was not a focus of this analysis but may be of merit at a later stage.

The disposal of CCA treated posts is likely to incur a cost of $75 per m^3 ($1 per post at a post size of 1.8m long and 100mm diameter) as they have to go to a lined landfill. On the other hand, durable Eucalypt posts can be used as a low carbon fuel.

CONCLUSIONS

The total market for treated wooden posts is estimated at 290,000 cubic metres (13 to 14 million posts) per annum.

The number of steel, concrete and plastic posts sold is unknown, but given the significant cost advantage that CCA treated wood posts have it is likely to be a modest percentage of the total market and possibly limited to areas where non-CCA posts are required. This market is estimated to be around 240,000 to 250,000 posts (5,200 m^3) per annum.

CCA treated wooden posts are the cheapest option out of those currently on the market. The costs (including grower and processor profit margins and retail sales margins) of growing and processing durable Eucalypt posts was estimated at $890 per m^3. This is 20% higher than CCA treated posts. However, this cost is also lower than the other non-wood options.

The production of durable Eucalypt posts for use on organic or zero-waste farms, orchards and vineyards would appear to be cost competitive with the alternative options whilst giving a modest profit (ROCE of 11 to 12%).

Given the crop harvest volumes predicted and the assumed conversion factors likely to be achieved it was estimated that a harvest area of around 20ha per annum would be required to meet the national demand from organic growers. This implies a total estate dedicated to growing posts of around 900 hectares.

For all New Zealand wine growing the post demand could be met from a forest are of around 1100 ha.

If the initial growing effort was focussed just on the Marlborough region and wine growers specifically the estate required would be around 800 to 900 hectares.

ACKNOWLEDGEMENTS

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APPENDICES

Appendix 1: Post and Pole log price (not cut to length)