SCION
forests · products · innovation

Statement of Corporate Intent 2016 - 2021

Prosperity from trees *Mai i te ngahere oranga*

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Statement of Corporate Intent **2016 - 2021**

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www.scionresearch.com

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Profile

New Zealand Forest Research Institute Limited	Trading as Scion
Ownership	Crown owned entity (established under the Crown Research Institutes Act 1992).
Head Office	49 Sala Street, Rotorua
Postal Address	Private Bag 3020, Rotorua 3046
Web Address	www.scionresearch.com
Governance	Shareholder-appointed Board: Chair, Tony Nowell (2010); Deputy Chair, Judith Stanway (2010); Directors, Sheldon Drummond (2008), Barry O'Neil (2012), Colleen Neville (2014), Jon Ryder (2016).
Executive Management	Chief Executive, Warren Parker; General Manager Research and Investments, Russell Burton; General Manager Manufacturing and Bioproducts, Elspeth MacRae; General Manager Business Development and Commercialisation, Roger Schwarzenbach; General Manager Forest Science, Alison Stewart; General Manager People, Culture and Safety, Keri-Anne Tane; Chief Financial Officer and Company Secretary, Rob Trass.
Staff	277 full-time-equivalent staff at three sites: Rotorua (254), Christchurch (22), Dunedin (1), as at 31 May 2016.
Vision	Prosperity from trees - *Mai i te ngahere oranga*
Core Purpose	To drive innovation and growth from New Zealand's forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand.
Values	Ingenuity, Collaboration, Excellence, Manaakitanga.
Reporting	Financial and non-financial performance against SCI targets is reported to the Shareholder quarterly and to the public via a six month and annual report.
Shareholder Funds	Total book value of $34,548 million at 30 June 2015.

Shareholdings

Company	Company type	Scion shareholding %
Te Papa Tipu Properties Ltd	A land-holding subsidiary	100.00
Biopolymer Network Ltd	An incorporated joint venture	33.30
WQI Ltd (Solid Wood Innovation)	An MBIE-industry partnership in wood processing	5.95
Sala Street Holdings Ltd	Holds Scion's 50% shareholding in Terax (2013) Ltd	100.00
Terax (2013) Ltd (through Sala Street Holdings)	The General Partner in Terax Limited Partnership	50.00

Contents

Chair and Chief Executive overview

We are pleased to present Scion's 2016-2021 Statement of Corporate Intent (SCI). In formulating this SCI we considered the 2025 Business Growth Agenda targets, the National Statement of Science Investment (NSSI) signals, New Zealand's Nationally Determined Contribution (NDC) to the Paris Climate Agreement, regional implementation of the 2014 National Framework for Freshwater Management and the economic action plans for regional growth studies.

We also accounted for Scion's key stakeholder priorities (such as the New Zealand Wood Council's (Woodco) goal of $12 billion of exports by 2022); trade developments such as the Trans Pacific Partnership Agreement (TPP) and Scion's 2015 Four Year Rolling Review[1]. This assessment of external factors and macro trends supported our decision to further build on the success of Scion's current strategy, science plan, and Te Papa Tipu Māori Plan.

Our strategic review confirmed international and domestic developments are generally favourable for the New Zealand forest industry and the advanced wood and fibre-based manufacturing firms we work with. Global demand for forest biomass is projected to grow by at least 300% by 2050 as supply chains decarbonise and more wood is used in buildings and other construction[2]. Increased forest plantings will be necessary if New Zealand is to plausibly meet its 2030 greenhouse gas reduction target and achieve new nutrient limits imposed on land use. Greenhouse gas emitters, such as transport firms, will have increased demand for carbon credits (NZUs) through the Emissions Trading Scheme (ETS). Also, Māori want to generate more wealth from the estimated 500,000 hectares of their under-utilised land that is best suited to forestry[3].

Large capital investment has been made recently into new sawmills (e.g. Lumbercube, Red Stag, Sequal Lumber and Wood Engineering Technology Limited) and to modernise existing mills (e.g. Tenon, Pan Pac, Kiwi Lumber, Clelands Timber Products and Taranakipine). This investment, combined with a more favourable exchange rate and lower interest rates, has boosted the international competitiveness of domestic wood processors and manufacturers. Associated mill and factory productivity gains are helping to meet the Woodco target of "processing 70% of logs onshore" (currently 50%). Such gains are reducing forest growers' over reliance on the China log market and putting the spotlight on the importance of long-term security of log supply.

Given this context, the further loss in 2015 of some 13,000 hectares of plantation forest and only 3000 hectares of new plantings is disturbing.

The forest industry incorporates forest production, solid wood and fibre processing; and the rapidly emerging industrial bioproducts sector (renewable lightweight materials, bioenergy and 'green' chemicals). It is New Zealand's third largest exporter and a major contributor to the domestic economy through the construction and housing sector, regional employment, and the provision of ecosystem services such as flood and erosion mitigation. Māori own 40% of the land on which plantation forests grow. Domestic and export forest industry value chains combined generate more than $12 billion of sales annually. As well, ecosystem services worth an estimated $600-800 million per annum are produced. These are vital in addressing climate change and managing land within environmental limits.

Scion's research is critically important to reversing deforestation by increasing the competitiveness of forestry as a land use, lowering the cost of forestry operations and logistics, monetising forest ecosystem services (such as for carbon sequestration) and growing the capacity of processors to meet market prices for logs through higher-margin solutions for their customers. Indeed, a shortage of pruned and high-quality structural logs is already evident in regions such as Northland. This shortage will worsen after the mid-2020s harvesting peak and requires reforestation and afforestation to urgently and sharply increase.

Remediating water quality, a national priority, and afforestation (whether for plantation, honey or other purposes) go hand-in-hand. Experience at Lake Taupo, the Waikato/Waipa River catchments and Rotorua Lakes confirms afforestation must occur at a reasonably large scale to meet the early 2030s water quality targets for these waterways. Land use within environmental limits also coincides with the Paris Climate Agreement because increased plantings reduce greenhouse gas emissions, provide long-term log supply security and generate other ecosystem benefits such as more biodiversity. Further, exploiting complementarity between land use sectors, such as forestry and dairy, improves the sustainability of land management and encourages the allocation of capital into higher performing infrastructure and manufacturing assets.

This systems thinking at different spatial scales and across value chains is a strong feature of Scion's *modus operandi*. It

[1] Ministry of Business, Innovation & Employment. (n.d.). *Crown Research Institutes*. Retrieved May 2016 from: http://www.mbie.govt.nz/info-services/science-innovation/research-organisations/crown-research-institutes

[2] World Wildlife Fund. (2013). *Industry key to conserving forests as demand for wood projected to triple by 2050*. Retrieved May 2016 from: http://wwf.panda.org/wwf_news/?207367/Industry-key-to-conserving-forests-as-demand-for-wood-projected-to-triple-by-2050

[3] PwC. (2014). *Growing the productive base of Māori freehold land – further evidence and analysis*. Report prepared for the Ministry for Primary Industries. Retrieved May 2016 from: https://www.mpi.govt.nz/document-vault/4957

has informed the alignment of Scion's strategic investment (core funding) into the five National Science Challenges we contribute to and fits well with our customer-focussed approach to delivering the science for the six Intermediate Outcomes (IOs) in our science plan. Core funding ($17.7 million) is invested across the IOs at varying levels and about 60% direction to strategic (Horizon 2 and 3) research.

SECTOR CO-BENEFITS AND COMPLEMENTARITY

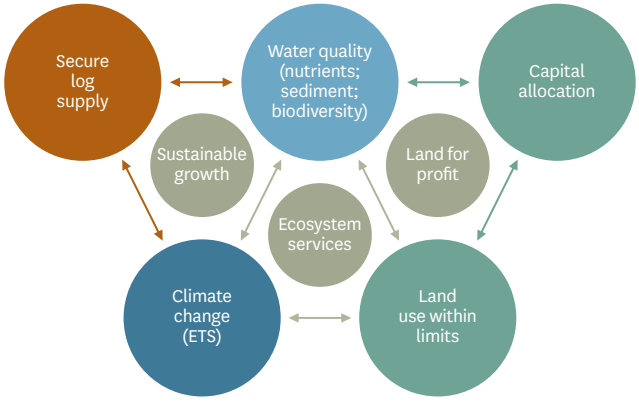


Figure 1: *Linkages that support sector complementarity and resilient regional economic growth*[4].

Through the science IOs we are seeking to:

1. Maximise the value and profitability of commercial forests and their ecosystem services.
2. Increase the profitability of solid wood processing through customer solutions and supply chain innovations.
3. Expand opportunities in the wood fibre, pulp, biopolymer, packaging and biochemical industries and from their biomass side streams.
4. Increase New Zealand's energy security through the use of forest and waste biomass for bioenergy.
5. Protect and enhance market access and improve risk management in the forest industry, including forest health and preparedness for biosecurity incursions, fire and climate change.
6. Ensure the forest industry and bioeconomy businesses' licence to operate.

Our business model is evolving to increase Scion's financial resilience and grow science excellence and impact. For example, we are investing with international partners to co-develop technologies for New Zealand application, gain insights into future markets and open new export markets for our domestic customers. Benefits from our partnerships with Māori are growing. Capital investments made over recent years into specialist equipment, pilot plant and scale-up infrastructure, and nursery are increasing our competitive edge in technology scale-up and commercialisation.

The re-investment of surpluses into Learning and Growth (L&G) initiatives in order to diversify Scion's revenue and make Scion a great place to work is bearing fruit. Reinvestment of $1.465 million is proposed for 2016/17 to accelerate commercialisation, build depth with our international partners, continue staff secondments into firms and support the establishment of a Scion Chair of Sustainable Forest Management at the Waiariki Bay of Plenty Polytechnic[5], grow the Māori economy via forestry, and exploit the potential of 'big data' tools at Scion and with other parties.

Last year we adopted a new 10-year development plan for Scion's Rotorua Campus. We expect to commence construction work in 2016/17 to co-locate the innovation hub within our main science buildings, refurbish our wood engineering laboratories and pilot plant facilities, and improve public access to our science. This two-year development will cost an estimated $16 million. There will be scope to significantly increase Scion reinvestment from 2019/20 when this major capital works programme is scheduled to be completed.

While inflation and oil prices are low, market volatility and the risk of a 'global shock' remain high in historic terms. Accordingly, realistic top line growth, cost control and balance sheet flexibility are all reflected in Scion's financial projections to June 2021. Revenue for 2016/17 is budgeted at $50.032 million, and earnings before interest and tax and after reinvestment is budgeted at $1.596 million. This generates a return on equity before reinvestment of 7.1% and a tailored rate of return of 4.3%.

Our financial performance is predicated on MBIE contestable revenue being regained and won, contracts with the National Science Challenges, success with commercialisation initiatives (TERAX® and Woodforce), new Primary Growth Partnerships with industry and expansion of our partnerships with Māori. Notwithstanding these uncertainties, with the commitment of our staff and on-going industry support, we expect Scion to sustain its financial performance and capacity to invest in initiatives to assist the forest industry to achieve $12 billion of exports by 2022 consistent with our vision of Prosperity from trees.

Tony Nowell CNZM
Chair

Dr Warren Parker
Chief Executive

[4] Monge, J., Velarde, S., Yao, R., & Pizzirani, S. (2016). *Identifying complementarities for the dairy and forestry industries in the Central North Island*. Report to Oji Fibre Solutions and Waikato Regional Council. Rotorua, New Zealand: Scion.

[5] Waiariki Bay of Plenty Polytechnic came into being on 1 May 2016 through the merger of the Waiariki Institute of Technology and Bay of Plenty Polytechnic.

1 Scion's purpose and business model

The New Zealand Forest Research Institute (trading as Scion) was established as a Crown Research Institute (CRI) in 1992. It is wholly owned by the New Zealand Government and constituted as a limited liability company under the New Zealand Companies Act 1993. Scion is New Zealand's leading provider of science and technology to New Zealand forest-based companies.

Statement of Core Purpose

In October 2010 Scion's Statement of Core Purpose (SCP) was adopted. Scion's purpose is to **"drive innovation and growth from New Zealand's forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and beneficial environmental and social outcomes for New Zealand"**[6]. Scion is responsible, in partnership with industry, Government and Māori for achieving four national outcomes:

- Increase the value and productivity of these industry sectors to the New Zealand economy through improved forestry practices and production systems and increased diversification of New Zealand's biological industry base to meet current and future global market needs.
- Protect and enhance market access and improve risk management in the forest industry.
- Increase renewable energy production and energy security by growing New Zealand's ability to produce sustainable bioenergy and liquid biofuel products.
- Enhance New Zealand's opportunity to benefit from forestry-based ecosystem services to improve both the global market position of industry and the environmental sustainability of forestry production in New Zealand.

Scion's development has paralleled the evolution of commercial forestry and its associated industries in New Zealand over the past 100 years. For example, Scion, and its predecessors from the 1920s, developed the genetics of trees whose progeny now populate over 90% of the commercial forest estate. In 1947, the forest health group was formed and the control measures they developed for dothistroma needle blight and sirex woodwasp still apply today. In the late 1950s, research into wood manufacturing and wood products commenced, and led to the development of many of the technologies (e.g. drying, preservation, fibre production) now widely used by New Zealand's wood processors. In 2000, Scion extended its focus to the development of renewable chemicals, materials and energy from forest resources and, later, into ecosystem services (such as payments for carbon storage) to further extend the revenue streams available from forests. These changes reflected the rapidly increasing international interest in developing substitutes for petrochemicals and need to enhance New Zealand's environmental performance and energy security.

These achievements have built Scion's reputation as a world-leader in forest industry research and development. It has developed a distinct multi-disciplinary capability across the value chain from germplasm generation to the design and application of wood, fibre and other forest resources in commercial products and services. These capabilities have established knowledge and technology platforms that can be applied to non-forest biomaterials such as in the packaging and waste sectors. Scion also fulfils an important role in providing the evidence base for public policy on forestry and working internationally to formulate, for example, new biosecurity protocols and standards for wood products, packaging and new industrial bioproducts.

Scion's business model

Scion's business model is designed to create economic, environmental and social value for New Zealand. Its purpose is to support the forest industry, advanced manufacturing (for industrial bioproducts), iwi, policy agencies (such as the Ministry for Primary Industries) and other stakeholders Scion works with to meet their goals. Scion can only achieve the national outcomes in its Statement of Core Purpose by working alongside and partnering with these parties. This imperative requires Scion staff to work closely with customers and stakeholders to identify needs and opportunities, develop new knowledge and technology to meet their requirements, and ensure that Scion's outputs are readily adopted into the relevant value chains (see Figures 2 and 5).

The foundations of this model are high-quality partnerships with customers and Māori; an extensive national and international research network to access new ideas, intellectual property for adoption and adaption to New Zealand; internationally competitive science and support staff; and, modern research laboratories, plant, equipment and ICT systems. Recurring revenue streams, mostly for contract services, are built through these activities.

[6] The full Statement of Core Purpose is available at www.scionresearch.com

SCION'S BUSINESS MODEL CANVAS

OUR PARTNERS ARE:	OUR RELATIONSHIPS WITH THEM ARE TO:	PROBLEMS WE SEEK TO SOLVE ARE:		OUR CUSTOMERS IN NEW ZEALAND AND OFFSHORE ARE:
The stakeholders along the forest industry and biomaterials manufacturing supply chain	Build quality partnerships with the stakeholders along the supply chain including firms in New Zealand and offshore	Grow New Zealand forest industry exports to $12 billion by 2022	WE DELIVER OUR PRODUCTS BY:	Forest growers
Investors that align to delivery of our core purpose	Foster collaborations with national and international researchers and selected institutes	Enable New Zealand's natural capital to be used within ecosystem limits	Partnering with stakeholders along the supply chain to identify the technology based barriers to achieving their target outcomes	New Zealand wood processors converting logs into solid wood products and providing residues to pulp and paper mills
National and international science and innovation entities that strengthen Scion's customer offering	Nurture partnerships with Māori consistent with Treaty of Waitangi principles and enable economic development	Find new ways to create value and increase profit for customers and their shareholders	Building the best user-investor-technical partnerships to develop and implement the solutions	Manufacturers deploying wood fibres and other biomaterials (non-food) to design, invent/or create value-added products
	OUR RESOURCES DELIVER:	Diversify customers' product portfolios through new product offerings		Land owners seeking to sustain and grow value from their land through forestry
	New or substantially enhanced knowledge intensive solutions for our customers over the three horizons: 1. current industries' improved products and efficiency 2. current industries' new products and synergies 3. new industries, new products, new value chains			
	Capability growth to sustain our delivery model			

OUR COSTS ARE INCURRED IN:	WE SECURE OUR REVENUE THROUGH:
Staff remuneration and growing Scion's scientific capability	CRI Core funding
Operating and maintaining the Rotorua campus infrastructure and leased facilities at other sites	Research contracts with the New Zealand Government through the Ministry of Business, Innovation and Employment (MBIE) and, in particular, the Ministry for Primary Industries (MPI), Ministry for the Environment (MfE) and Department of Conservation (DOC)
Building national and international partnerships to access new ideas, talent, technologies and markets for New Zealand	Collaboration with other research providers including CRIs, universities and international research institutes and companies
Transferring technology to customers (industry, firms, public agencies), including through commercialisation	Selling contract services to customers
	Licensing and selling intellectual property

Figure 2: *Scion's business model canvas*[7].

[7] Adapted from Osterewalder, A. & Pigneur, Y. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers* (pp. 18-19). New Jersey, USA: John Wiley & Sons, Inc.

A values-based culture focussed on customers. A customer-centric culture, strong science translation capability and a value chain perspective imbues Scion's approach to science and business. Scion's values (Figure 3) promote the behaviours associated with this distinctive customer-centred approach to science and technology delivery.

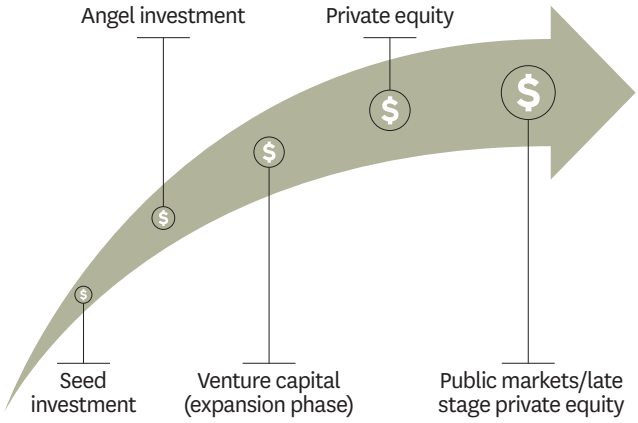
Figure 3: *Scion's values define the behaviours that drive business model execution and shape its brand identity.*

Growing commercialisation revenue and impact

Currently Scion's revenue is largely generated from 'fee-for-service' science contracts, however, the aspiration for 2025 is to generate at least 25% of total income from the licencing and sale of technologies. To achieve this 2025 goal, Scion will, as outlined below, step-up its focus and capabilities in commercialisation, value chain analysis and integration, and impact analysis.

Accelerate commercialisation. Growing revenues from the sale of intellectual property (IP) and royalties from licencing will increase the impact and economic benefits of Scion science; improve Scion's financial resilience and reduce its current relatively high reliance on Crown funding. Achieving this requires ongoing culture change, strong technology platforms with distinct and protected IP; and new sources of investment as illustrated in Figure 4. Also shown is the spectrum of investment available to Scion to accelerate commercialisation.

SOURCES OF CAPITAL FOR COMMERCIALISATION



SCION STAGE GATE MANAGEMENT

Ideation, scoping → Prototype → Pilot, scale-up → Launch

TECHNOLOGY PLATFORM	PRODUCT EXAMPLES
Alternative and improved tree germplasm	Biotech trees: sterility
Forest management systems	Remote sensing, DSS tools
Wood fibre composites	Woodforce
Bioadhesives	Plywood, MDF
Bioenergy	Bio oils, bark briquettes
Wet oxidation	TERAX®

Figure 4: *Sources of investment capital to support Scion's technology commercialisation pipeline and examples of technology platforms and products supported by this investment.*

Securing an array of investment into Scion's product pipeline portfolio requires new capabilities for structuring financial arrangements for commercialisation and will enable large uninterrupted periods of staff time to be dedicated to product development, pilot plant scale-up evaluation, and in-situ trials with businesses.

Value chain design, resource economics and systems integration. Scion's science capability spans the value chain (Figure 5). This key strength in providing solutions to customers, differentiates Scion as a research provider. 'Gene to consumer' capability, paired with close relationships with customers and investors allows Scion to identify how forest growing technologies and industrial bioproducts can be optimally integrated into supply chains. Many of the value chains Scion engages with are global and complex with suppliers located in multiple jurisdictions. This is exemplified

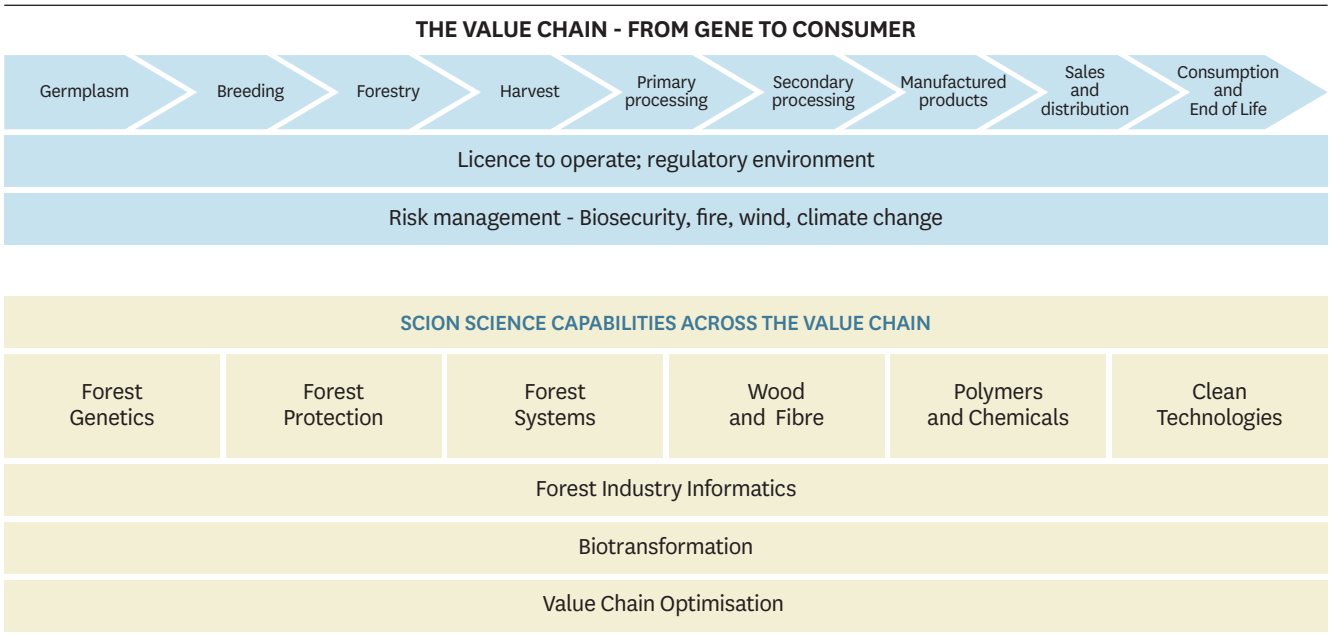


Figure 5: *Scion has capabilities across forestry value chains, which is rare internationally and a competitive strength in providing market solutions for customers.*

by the commercialisation of Scion's wood plastic pellet technology (Woodforce[8]) where the key influencers in the value chain are not only the final users (e.g. an automobile maker) but also the intermediaries such as the original equipment manufacturers (OEM). Scion is building specialist capability in value chain optimisation (see Section 3, page 23). All market-facing research programmes incorporate a value chain dimension and market assessment.

Climate change, bans on illegal logging and consumer preference are drivers for increased research into chain of custody ('track and trace') and environmental footprint analysis. Likewise, developing effective policies for regulators and solutions for resource managers to operate within limits and sustain their licence to operate – whether for nutrients and sediments in relation to water quality, greenhouse gas emissions or some other ecosystem service – requires a systems approach and multi-disciplinary teams. Resource economics, a primary organising discipline for this research and important support for value chain economics, is therefore being built into Scion's science capabilities.

Science impact assessment. At Scion excellent science goes hand-in-hand with high impact. Scion, through its Statement of Core Purpose and science programme, is strongly aligned to industry priorities and future aspirations, e.g. the Woodco $12 billion by 2022 goal. An improved methodology for assessing and illustrating the impact of Scion research will be adopted from July 2016. This involves consideration of the three orders of impact as illustrated in Figure 6.

Innovation hubs to enable Scion's business model. Working closely with industry, policy agencies and investors is central to Scion's modus operandi. As outlined in Section 3 (page 25), Scion is developing an innovation hub on its Sala Street campus. The 2015 refreshed 10-year Campus Master Plan co-locates the hub with Scion's main buildings and opens up a new public entrance way from Long Mile Road (where some 500,000 people per year visit The Redwoods – Whakarewarewa Forest). The hub tenants will bring new capabilities, networks and investment into the Rotorua district and facilitate regional economic growth. Scion's North Drive Innovation Park, industry tenants (27 firms) and the Bay of Plenty tertiary education initiative remains an important element of this.

Scion's other major site is within the School of Forestry at the University of Canterbury, Christchurch. Close contact is being maintained with the school, university and CRI ESR regarding their rejuvenation plans, and also with the Lincoln Hub development, to ensure the forest industry and industrial bioproducts sector are well placed with regard to these developments.

[8] For information about this technology licenced to Sonae Indústria see: www.woodforce.com

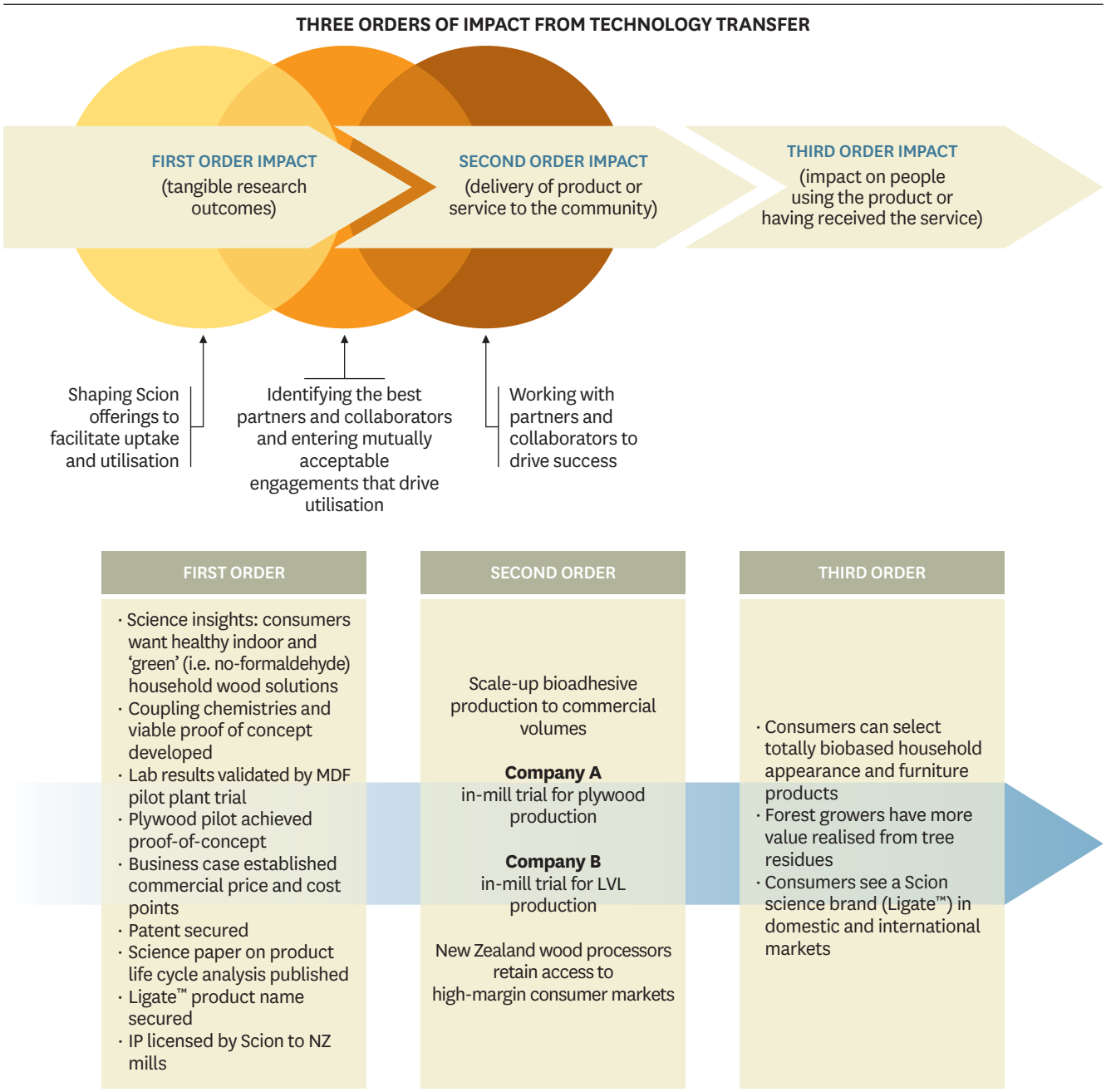


Figure 6: *An improved approach to quantifying and demonstrating the impact of Scion science and technology. (Adapted from Mathou, N. 2015 and illustrated with Scion's bioadhesive technology platform.)*

2 Growing and transforming the New Zealand forest industry

The New Zealand forest industry's overarching goal is to increase exports of wood-based products and logs to $12 billion (from a $4.8 billion baseline in 2011). Concurrently, the value of related forest technologies is expected to grow by at least $2 billion annually by 2022[9]. National energy security will be improved by creating 24 petajoules (PJ) of energy; and climate change effects mitigated in a small way by sequestering 26.7 million tonnes of carbon per annum[10].

LOG FLOW IN THE NEW ZEALAND FOREST INDUSTRY
Volumes in m³ roundwood equivalent, year ended 31 December 2015

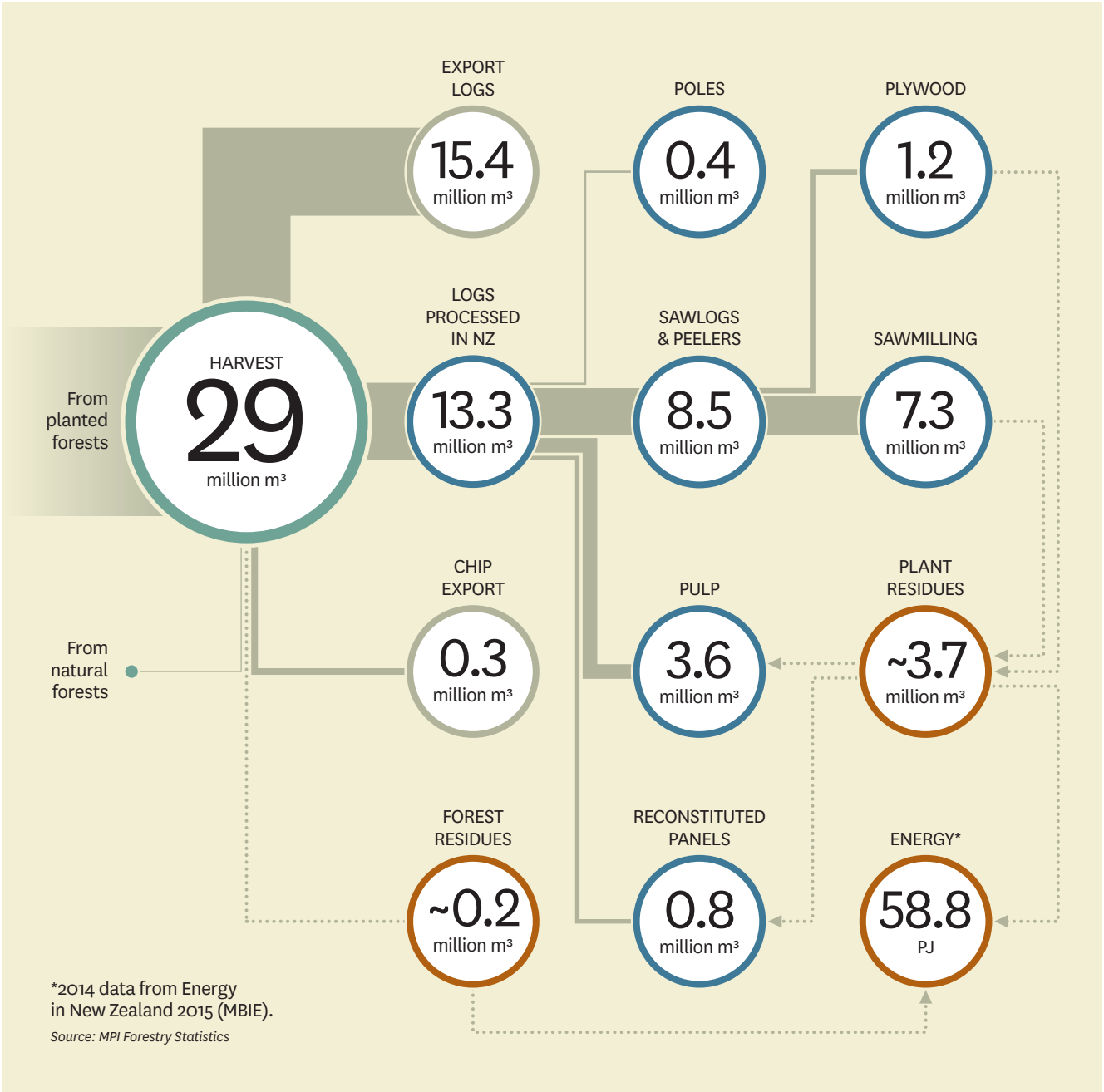


Figure 7: *New Zealand forest industry scale and log flow*[11].

[9] Wood Council of New Zealand Inc. (2012). *New Zealand Forest and Wood Products Industry Strategic Action Plan*. Retrieved April 2014 from: www.woodco.org.nz/
[10] Ministry for the Environment. (2014). *New Zealand's Greenhouse Gas Inventory 1990-2012*. www.mfe.govt.nz/publications/climate-change/new-zealands-greenhouse-gas-inventory-1990-2012-and-net-position
[11] See also Forest Owners Association. (2015). *2014 Facts & Figures: New Zealand Plantation Forest Industry*. nzfoa.org.nz/images/stories/pdfs/factsandfigures_2014_web.pdf

The foundation of the industry is 1.7 million hectares of plantation forests. These generate the log flows illustrated in Figure 7. Further information describing the characteristics and performance metrics of the forest growing and post-forest 'gate' sectors is presented in Appendices 1 and 2, respectively.

Trees create value for New Zealand in many ways, both directly and indirectly. During its growth a tree stabilises land, enhances water and air quality, absorbs carbon and provides a back-drop to amenity activities such as recreation and eco-tourism. On maturity a tree can be disassembled to provide materials for construction, interiors and landscaping; fibre for packaging and paper; and a growing array of chemicals and energy products. In conjunction with this supply chain, companies produce furniture and other high-value manufactured goods, and develop and supply technologies and machinery such as timber drying kilns, harvesting machines, biorefinery plant and process automation equipment. Forests are typically the environment for New Zealand's fast growing ecotourism industry.

New Zealand's commercial forests

New Zealand's 1.7 million hectares of commercial forests have a standing volume of 494 million m³ of timber as at 1 April 2014. About 90% is radiata pine, 6% is Douglas-fir and the balance consists of cypresses (0.5%), eucalypts (1.4%), other exotic softwoods (1.4%) and exotic hardwoods (0.7%). The majority (94%) of forests are privately owned, with the balance owned by the Crown (2%), local government (3%), state owned enterprises (1%) and public companies (2%). A total of 40,867 hectares of replanting and 3,500 hectares of new planting occurred in 2013. Some 46,001 hectares were harvested in the year to April 2014, representing an average age of 28.9 years. Almost 1.0 million hectares are FSC certified.

(See Appendix 1 also)

Forest growing, processing, design and construction companies within the forestry industry produce about $6.4 billion of sales per annum[12]. Adding sales from furniture manufacture, resins, carbon, kilns and other parts of the forest value chain at least doubles this value[13] with exports of pulp, paper, wood manufactured products and logs being New Zealand's third largest merchandise export earner[14]. The forest industry generates high value per full-time worker (on average about $215,000 of GDP/FTE in the Bay of Plenty[15] region) and about 4 to 6 'downstream' jobs per employee. Thus, while the industry comprises many small to medium and a few large firms, it has a powerful influence on regional development and community well-being, especially in smaller urban centres and rural districts of New Zealand. As well, there are an estimated 100,000 investors in forests (many are from urban areas).

Macro drivers of economic and societal change

The forest industry, by the mid-2020s, will be very different from that of today as it responds to and supports a world where assets such as materials (for construction and consumer goods), energy, and water availability are scarcer and much more highly valued than at present (Figure 8)[16].

Even with proactive and unified action on the 2015 Paris Climate Agreement average global temperatures in 2050 will be 1.5-2.7°C warmer than in 2016. Extreme weather events (floods, wild fires, high winds) and biosecurity outbreaks will be more frequent, and food and water security concerns will intensify[17,18].

With a world population expected to be about 9 billion (currently 7 billion)[19] by 2050, and overall wealth increasing especially in emerging economies, global food and fibre production needs to dramatically increase off a smaller base of natural resources. An estimated 75% of all **new market growth will occur in cities**, with the largest 100 of these being responsible for 35% of future demand[20]. Many 'advanced' economies confront the challenges of an aging population with fewer workers and negative population growth particularly in Europe, Russia and Japan. Migrant flows due to regional conflicts and climate change will increase. By 2030, New Zealand will be more ethnically diverse with more Māori (25%), Pacifica and Asian (perhaps 20-25%) populations and concentrated in the upper North Island.

These global drivers, as illustrated by the ESTEMPLE analysis for the forest industry in Table 1, are reshaping the New Zealand economy and precipitating very large public and private sector investment into technology that will enable a transition

[12] Wood Processors Association of New Zealand and New Zealand Pine Manufacturers Association. (nd). *Wood Processing and Manufacturing Science and Innovation Plan*. www.nzwood.co.nz/wp-content/uploads/2013/08/WPAScienceandInnovationPlan.pdf
[13] Based on data (including forestry, wood processing, paper manufacturing, wood buildings, furniture, kilns and forest machinery) sourced from the 2009 Annual Enterprise Survey, New Zealand Department of Statistics.
[14] Wood Council of New Zealand Inc. (2012). *New Zealand Forest and Wood Products Industry Strategic Action Plan*. Retrieved April 2014 from: www.woodco.org.nz
[15] John Galbraith personal communication, May 2012
[16] Winston, A. (2014, April). Resilience in a hotter world. *Harvard Business Review*, 56-64.
[17] International Panel on Climate Change. (2014). *Climate change 2014: Impacts, adaption, and vulnerability*. Retrieved April 2016 from: www.ipcc.ch/report/ar5/wg2/
[18] Royal Society of New Zealand. (2016). *Climate change implications for New Zealand*. Retrieved April 2016 from: http://www.royalsociety.org.nz/expert-advice/papers/yr2016/climate-change-implications-for-new-zealand/
[19] United Nations. (2004). *World Population to 2300*. www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf
[20] Dobbs, R., Remes, J., Manyika, J., Roxburgh, C., Smit, S., & Schaer, F. (2012). *Urban World: cities and the rise of the consuming class*. (p. 3). McKinsey Global Institute.

to a more **biobased future** during the twenty-first century. Energy, water and food security are much more pressing issues in Europe, the Americas and Asia than in New Zealand. Nations within these regions are generally less well endowed with natural resources than New Zealand and have started transitioning to a more energy-efficient, bioeconomy[21] future through the installation of biorefineries, land use change and prioritising 'green economy' research and development investment. **Additive manufacturing** utilising 3-D printing is transforming how and where goods are produced.

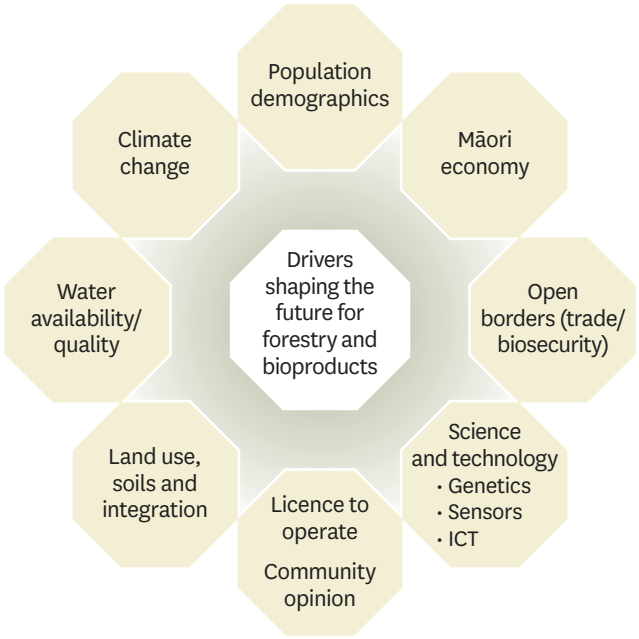


Figure 8: *Macro drivers of change in the forest industry.*

Many governments are also strongly promoting the concept of the circular economy (recycling, renewable energy, process efficiencies to reduce waste and eliminate emissions), industrial biotechnology[22] and use of **genetic technologies** (such as for disease and drought tolerance) to find solutions to food and fibre supply and energy security and at the same time improve environmental protection.

The New Zealand forest industry encompasses companies that:

- *Grow and manage forests for economic, environmental and amenity purposes.*
- *Convert trees into multiple products including logs, timber for construction, and manufactured products (e.g. pulp, paper, panels, fit out and furniture) and engineered products (e.g. laminated timber).*
- *Produce renewable chemicals (e.g. biopolymers and extractives), composite products (e.g. fibre plastic componentry), adhesives and coatings, packaging and energy (e.g. wood pellets, biofuels) from wood and forest resources.*
- *Manufacture machinery and equipment for forest management (e.g. harvesting) and forest resource processing (e.g. drying kilns, biorefining plant).*
- *Provide support services that supply systems to protect forests, treat timber, software, engineering and logistics.*

The forest industry can play a significant role in helping New Zealand 'future proof' its economy, meet international obligations with respect to greenhouse gas emissions reduction and biodiversity, and the 2025 Business Growth Agenda aspiration to **grow export revenue, create high wage jobs** and improve **environmental resilience**. The industry will also contribute to better social outcomes for New Zealanders, **build the manufacturing sector** and strengthen the **Māori economy** by adding to their more than $2 billion forest asset base.

[21] The term 'bioeconomy' includes all industries and branches of the economy that produce, manage or otherwise harness biological resources (and related services, supply or consumer industries), such as agriculture, food, fisheries and other marine resources, forestry. Source: European Union. (2012). *FP7 Cooperation Work Programme Food, Agriculture and Fisheries, and Biotechnology.* ec.europa.eu/research/participants/data/ref/fp7/132093/b-wp-201301_en.pdf

[22] Industrial biotechnology enables industries to deliver novel products, which cannot be produced by conventional industrial methods; in addition it will make possible replacing chemical processes by more resource efficient biotechnological methods with reduced environmental impact (Source: ibid.).

ESTEMPLE ANALYSIS OF THE MACRO ENVIRONMENT FOR THE NEW ZEALAND FOREST INDUSTRY	
Economic	• New Zealand well aligned to growing and emerging economies, including North Asia, India and ASEAN block. • Growing log shortages (pruned and structural) in some regions; global shortfall in softwoods by 2020 or earlier. • Demand for solid wood and wood fibre products improving with domestic and US economies; log prices squeeze margins. • Deforestation-afforestation sensitive to carbon prices and competing land use (dairy) returns. • Māori are increasing (e.g. Central North Island) and reducing (Ngāi Tahu) investment in forestry. • New Zealand currency overvalued on fundamentals creating pressure for exporters; volatility (3-5 year) dissuades investors. • New 2030 greenhouse gas (GHG) Nationally Determined Contributions (NDC) 11% below 1990. • ETS review 2016 removes 2:1 subsidy and $25/t CO_2 e carbon cap.
Social	• Forestry worker health and safety a major concern; impacts attractiveness of forest industry careers. • Closure of (mostly) older, smaller mills impacts rural regions. • Low skills, high (Māori) youth unemployment in forestry regions - Northland, East Coast, Western Bay of Plenty. • Social licence to operate adversely impacted by harvesting log debris and sediment in waterways.
Technological	• Global trend towards low 'carbon' renewables; natural products; lightweighting and zero waste. • Engineered wood products, prefabrication building systems grow demand for solid wood; reduce labour constraints. • ICT - broadband, hand-held devices and 'apps', big data, sensors - integrate across value chain and enable precision systems. • 3-D printing, robots and automation, design and logistics redefine manufacturing. • Biotechnologies - primary and industrial - tap the latent potential of genomes and enables sustainability. • Smart connected products (systems disrupt current technologies).
Ecological	• Paris Climate Agreement to reduce average temperature to less than 2°C by 2050 (more extreme weather (wind, drought, floods)). • Global trend towards renewable energy and green chemicals; clean technologies and zero waste. • Natural resources (forests) become scarce as world population and wealth grows to increase fibre and energy insecurity. • Bans on illegal logging and 'chain of custody' requirement for certification is reducing tropical log hardwood supply. • Valuation and monetisation of forest ecosystem services for carbon, biodiversity, avoided erosion (polluter pays). • Weed (e.g. wilding pines) and pest control costs rising; NGO certification systems constrain use of proven chemicals and new breeding technology. • Environmental footprint analysis and independent certification.
Media	• Social media has powerful influence on licence to operate and public perceptions of forestry. • Anti-science lobby achieves disproportionate media 'voice' reflecting weak citizen science, e.g. genetic engineering technology. • News is global, real-time and easily accessed (information age).
Political	• Government Business Growth Agenda to increase exports to 40% of GDP by 2025; Regional Growth Action Plans. • Treaty of Waitangi settlements nearing completion; rapid growth of the Māori economy including in forestry. • Australia-New Zealand Closer Economic Relations and new Federal legislation provides scope for increased forest industry R&D collaboration. • China-New Zealand Free Trade Agreement boosts trade and investment flows; due for review 2017? • Trans-Pacific Partnership (TPP) Agreement will lower some tariffs if ratified.
Legal	• New national framework for freshwater management set nutrient limits that will drive land management change. • Changes to Resource Management Act needed to strengthen Hazardous Substances and New Organisms Act (and national governance of introduced organisms; allow new breeding technologies such as 'gene editing'). • Race to own-secure intellectual property for the renewable bioeconomy including forest biomass technologies. • Ban on illegal logging; supply chain traceability becoming mandatory.
Ethical	• Advocacy group concerns about new technology such as genetic engineering and nano-technology. • Protection of privacy, information security and cyber-espionage in a digital age.

Table 1: *An ESTEMPLE analysis of the macro environment for the New Zealand forest industry.*

Significant trends for Scion science and technology

The preceding analysis has highlighted technology developments and significant trends that will be influential for Scion's key stakeholders and therefore for Scion's future science direction. These developments and trends are summarised as:

1. The transition to renewable, low carbon substitutes for petroleum products; the 'greening' of business and requirement to verify 'forest to consumer' environmental (and social) footprint. (The Paris Climate Agreement, bans on illegal logging and move towards increased transparency of the social responsibility exercised by business adds momentum to this.)

2. Information communication technology (ICT), 'big data' and smart connected products enabled by the internet are disrupting business and science.

3. Improvements to the precision, safety and productivity of forestry and wood processing, through automation, sensors, robots and machine learning, are dramatically changing workforce skill requirements.

4. New technologies such as genetic modification, industrial biotechnology and precision technologies are enabling productivity gains from finite natural capital but the use of some in New Zealand is heavily restrained by regulation and lack of 'social licence'.

5. Social licence to operate is more difficult to maintain and secure in a world where information is available in real-time, conveyed by an array of social media, and communities are more diverse. The anti-science lobby is disproportionately influential in shaping policy regulating the use of new organisms, technologies and natural resources for economic development.

6. 'Tougher to achieve' ecosystem limits are being regulated such as for greenhouse gas emissions, biodiversity and water quality (i.e. the cost of externalities are internalised to their source).

7. Standards and consumer safety protocols for packaging, wood and fibre products, and bioprotection technologies are also becoming more scientifically rigorous and costly to comply with.

8. Land-use integration at different scales and the exploitation of complementarities between the supply chains for different land enterprises (e.g. pastoral livestock and forestry, see Figure 1).

9. Industrialisation of the building supply chain (e.g. prefabrication that utilises engineered wood products) in order to meet demand for affordable housing and provide commercial building solutions that are resilient to hazards such as earthquakes and fire.

10. Energy security and sovereign risk management through increased supply and reliability of cost competitive, low emissions, renewable energy such as that derived from forest biomass, as well as geothermal, hydro dams, solar and wind sources.

11. Indigenous peoples are recovering lost assets, rectifying grievances and seeking increased rights for governance.

The forest industry and Scion in 2025 - a preferred future[23]

By 2025 the New Zealand forest industry is strongly capitalising on the global economic, environmental and societal changes described in the previous sections. Appendix 3 describes what we can expect in this preferred future, which is summarised in Figure 9.

Scion's stakeholders' plans for the forest industry

New Zealand forest industry organisations each have growth and development strategies and associated science and innovation plans, which provide critical direction to Scion and the focus of this SCI.

These stakeholders include:

The Wood Council of New Zealand (Woodco)[24]: Woodco's lead document is the New Zealand Forest and Wood Products Strategic Action Plan that sets an aspirational target to grow wood-based products to $12 billion ($4.8 billion in 2010/11) and the value of forest technologies to at least $2 billion annually by 2022. This will be achieved by:

- New Zealand wood becoming the preferred construction and finishing product in New Zealand and Australia.
- Expanding exports of New Zealand wood into Asia, India, USA and Australia.
- Delivering more value from the existing resource.
- Transforming the use of wood in building systems.
- Expanding new high-value fibre products and integrating new co-product value streams such as biochemicals, biofuel and other bioenergy options.
- Developing new fibre-based packaging products to support New Zealand growing high-value food exports.

Forest owners: The New Zealand Forest Owners Association (NZFOA), in its Science and Innovation Plan[25] has stated an ambition to grow the forest sector by $3 billion by 2030. The key to this will be improved profitability through the doubling of productivity (biomass production) on a per hectare basis while also improving wood quality (uniformity and stiffness) and increasing tree resistance to pests and diseases. Forest growers including those with trees on farms and owners of small woodlots (<250 hectares) adopted a mandatory commodity levy in March 2013 at 27c/m^3 of log harvested. In recent years the circa 30 m m^3 harvest has generated $8.1 million per calendar year (with approximately 50% allocated to research). The Forest Grower Levy Trust Board (FGLT) and FOA R&D Committee (part of the FOA secretariat service to the Trust) are functioning well for research providers such as Scion. The levy, while modest in scale compared to the sector's earnings, has increased certainty and flexibility for forest industry good research such as increasing the total recoverable value per hectare and improving efficiency in the forest to mill supply chain. Forest owners are also the major shareholders in the **Radiata Pine Breeding Company** (RPBC)[26] whose purpose is to provide "superior radiata pine germplasm to its shareholders and customers in Australasia". The RPBC purchases and undertakes research into radiata pine tree breeding and the development of superior genetics for its shareholders and customers.

[23] The 2025 vision comprises information from the Woodco Strategic Action Plan, industry association R&D plans, science and technology trends, and Scion's strategy and People, Culture and Safety Plan.
[24] Wood Council of New Zealand Inc. (2012). *New Zealand Forest and Wood Products Industry Strategic Action Plan.* Retrieved April 2014 from: www.woodco.org.nz
[25] Forest Owners Association. (2012 and updated April 2016). *New Zealand Science and Innovation Plan*. Wellington, New Zealand. Retrieved April 2016 from: www.nzfoa.org.nz
[26] Radiata Pine Breeding Company; www.rpbc.co.nz

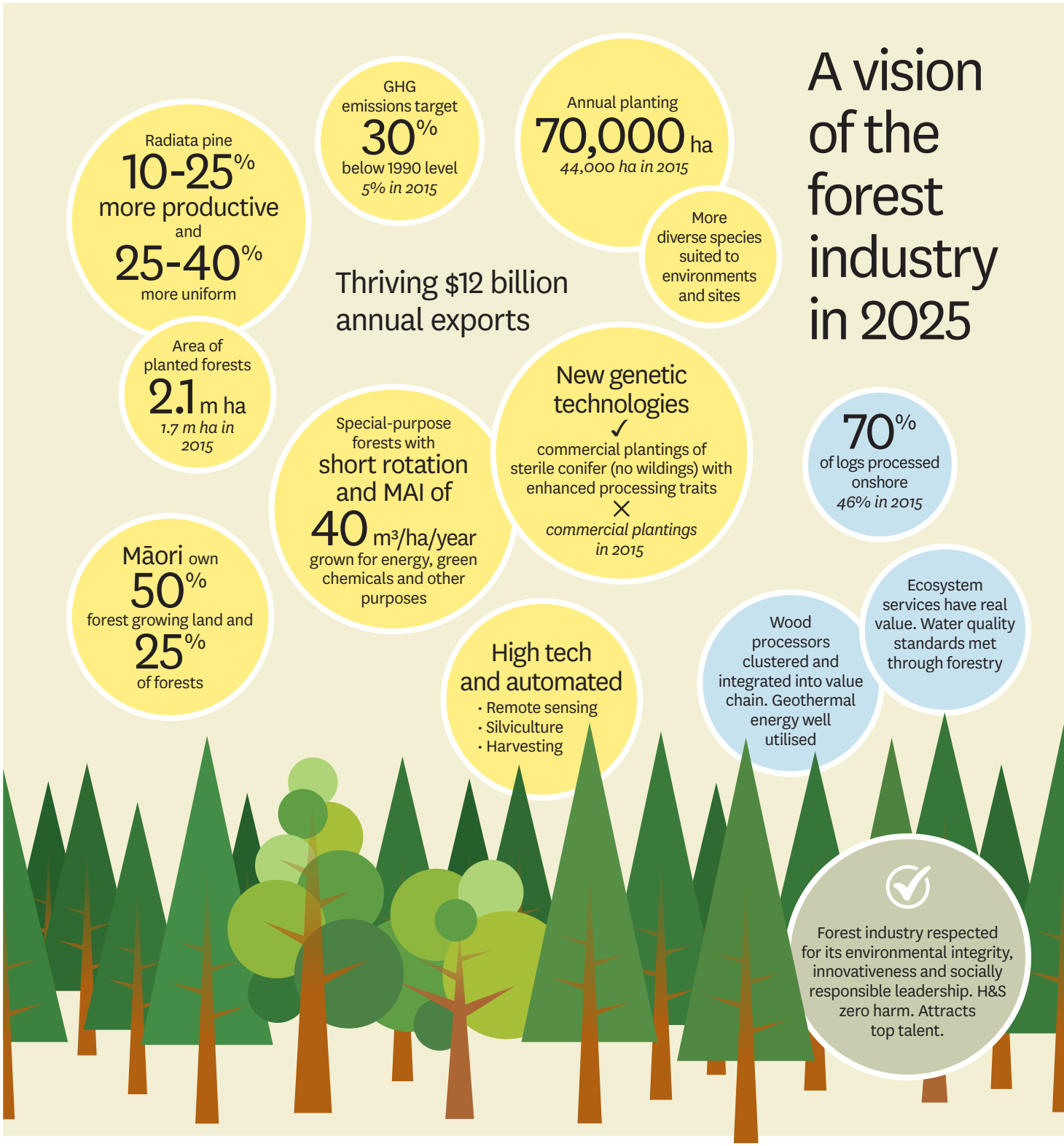
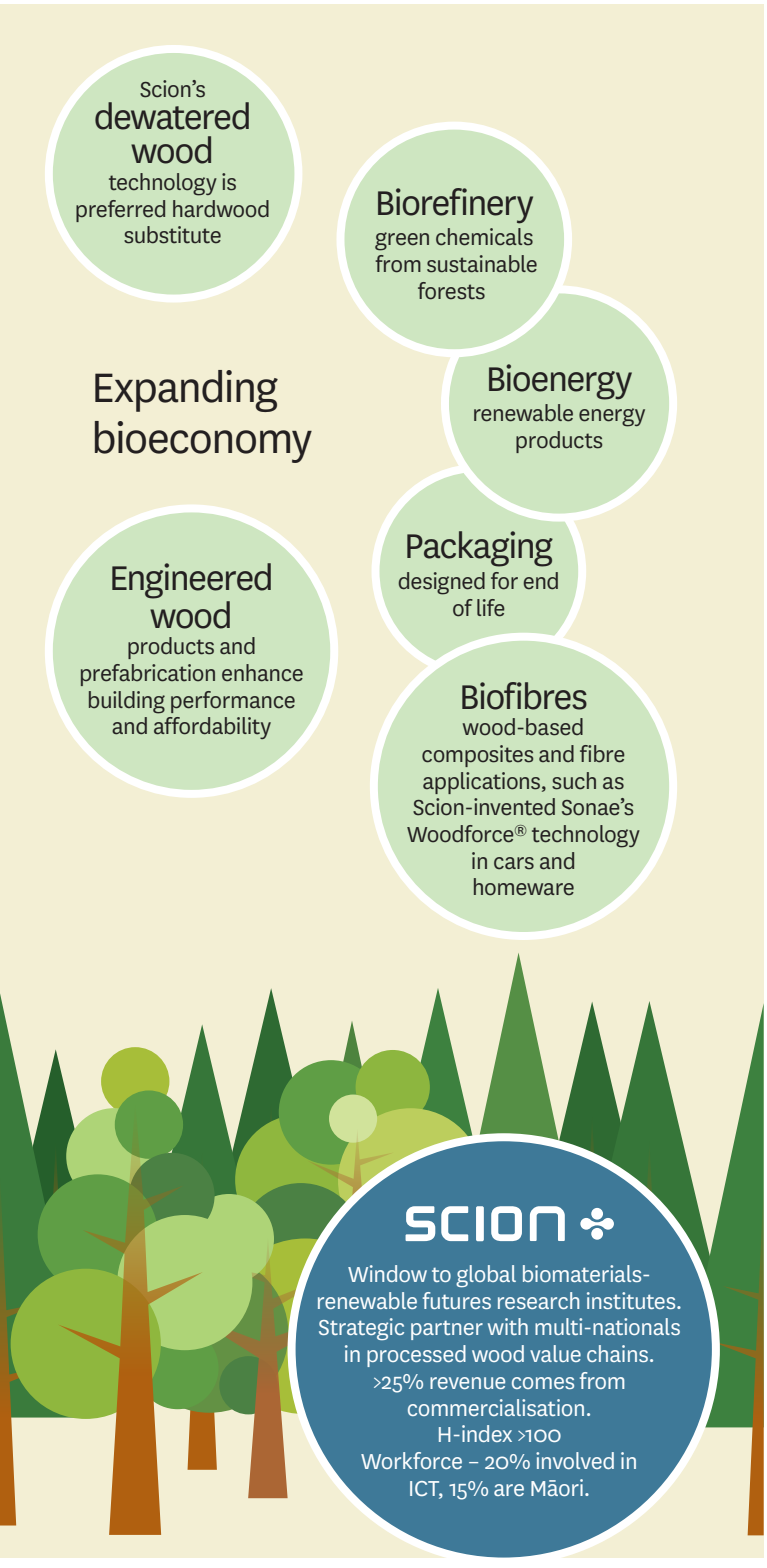


Figure 9: *Vision of the forest industry and Scion in 2025.*



Farm foresters and woodlot owners[27]: The New Zealand Farm Forestry Association (FFA) has a diverse membership drawn from ca 15,000 farm foresters, woodlot owners, forest investors and managers. While large forest owners are predominantly involved with radiata pine and Douglas-fir, FFA members grow a wide range of forest species for speciality timber and, to a lesser extent, wood fibre production. Examples of exotic species are cypresses, eucalypts, redwood (sequoia), and poplars; indigenous species include totara and kauri. The FFA are partners with the FOA in the FGLT for most of its research but also purchases some research directly on behalf of its members directly.

Wood processors and manufacturers[28]: The Wood Processors and Manufacturers' Association (WPMA) membership "spans the whole wood supply chain post forest gate. Its members produce pulp, paper, sawn lumber, panels, laminated products and mouldings. Increasingly they are also producing or have the potential to produce biochemicals, biofuels, textiles and bio composite materials". The WPMA advocates for and represents the interests of its members to government on matters such as standards, trade policy, science and innovation and links with related industry groups such as Frame & Truss Manufacturers Association of NZ[29]; the Timber Industry Federation[30], and New Zealand Building Industry Federation[31].

The WPMA adopted a 2050 vision "ReNewing New Zealand (Figure 10) in August 2014 and this provides a common reference point for checking the alignment of Scion research in the processing sector. Woodco remains the forest industry umbrella organisation for the WPMA.

Factors common to the NZFOA (and FFA) and WPMA plans are:

- Log supply security and the competitiveness of forestry as a land-use. Deforestation needs to be reversed through a mix of policy and productivity gains.
- Genetic improvement underpins forest productivity and disease resilience. Annual replanting of up to 50,000 hectares[32] provides significant scope to now influence the genetic quality and species diversity of New Zealand's future forest estate.
- Forest ecosystem services payments, such as for carbon sequestration, can significantly alter the viability of forestry by providing additional sources of revenue and changing cashflows[33].
- Up to 100,000 investors in smaller-scale forestry during the 1990s are unlikely to reinvest for a second rotation (starting ca 2015-2020). Recruitment of a new cohort of investors into forests is required.

[27] Farm Forestry Association; www.nzffa.org.nz
[28] Wood Processors and Manufacturers Association; www.wpma.org.nz/about/what-wpma-do. *The Wood Processing and Manufacturing Science and Innovation Plan* from 2012 continues to provide guidance on these sectors' priorities: www.nzwood.co.nz/wp-content/uploads/2013/08/WPAScienceandInnovationPlan.pdf
[29] Frame & Truss Manufacturers Association of New Zealand; www.ftma.co.nz. Representing the majority of the New Zealand prefabricated timber framing industry in New Zealand, the FTMA purpose is to ensure prefabricated timber wall frames and roof trusses remain the preferred choice for building in New Zealand.
[30] Timber Industry Federation; www.nztif.co.nz. The NZTIF works on behalf of its members to ensure the New Zealand sawmilling industry continues to produce top quality and environmentally superior wood products.
[31] New Zealand Building Industry Federation; bifnz.co.nz. The BIFNZ represents the supply chain of the building industry and represents the interests of its members to government on important policy issues that affect the construction sector.
[32] Provisional estimates of tree stock sales and forest planting in 2013. Source: www.mpi.govt.nz
[33] Monge, J.J., Parker, W.J., & Richardson, J.W. (2016). Integrating forest ecosystem services into the farming landscape: A stochastic economic assessment. *Journal of Environmental Management*, *174*, 87-99.

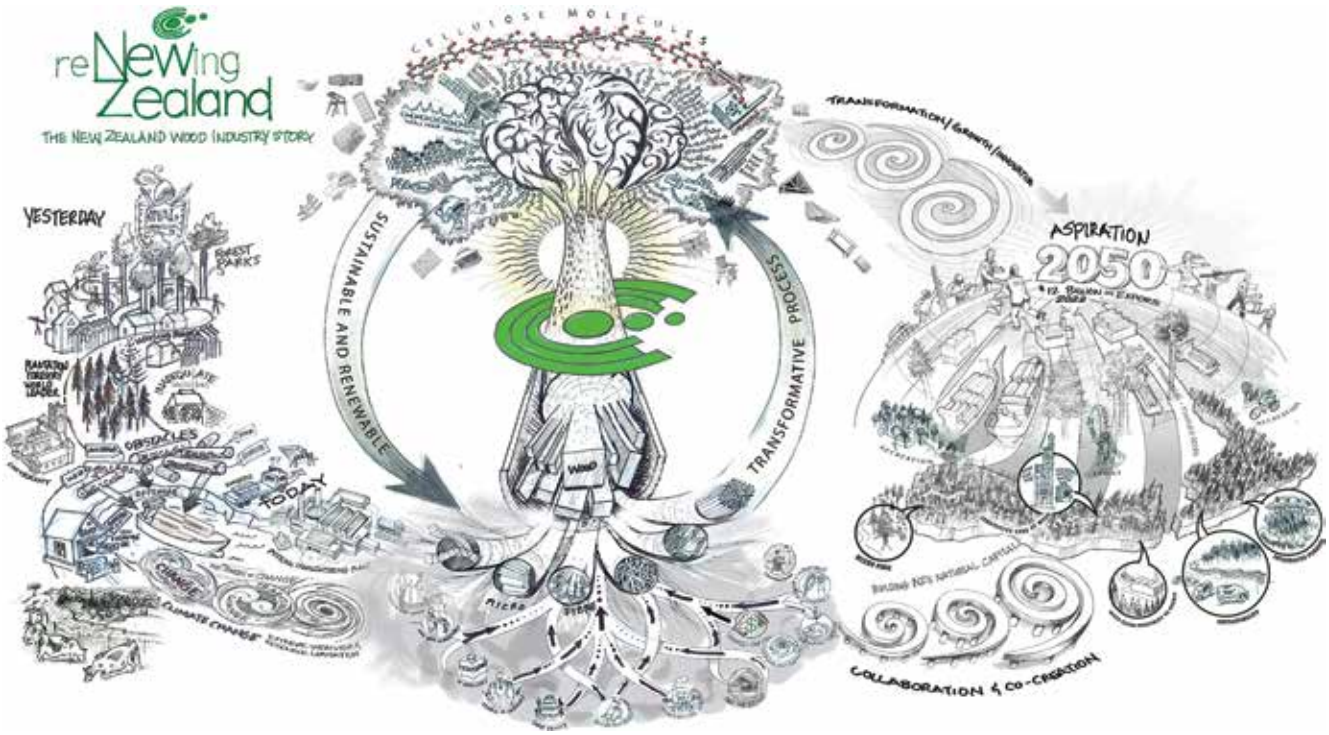


Figure 10: *The Wood Processors and Manufacturers' Association 're**New**ing **Zealand**' 2050 vision shows the transition pathway envisaged to achieve a high value, integrated, technologically advanced and low environmental impact industry.*

- Wood offers superior environmental credentials and hazard resilience compared to steel and concrete in a carbon-constrained world and in earthquake-prone zones, respectively.
- Forestry strongly complements New Zealand's other primary production sectors. Increased integration of land use, genetic improvement and manufacturing would be beneficial.
- The forest industry needs to improve integration and traceability along the value chain, and the matching of feed stocks with end uses through different types of forest systems (e.g. special purpose, short rotation industrial forests).

Māori: The Crown/Māori strategy and action plan for economic development, *He Kai Kei Aku Ringa* (2012) emphasised the importance of Māori building meaningful science collaborations with CRIs and universities, and of improving the performance of their land and other assets. A 2013 report, *Growing the productive base of Māori freehold land*, suggested at least 470,000 hectares is best suited to forestry. Both opportunities are aligned with Scion's Māori Plan (see Figure 16) to grow the Māori economy through forestry. Māori have more than $2 billion of assets in forestry[34] with about 500,000 hectares of pre-1990 forests. As Treaty settlements conclude, Māori ownership of land and forests will increase. However, Māori have challenges with:

- fragmentation of land ownership (around 550,000 hectares of Māori land has no formal administration);
- remoteness from processing sites and associated transport costs;
- accessing working capital for forest establishment;
- managing intergenerational investment;
- implementation of the ETS; and,
- developing local employment opportunities for their people.

Proposed changes to the Te Ture Whenua Māori Act 1993 should assist Māori to realise their aspirations[35].

Some Māori forest owners wish to diversify species and, in some cases, re-establish land in species other than radiata pine (including kauri, totara and beech). Their desire to re-establish taonga species is part of their cultural reinvigoration, for carbon revenue and ngahere for traditional uses. They are also interested in creating multi-layered forests to generate several income streams from ginseng, honey, essential oils, wood and carbon for example.

In considering the use of forest resources, Māori also strongly want to incorporate Mātauranga Māori (traditional knowledge) and increase the education and skills of iwi/hapū members. Science and innovation are seen as enablers of a strengthened future Māori economy. A number of iwi are currently

[34] Nana, G., Stokes, F., & Molano, W. (n.d.). *The Asset Base, Income, Expenditure and GDP of the 2010 Māori Economy*. Wellington, New Zealand: Maori Economic Taskforce. berl.co.nz/assets/Economic-Insights/Economic-Development/Maori-Economy/BERL-2011-The-Asset-Base-Income-Expenditure-and-GDP-of-the-2010-Mori-Economy.pdf

[35] Te Puni Kokiri. (2013). *Discussion document: Te Ture Whenua Māori Act 1993 Review Panel*. Retrieved May 2016 from: https://www.tpk.govt.nz/en/a-matou-mohiotanga/land/te-ture-whenua-maori-act-1993-review-panel-discuss

pursuing the use of science, innovation and technology strategies to better understand the potential benefits for iwi economic, social (cultural) and environmental outcomes.

As Māori increase their influence over land and forests they will play a greater role in shaping the future New Zealand forest industry than in the past. Accordingly, through forestry *"There is enormous potential for the Māori economy to lead aspects of growth in the New Zealand economy"*[36].

Central government: The Government's goal is to foster economic development that will deliver greater prosperity, security and opportunities to all New Zealanders. The centrepiece for this is the Business Growth Agenda[37] that constitutes six inter-linked 'ingredients' for business growth: export markets, innovation, infrastructure, skilled and safe workplaces, natural resources, and capital. It can be readily adapted to the forest industry and industrial bioproducts sectors Scion works with as illustrated in Figure 11.

Each element of the Business Growth Agenda – Towards 2025 has its own programme of work, and they impact the way Scion works with government departments such as:

- **The Ministry for Primary Industries** (MPI) role is to grow and protect New Zealand by maximising export opportunities, improving sector productivity, increasing sustainable resourse use and protecting from biological risk. MPI also has a goal to double the value from primary sector exports by 2025. MPI oversees biosecurity, and administers the Primary Growth Partnership (PGP), Sustainable Farming Fund (SFF), the forestry elements of the Emissions Trading Scheme (ETS) and is overseeing the National Environment Standard (NES) for forestry. The MPI Science Strategy, released in 2015[38], sets out the strategic direction and seven priorities for MPI science and its approach to science investment. In 2016, MPI will lead the development of a Primary Sector Science Direction with a 20-30 year horizon. Scion will provide imput into this.
- **The Ministry of Business, Innovation and Employment** (MBIE) and New Zealand Trade and Enterprise (NZTE). MBIE has responsibility for business growth (including increasing exports to the equivalent of 40% GDP by 2025), building and housing, timber and wood treatment standards, energy policy, development of key markets such as China and India, and science and innovation policy, investment and monitoring.
- **The Ministry for the Environment** (MfE), which is responsible for environmental policy and forestry policy and regulation (e.g. the national policy statements for forestry, water and biodiversity, the Land and Water Forum), climate change policy, aspects of local government.
- **The Environmental Protection Authority** (EPA), which has responsibility for the HSNO Act which is central to the approval of Scion's genetic modification research and chemicals for use in forests and by wood processors. The EPA administers the whole Emissions Trading Scheme (ETS).
- **The Department of Conservation** (DOC), which is concerned with forest conservation management, biodiversity protection, weed, fire and pest management.
- **The Ministry of Foreign Affairs and Trade** (MFAT), which addresses forest biosecurity risks, global standards and market access protocols, and access to international markets through science diplomacy.
- **The Government to Government** (G2G) joint initiative between MFAT and NZTE, which provides a new, low risk avenue for Crown intellectual property to be licensed and applied off shore.

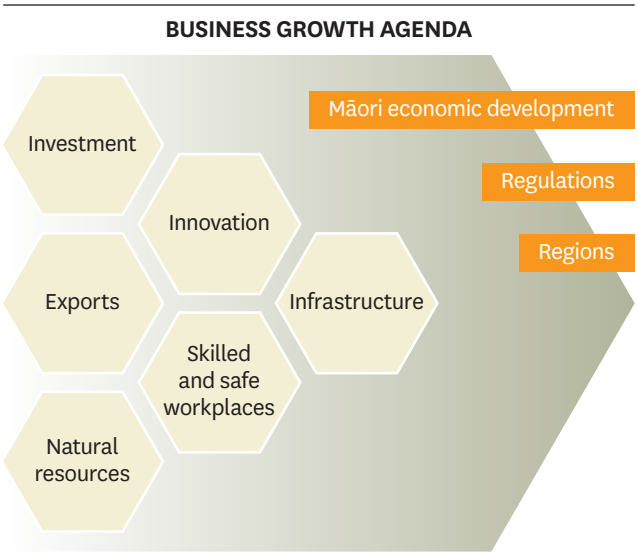


Figure 11: *The New Zealand Government Business Growth Agenda framework aligns directly to the forest industry and industrial bioproducts sectors Scion works with.*

Regional growth studies and their respective action plans have been released for Northland, Bay of Plenty, East Coast and Manawatu/Whanganui. These are overseen by MBIE and MPI and coordinated with local agencies such as Bay of Connections for the Bay of Plenty region[39]. These identify and prioritise forestry and wood processing as the best opportunities for economic growth in these regions.

Callaghan Innovation[40] was established as a Crown Agent on 1 February 2013 and represents a fundamental shift in the Government's focus for growing the high-value manufacturing sector and innovation by firms. Scion signed an MOU with Callaghan Innovation in June 2013. Scion is now the largest provider of manufacturing research and development among the CRIs, which represents a significant opportunity to boost its "high end" wood and wood fibre manufacturing and bioproduct development research. Callaghan Innovation will also assist Scion to translate its expertise and technology (such as for renewable packaging and bioenergy products for household consumer goods) into other industries.

[36] Te Puni Kōkiri. (2012). *Māori Economic Development Panel Discussion Document*. http://www.tpk.govt.nz/_documents/medp-discussiondocfinal-2012.pdf
[37] Ministry of Business, Innovation & Employment. (2015). *Business Growth Agenda – Towards 2025*. Retrieved April 2016 from http://www.mbie.govt.nz/info-services/business/business-growth-agenda/towards-2025
[38] Ministry for Primary Industries. (2015). *Science Strategy Rautaki Putaiao*. Retrieved April 2016 from: http://www.mpi.govt.nz/document-vault/10172
[39] Bay of Connections (n.d.). Retrieved April 2016 from: http://www.bayofconnections.com/growth-study
[40] Callaghan Innovation; www.callaghaninnovation.govt.nz

National Statement of Science Investment (NSSI): The NSSI, released on 5 October 2015, outlines the Government's vision for the science system for 2025 of "a highly dynamic science system that enriches New Zealand, making a more visible, measurable contribution to our productivity and wellbeing through excellent science"[41]. The NSSI indicates the direction for changes in investment. The 10 National Science Challenges, announced on 1 May 2013[42], and still being operationalised sit within this overarching investment plan. As described in more detail later (Section 3 page 24), the challenges provide new impetus to connect science providers to tackle 'big' national problems through 'stretchy' horizon 2 and horizon 3 science. Scion is participating in five of the challenges and these will increasingly impact Scion's science strategy and investment.

Local government: Local government own 3% of the national forest estate. The local government sector consists of 11 regional councils, 61 territorial authorities (11 city councils and 50 district councils) and six unitary councils, which are territorial authorities with regional council responsibilities. Research priorities for regional councils[43] relevant to the forest industry include integrated land and freshwater management, nutrient and contaminant management, hazard management

FOREST INDUSTRY KEY STAKEHOLDER PRIORITES

Forest owners/ Farm foresters	• Make forestry more competitive as a land use • Value and monetise forest ecosystems services • Forest protection (biosecurity; wind, fire hazards) • Improve operating/supply chain efficiency • Improve worker health and safety • Licence to operate-steepland harvesting • Reduce dependence on China log market; credit risk • A cost effective alternative log fumigant to methyl bromide before 2021; increase bark value • Alternative species diversification options • Access to latest genetic technologies; produce a sterile Douglas-fir, radiata pine	Wood processors	• Log supply security and pricing • Increased profitability (new products; efficiency; customer solutions) • Modernise building standards for wood products and keep them current • Improve international market access and trade terms (level playing field); remove policy disadvantages to wood processing • Economic 'stability' to encourage investment in mills, plant and equipment; accelerate depreciation • Raise earnings through design-led and IP protected innovation
Māori - tangata whenua	• Finalise Treaty settlements • Generate sustainable wealth from primary sector assets; develop under-utilised land • Employment and higher living standards for Māori • Vision Mātauranga Māori integrated into R&D; partnerships with Scion-research providers	Forest investors (domestic-foreign)	• Meet Weighted Average Cost of Capital and target portfolio returns • Forest protection (biosecurity, wind, fire hazards) • Increase asset (forest) value • Enable liquidation of assets • Confidence in long-term returns relative to other investments • Adjust land values to free cash-flow earnings
Government	• Meet Business Growth Agenda targets • More jobs and higher wages • Action regional growth studies • Land-use intensification within limits • Affordable housing • Complete Christchurch rebuild • National Statement of Science Investment (Excellence; Impact); increase collaboration (NSC) across science system • Callaghan Innovation formed to accelerate the commercialisation of innovation by firms • Regional research institutes	NZ Wood Council (Woodco)	• Achieve $12 billion exports by 2022 by processing 70% logs onshore; increase log conversion 5% • Improve regional infrastructure to reduce logistics costs; lower GHG emissions • Encourage (and enable) wood use domestically • Establish clear and consistent policies for land use and land investments • Support a skilled and safe workforce • Agriculture introduced to the EST post the 2016 review; carbon price greater than $15/t CO_2 e to encourage new forests and decarbonisation • Invigorate NZ Wood brand

Table 2: *Forest industry key stakeholder priorities*.

[41] Ministry of Business, Innovation & Employment. (n.d.). *National statement of science investment*. Retrieved April 2016 from: http://www.mbie.govt.nz/info-services/science-innovation/national-statement-science-investment

[42] Ministry of Business, Innovation & Employment. (n.d.). *National Science Challenges*. Retrieved April 2016 from: http://www.mbie.govt.nz/info-services/science-innovation/national-science-challenges

[43] Envirolink. (n.d.). *Research Strategy*. Retrieved 18 March 2014 from: http://www.envirolink.govt.nz/Research-Strategy

including climate change mitigation and adaption, hazard risk mapping, air quality, valuation of ecosystem services, planning and monitoring tools for the management of cumulative effects and for integrating decision making across scales (from forest (or farm) to catchment to region).

The Bay of Plenty, Northland and Waikato Regional Councils' plans with regard to forestry are especially significant in the near term for Scion. For example, Scion has helped shape the Bay of Connections Strategy pertaining to forestry[44] and energy development[45]. Improving water quality, whether for the Waikato River, Rotorua Lakes or Northland waterways, is a significant challenge for these regions. In Northland, there is considerable potential to add economic value to totara and utilise geothermal energy at Ngawha for wood processing. Scion will continue to work closely with the local government sector to address these needs, including via initiatives arising from the regional growth studies.

Forest industry stakeholder priorities

Forest industry stakeholders' priorities have been distilled from industry and government department input into Scion's strategy workshops, discussions with industry leaders, the ESTEMPLE analysis and industry association R&D plans presented earlier, the Shareholders' Outlook Letter to CRIs, the Government's Business Growth Agenda and public sector requirements. These are summarised in Table 2 and highlight commonality of purpose in areas such as forest plantings, log supply security and climate change adaption. Other priorities are distinct to a sector, such as the need to find an acceptable, cost effective alternative to methyl bromide for fumigation of export logs.

Shareholders' guidance

The Government has identified 'science and innovation' as the main driver of a modern, future-looking economy and one of the six 'planks' in its business agenda (Figure 11). This is complemented by regional growth studies, which identify the best prospects for lifting growth in 'sub-performing' regions. Shareholding Ministers expect Scion to clearly articulate how it will achieve its Statement of Core Purpose outcomes, work openly and collaboratively with other science providers, establish a performance framework for core funding to assure value for money and end user impact, ensure easy access and reuse of data held by CRIs, ensure early and high uptake of new knowledge and technology to maximise its impact in regional development and for New Zealand, and maintain financial viability.

Scion's response

With this strategic and operating context in mind, Scion has developed its strategy and science and innovation plan to directly address the priorities above and, in so doing, support forest growing, wood and wood-derived products' manufacturing companies, new investors and new companies meet their growth and other performance targets. Scion's strategy and science and innovation plan are described in the following section.

[44] Bay of Connections. (2011). *Bay of Plenty Forestry and Wood Processing Strategy*. http://www.bayofconnections.com/downloads/Forestry_and_Wood_Processing_Strategy_September_2011.pdf

[45] Bay of Connections. (2011). *Bay of Plenty Energy Strategy*. http://www.bayofconnections.com/downloads/Energy_Strategy_December_2011.pdf

3 Scion's strategic priorities

Scion's 2016-2021 strategy builds on the foundations laid in previous years and is formatted in the balanced scorecard approach as shown in Figure 12. The goal of the strategy is to deliver the science and technologies required by Scion's stakeholders to address their critical challenges and priorities (see Section 2 and summary in Table 2). In particular the strategy seeks to:

1. Support the forest industry to achieve its long-term potential and contribution to New Zealand.

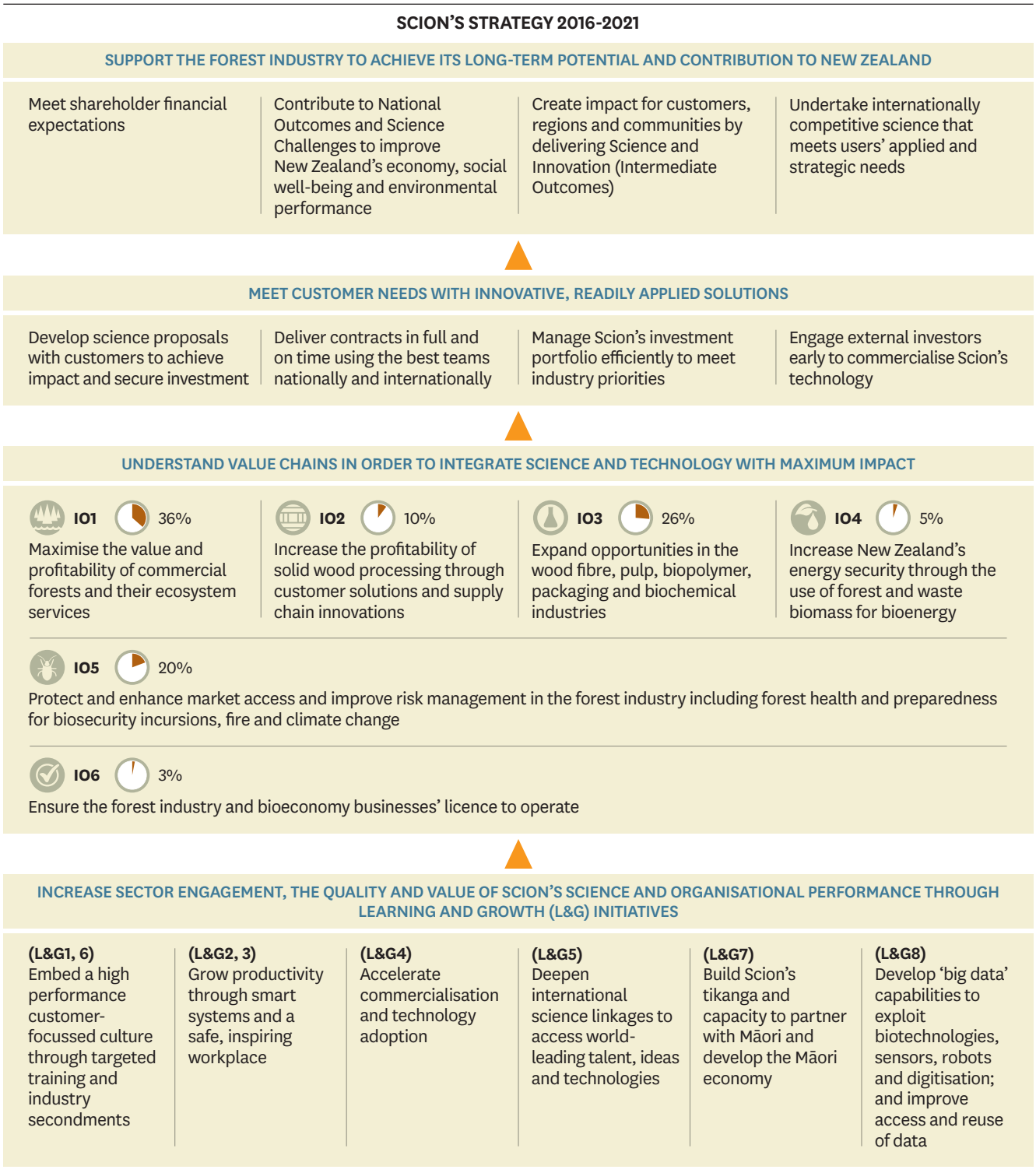


Figure 12: *Scion's strategy mapped in a balanced scorecard format.*

2. Meet customers' needs in the forest industry and bioproducts sector with innovative, readily applied solutions.
3. Understand value chains in order to integrate the new knowledge and technology arising from Scion's six Intermediate Outcomes (IOs) with maximum impact.
4. Increase Scion's engagement with forest industry sectors, the quality and value of Scion's science and organisational performance through Learning and Growth (L&G) initiatives.

Specific initiatives within each of these four inter-related themes are shown in the text boxes. For example, with respect to science excellence, Scion's goal is to "Undertake internationally competitive science that meets users' applied and strategic needs", and with respect to impact Scion will "engage external investors early to commercialise Scion's technology" and facilitate early adoption by understanding the value chains into which science outputs will be placed. L&G initiatives are areas where Scion needs to develop its capabilities, infrastructure, systems, networks and relationships in order to fulfil its strategy. L&G4, for example, to "accelerate commercialisation and technology adoption" builds skills in commercialisation within the framework of technology platforms and sources of investment as illustrated in Figure 4. Scion's operating plan, prepared annually, specifies objectives to be completed for each of these initiatives during the financial year concerned. Monitoring and reporting to the Board is via monthly scorecard performance indicators that mirror the strategy.

Expected income and reinvestment in 2016/17 is overlaid on the strategy map to illustrate the relative scale of each IO.

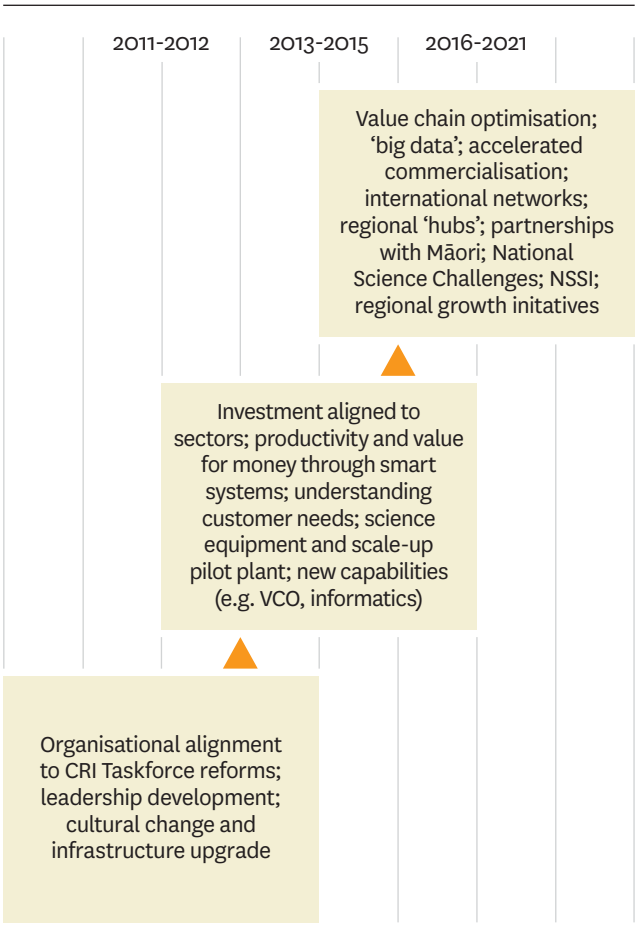


Figure 13: *Evolution of Scion's strategy and implementation priorities.*

Phasing the execution of Scion's strategy

Each year, particular areas of Scion's strategy are prioritised for additional management focus and investment through the Annual Operating Plan. Scion has progressed from building its internal capabilities - culture, systems and capacity (2011-2012) - to increasing the alignment and impact of its research through more effective transfer and commercialisation of technology, building national and international collaborations, and supporting regional development (2015-) as illustrated in Figure 13. Matching the pace of organisational change, and prioritising investment accordingly is a critical success factor in increasing Scion's contribution to the forest industry and New Zealand, and building its reputation as a world-class research provider.

Scion's priorities (strategic initiatives) over the 2016-2021 period are described below, noting some commenced in 2013 and are not yet fulfilled. Some are supported by the reinvestment of Scion surpluses (see page 52 for an overview of the proposed reinvestment portfolio). Progress in achieving these priorities is monitored through the scorecard presented in Section 8 (Table 12).

Priority 1. Value chain optimisation. The New Zealand forest industry has a highly fragmented value chain, and information flows are generally poor between the main actors. This leads to inefficiency, averaging of prices and lack of improvement in quality. The main challenge for manufacturers of high price (>$3,000/m^3) and high margin radiata pine products is their wood supply not meeting specification. Increased capacity to supply to specification is essential[46] if New Zealand is to de-commoditise from logs and 'old style' wood products. Also a culture change within the industry is required, and that is a challenge when the ability to apply pricing signals within value chains is poor. The requirement to 'track and trace' and verify a product's chain of custody and environmental footprint from forest to consumer is rapidly increasing. Further, supply chains are increasingly global and non-linear; and logistics considerations, such as port hubs and forms of storage, are critical for export success and to reducing greenhouse gas emissions. Prerequisites to lifting the impact of Scion's research are understanding who captures value ('makes money') and knowing where environmental impacts (whether for carbon, water or other ecosystem attribute) can be reduced in order to target science and technology interventions where innovation may be most successful.

To support a value chain approach Scion has appointed staff to a new Value Chain Optimisation (VCO) science team with specialist, quantitative analysis and translation expertise in value chain research and market analysis (see Figure 5). The team has introduced new analytical tools (such as Discrete

[46] Jacobides, M.G. & MacDuffie, J.P. (2013, Jul-Aug). How to drive value your way. *Harvard Business Review*, 94-99.

Event Simulation) and frameworks to help science project teams understand the value chain context in which their work is to be placed. An industry/policy steering group that advises on supply chain research priorities is working well. Postgraduate students are now working on forest industry projects and new non Crown investment for VCO research has been secured but is not yet at the level required. The VCO team provides cross-team support to research programmes and works closely with firms and customers in order to understand the 'real' world of prices, costs, barriers and enablers within the supply chains they function. This includes reassessing practices such as multiple re-measurement of logs (JAS scaling) and almost three times as many log grades as the Chileans.

The main priorities for 2016/17 are to:

1. Deepen links with universities to increase the number of PhD students studying in forest industry and related value chains.
2. Increase research into distributed manufacturing in order to support regional economic development and make better use of forest biomass for purposes such as bioenergy.
3. Expand work into emergent value chains for industrial bioproducts derived from forest biomass, log and product traceability, and the environmental footprint of building systems.

Priority 2. Accelerate commercialisation. More effective commercialisation of Scion's technologies will increase its research impact and financial resilience. In addition to lead technologies TERAX® (reducing municipal wastes) and Woodforce (Sonae; wood plastics[47]), Scion has established technology platforms (e.g. biotech, bioadhesives, thermal modification and dewatering of wood – see Figure 4) and an associated pipeline of more than 40 product concepts, and improved and decision support tools are in various stages of development. A charter is in place with Callaghan Innovation to assist with the commercialisation of technologies and their application to sectors outside of Scion's scope.

To further improve commercialisation and rapid uptake of its technologies, Scion is:

1. Adopting best practice pipeline management of technologies.
2. Investing in 'larger' game-changing technologies such the Woodforce wood plastic pellets and TERAX® biosolids waste technologies (L&G4, Figure 12) as well as technologies that contribute to 'smaller-scale, incremental gains' in forest and mill productivity (e.g. decision support tools for smaller scale forests such as drone-enabled LiDAR, camera vision technology for forestry worker safety).
3. Seeking new sources of investment for technology commercialisation including Bay of Plenty investors such as Te Arawa Group Holdings, Quayside, Enterprise Angels and WNT.
4. Extending Scion's pilot plant infrastructure (such as the WHITE room packaging – see Section 6) in order to scale-up and de-risk technologies for investors.
5. Developing staff expertise in technology commercialisation through workshops tailored to Scion's needs and via secondments to firms and mentoring (L&G1 and L&G6).
6. Improving the post-commercialisation management of Scion's licensed technologies.
7. Attracting tenants with new technology, capital and expertise to Scion's Innovation Hub and North Drive Innovation Park (see Priority 5).

Priority 3. Develop international networks. Building strong international linkages with world-leading research providers in the forestry, wood processing and bio-based products sectors provides significant strategic and technical advantages to New Zealand firms and ensures Scion can leverage its organisational capabilities with the resources of others. Scion will remain conscious of the ongoing choices between invention and adaptation and the implied cost implications. In addition, Scion offers a rare combination of multi-disciplined skillsets spanning the value chain that are attractive to many non-New Zealand stakeholders.

Scion is implementing a Learning and Growth initiative (L&G5, Figure 12) to deepen and extend its international network through staff exchanges/sabbaticals, formal agreements at both a technical and strategic level, coordination of funding applications to leverage co-investment and cross-licensing opportunities, and establishing mechanisms to support the adaption and co-invention of technology into the New Zealand forest industry and biomaterials sector. This includes:

1. Building relationships with international partners to share new ideas and opportunities; and develop foresight on global science and market trends to assist long-term planning of Scion science investment.
2. Providing seed investment (via L&G5, see Table 8) to develop the best opportunities; support staff exchanges and sabbaticals; and secure external funding. This includes sustaining at least three – and some new – projects each year.

Priority 4. National Science Challenges. As outlined in the National Statement of Science Investment, National Science Challenges (NSC) represent a significant change in the operating model for New Zealand science. Scion is engaged in five of the NSCs as illustrated below.

During the SCI planning period, Scion expects to:

1. Finalise its role within the five NSCs shown in Figure 14 and commence science contract delivery.
2. Ensure the forest industry and the industrial bioproducts manufacturing sector, and Scion's customers are well-briefed on the NSCs and see pathways for realising the opportunities they present (e.g. apply knowledge on land management within environmental limits to the optimal spatial placement of forestry within catchments).
3. Utilise synergies between NSCs such as manufacturing with 3-D printing using novel lightweight materials from the 'Science for Technological Innovation' NSC and

[47] See http://www.woodforce.com for details about this product.

building innovative, energy efficient, smart prefabricated homes in 'Better building, homes, towns and cities'.

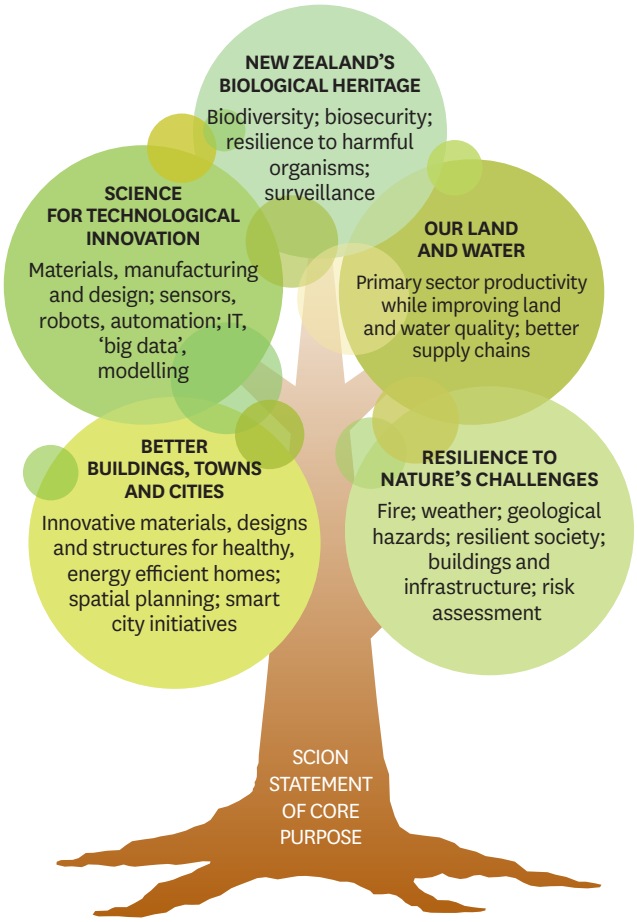


Figure 14: *The five National Science Challenges most aligned to Scion's core purpose.*

Priority 5. Regional hubs and development. Scion is forming an innovation hub at its campus within the Te Papa Tipu Innovation Park that supports district and regional economic development, and provides spill-over national benefits. The hub concept draws together the Bay of Plenty tertiary education strategy, Rotorua Lakes Council and GROW Rotorua economic development initiatives, forest industry firms, and iwi with substantial interests in forests in the central North Island. It will also integrate sciences for sustainable land use and improving freshwater quality. Scion has secured a $2.5 million interest free loan from the Bay of Plenty Regional Council Infrastructure Fund to construct an 'Innovation Centre Building', which is co-located with the main science buildings (Figure 15) to maximise the interaction between hub tenants and Scion's science capabilities. Design is underway with a timetable to commence Stage I construction in 2016/17. Opportunities to utilise the three fully serviced vacant sections on Scion's North Drive (within Te Papa Tipu Innovation Park) will also be pursued during the planning period.

During the planning period Scion expects to:

1. Fully tenant the innovation hub and generate synergies between the 27 companies already located in the Te Papa Tipu Innovation Park.
2. Work closely with GROW Rotorua (and Rotorua Lakes Council), Bay of Plenty Connections (and Bay of Plenty Regional Council) and Industrial Symbiosis Kawerau (ISK)[48] to undertake the initiatives it is identified for as either the lead or contributor to actions for the Bay of Plenty Regional Growth Study. For example, 35% of all forest stocks are in the Bay of Plenty region. In 2010, forestry contributed towards 10% of the Bay of Plenty's GDP and was a significant and positive attractant for employees[49]. By 2020, the region's annual harvest is forecast to be 2-3 million m^3 per annum greater than at present. This increase in log

Figure 15: *Concept drawing of the 'Innovation Centre Building' scheduled for staged construction to commence in 2016/17.*

[48] Kawerau District Council. (n.d.). *Industrial Symbiosis Kawerau*. Retrieved 23 May 2016 from http://www.kaweraudc.govt.nz/Economic_Development/industrialsymbiosiskawerau.asp

[49] Statistics New Zealand. (2013). *Regional Gross Domestic Product: Year ended March 2007–10*. (pp. 18-19). http://www.stats.govt.nz/~/media/Statistics/Browse%20for%20stats/RegionalGDP/HOTPYeMar0710/RegionalGDPYeMar0710HOTP.pdf

SCION'S TE PAPA TIPU MĀORI PLAN *Mai i te ngahere oranga*

SCION'S STRATEGIC OUTCOMES

SCION RECOGNISES

That 40% of forested land is owned by Māori and is increasing

Māori forested assets exceed $2 billion

Māori enterprises added an estimated $10.3 billion in value to New Zealand in 2010

Māori aim to realise greater value from their resources

Māori are the only assured stakeholder in land in 100 years time

Māori aspire to build businesses along the whole value chain and build stronger economic and social outcomes

The principles of Māori expressed in kaitiakitanga

The principles of Te Tiriti o Waitangi/ Treaty of Waitangi

Te Arawa are tangata whenua for Scion's corporate offices

IO1 Commercial forestry potential realised

IO2 Solid wood processing competitiveness improved

IO3 Expanded opportunities in fibre, pulp and biochemicals

IO4 Increased energy security

IO5 Minimising risk to New Zealand's forests and forest products

IO6 Assuring licence to operate

WHAT DOES SUCCESS LOOK LIKE?

Economic, social and cultural needs of Māori are met by incorporating Scion's science and innovations to:

- Create new Māori businesses building on their biological assets
- Establish new forests and land uses, and
- Build new value chains

Scion is respected as an authoritative source of information supporting Māori in achieving their aspirations

Vision Mātauranga is incorporated in all Scion programmes

WHAT ARE THE LEADING INDICATORS OF SUCCESS?

Māori are actively partnering and investing alongside Scion into programmes that meet the needs of both partners

Māori and Scion staff work in each other's organisations and share knowledge

Increased Government investment into programmes at Scion that support Māori aspirations

PLAN ASPIRATIONS

To enable each Māori landowner to benefit from the economic, environmental and cultural development of their assets

That Scion will have supported Māori to contribute to the economy at least $2.6 billion greater than 'business as usual' in 2040

KEY ENABLERS

FORM RELATIONSHIPS TO ENABLE STRATEGY

Nga Rangatira

Te Tumu Paeroa

Iwi engaged in growing the bio-based economy

Ministry for Primary Industries

Ministry of Business, Innovation and Employment

Federation of Māori Authorities

Te Puni Kokiri

Department of Conservation

Key iwi influencers

NURTURE PARTNERSHIPS TO DELIVER STRATEGY

Scion and Māori partner to:

- Identify opportunities
- Develop the pathway to realise those opportunities, and
- Deliver mutually successful outcomes

COMMUNICATE FOR MUTUAL UNDERSTANDING

Kanohi ki te kanohi and kanohi kitea

Clear expectations and delivery

Communicate in a form that accounts for the needs and expectations of Māori

Scion's science and innovation programmes incorporate Vision Mātauranga

INCREASE SCION'S CAPACITY TO WORK WITH MĀORI

Shape Scion's 'look and feel' to facilitate working with Māori

Extend Scion's collaborative networks

Build relationships with local schools to inspire careers in science and innovation that will support Māori asset development

Provide Scion staff opportunity to develop their knowledge of tikanga and te reo, and confidence to partner with Māori (L&G 7)

Figure 16: *Scion's Te Papa Tipu Māori plan 2014-2019.*

supply requires new processing capacity and, equally important, innovation to achieve export competitive wood and wood fibre products.
3. Work closely with the Bay of Plenty tertiary education alliance (including Waiariki Bay of Plenty Polytechnic, the newly merged Waiariki Institute of Technology and Bay of Plenty Polytechnic; and the University of Waikato) to foster initiatives such as a university-led 'freshwater centre of excellence' centred on the successful restoration of water quality in the Rotorua Lakes and boost the number of postgraduate students studying at Scion.

Priority 6. Partnerships with Māori. As described in Section 2, Māori are increasing their ownership of forests and forest lands in New Zealand. About 500,000 hectares of presently under-utilised Maori land is suitable for forestry[50]. The ability of Māori to realise economic value from such lands and forests is constrained by the parcels of land or forests they control typically being below economic critical mass, shortages of technical and governance expertise and insufficient working capital. Māori also want to undertake operations and develop products in a manner that respects Māori values, utilises Mātauranga Māori (traditional knowledge) and ensures environmental sustainability (Kaitiakitanga). Many Māori owned corporations now command substantial investment portfolios and actively manage these for growth for the greater benefit of their shareholders/trustees. Typically such assets include renewable energy, land and sea based industries and as such align to Scion's Core Purpose. Scion's Te Papu Tipu Māori Plan (Figure 16) addresses these issues and opportunities. The plan and progress in implementing it is assessed regularly by Scion's strategic Māori Panel (Ngā Rangatira Roopu).

Scion's priorities to grow the Māori economy through forest and forest derived products are:

1. Building partnerships (including with 'cooperating clusters') to support greater economic returns for Māori from their participation in the forest industry, such as those highlighted by the regional growth studies and in identifying bio-based manufacturing and related activities that align to the aspirations of Māori owned corporations.
2. Strengthening two-way communication channels within Māori to better align programmes within Scion to meet their aspirations.
3. Building partnerships with Māori to facilitate the integration of Vision Matauranga in Scion research programmes; the early engagement of iwi in research programme ideation and design; and the uptake of research outputs from Scion.

These initiatives align fully with *He Kai Kei Aku Ringa*[51], the strategy developed by the Crown Māori Economic Growth Partnership.

[50] Ministry for Primary Industries. (2013). *Growing the productive base of Māori freehold land*. Retrieved 24 May 2016 from https://www.mpi.govt.nz/document-vault/4261

[51] Maori Economic Development Panel. (2012). *Strategy to 2040, He kai kei aku ringa*. https://www.tpk.govt.nz/documents/download/215/He-Kai-Kei-Aku-Ringa-Strategy.pdf

4 Scion's science plan

STATEMENT OF CORE PURPOSE OUTCOMES

Increase the value and productivity of the New Zealand forestry, wood products and wood derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand

Protect and enhance market access and improve risk management in the forestry industry

Enhance New Zealand's opportunity to benefit from forestry-based ecosystem services to improve both the global market position of industry and the environmental sustainability of forestry production in New Zealand

Increase renewable energy production and energy security by growing New Zealand's ability to produce sustainable bioenergy and liquid biofuels.

NATIONAL KPIs 10-15 YEARS

Grow forest and wood product exports to $12 billion by 2022

Over 70% of logs processed onshore by 2026

Māori investment in forestry will have at least doubled to $4 billion by 2026

New Zealand has realised at least another $870 million p.a. of revenue from fibre, pulp and biochemical products

New Zealand packaging industry has grown by at least an additional $140 million p.a.

Increased the contribution of bioenergy to New Zealand's consumer energy production and liquid fuels by 16% and 9%, respectively, by 2026

Support improvements in New Zealand Natural Capital through forest system ecosystem services (National index) greater than 100 (2011) by 2026

SCIENCE INTERMEDIATE OUTCOMES (IOs) 5-15 YEARS

IO1
Maximise the value and profitability of commercial forests and their ecosystem services

IO2
Increase the profitability of solid wood processing through customer solutions and supply chain innovations

IO3
Expand opportunities in the wood fibre, pulp, biopolymer, packaging and biochemical industries

IO4
Increase New Zealand's energy security through the use of forest and waste biomass for bioenergy

IO5
Protect and enhance market access and improve risk management

IO6
Ensure licence to operate

IO5
Protect and enhance market access and improve risk management in the forest industry including forest health and preparedness for biosecurity incursions, fire and climate change

IO6
Ensure the forest industry and bioeconomy businesses' licence to operate

IMPACT KPIs 3-5 YEARS

1. Sustainably increase forest productivity
2. Extract value from dispersed forest holdings
3. Increase socio-economic and environmental outcomes from forests
4. New value chains for speciality wood products
5. Expand opportunities for wood products and building systems
6. Develop new industrial bioproducts for existing and emerging manufacturing industries in New Zealand
7. Improve readiness for bioenergy and liquid biofuels in New Zealand
8. Ensure New Zealand forests are resilient to current and future natural threats
9. Sustain New Zealand forest industry and bioproducts manufacturers' licence to operate

Figure 17: *Scion's Science Plan shows the inter-dependency between National and Intermediate Outcomes and performance measures (National and Impact KPIs, respectively).*

As described in the strategy map (Figure 12), Scion's science is focussed on delivering six interrelated Intermediate Outcomes (IOs)[52]:

IO1: Maximise the value and profitability of **commercial forests** and their ecosystem services.
IO2: Increase the profitability of **solid wood processing** through customer solutions and supply chain innovations.
IO3: Expand opportunities in the **wood fibre**, **pulp**, **biopolymer**, **packaging** and **biochemical industries**.
IO4: Increase New Zealand's **energy security** through the use of forest and waste biomass for **bioenergy**.
IO5: Protect and enhance **market access** and improve **risk management** in the forest industry including for forest health and preparedness for biosecurity incursions, fire and climate change.
IO6: Ensure the forest industry and bioeconomy businesses' **licence to operate**.

Each IO is described more fully in the following section. The integrated delivery of these, as illustrated by Figure 18, will achieve Scion's Statement of Core Purpose national outcomes. Strategic Advisory Panels[53] to the Scion Board provide, as required for specific fields of science, commerce or iwi development, independent and expert perspectives on science quality, user impact and Māori and assist with strategy formulation.

Science plan alignment to Scion's Statement of Core Purpose outcomes

Scion's Science Plan (Figure 17) describes the inter-dependence between Core Purpose national outcomes and Intermediate Outcomes (IOs) that will be delivered by Scion. The IOs are targeted at a 5-15 year horizon. Scion and its research partners provide the tools, technologies and knowledge that will enable users to achieve the impacts for industry and thus Scion's Core Purpose national outcomes. Each IO has 1-3 impact measures (Key Performance Indicators (KPIs)) that are to be achieved within a 3-5 year timeframe by which progress towards IO achievement is gauged. The hierarchy and performance framework for achieving national outcomes is illustrated in Figure 18 along with the principal stakeholder(s) responsible for delivering each output or outcome.

Industry and policy agency input into the science programmes for each IO is a high priority for Scion. In recent years, intervention logic mapping workshops have been used to facilitate this. An example for the forest growing sector is shown in Figure 19. Logic maps for other sectors Scion works with have been prepared and are regularly reassessed with stakeholders.

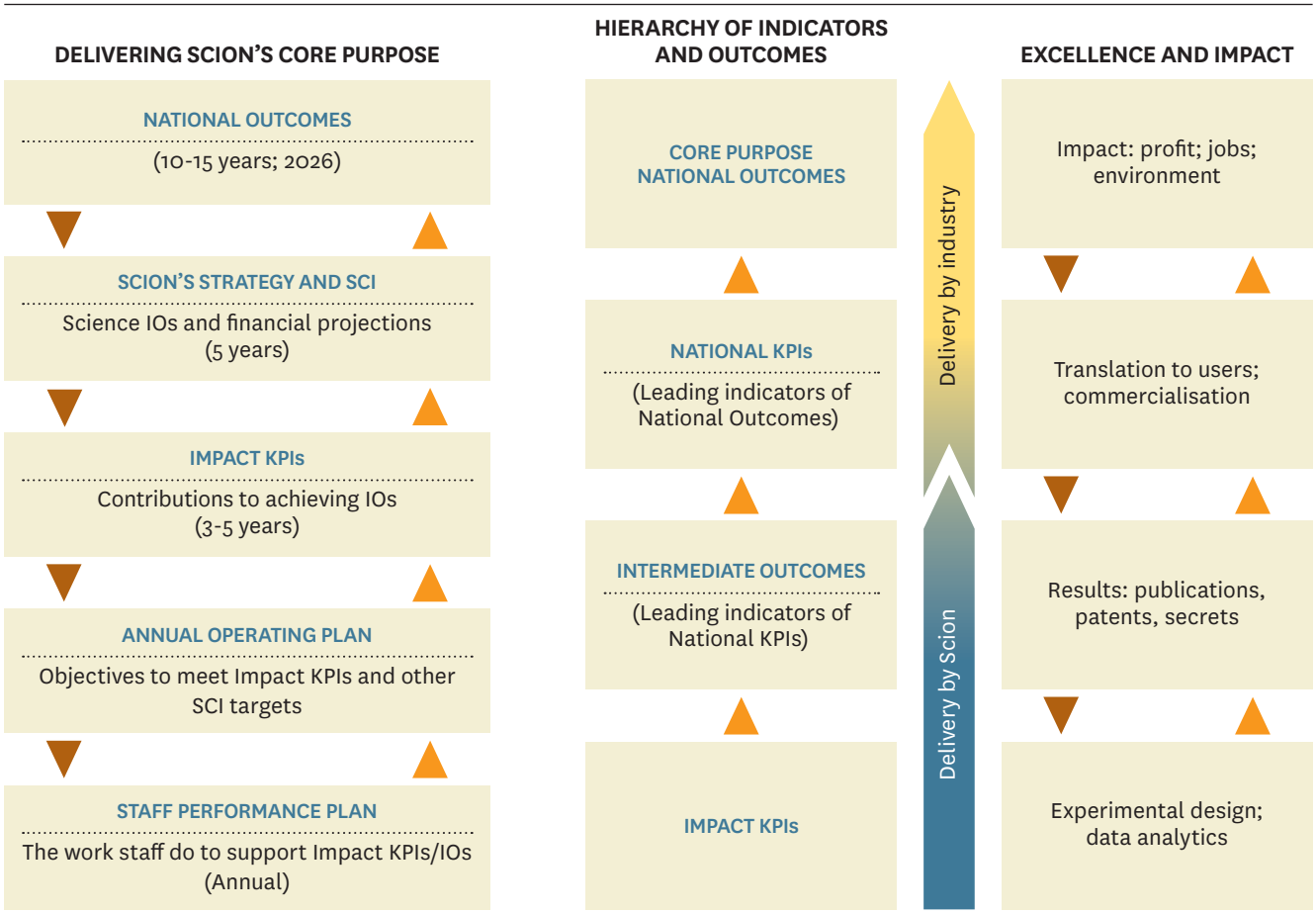
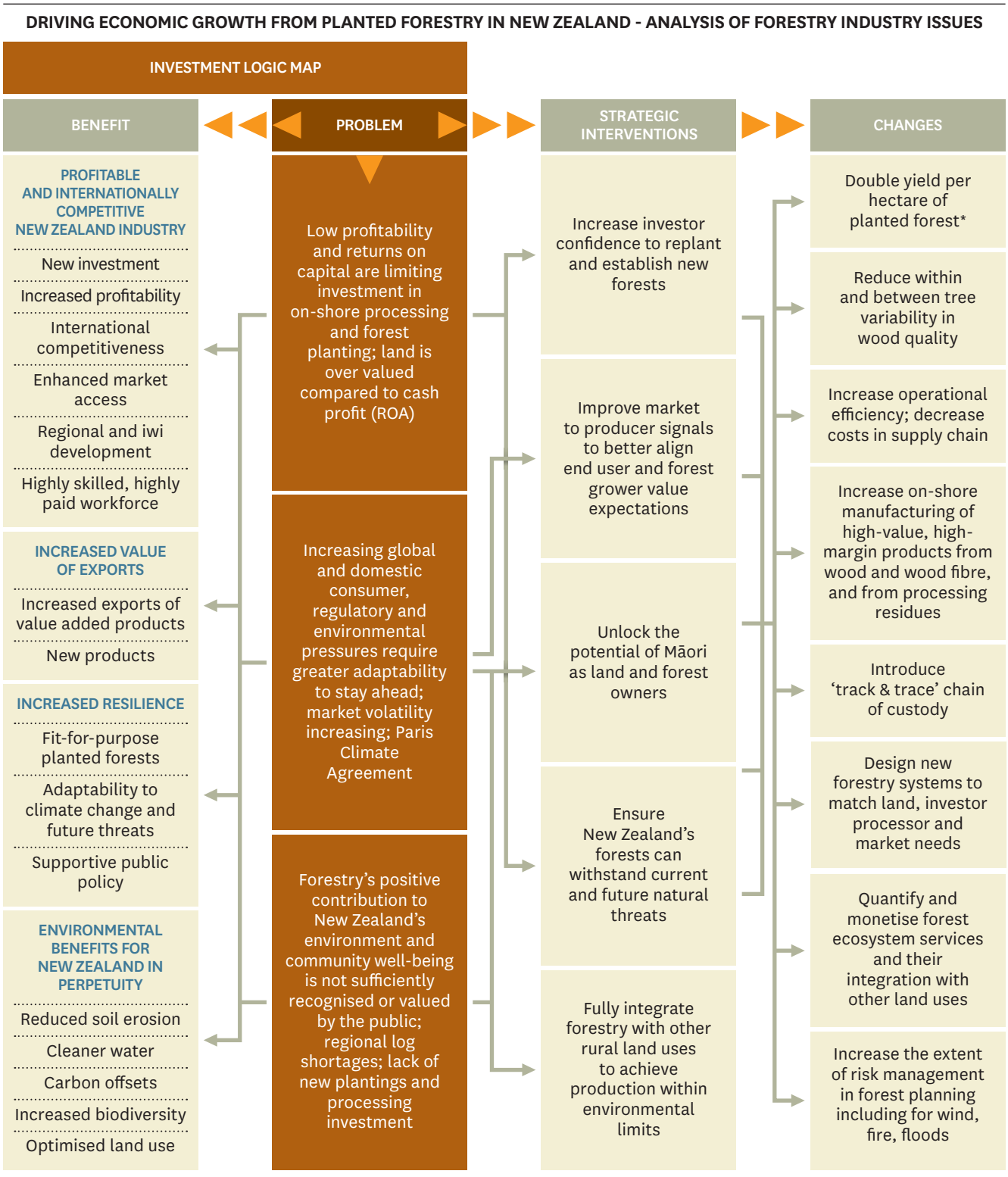


Figure 18: *Alignment of Scion's science IOs, Impact KPIs and staff performance plans with Core Purpose national outcomes and where accountability for implementation lies. The National Statement of Science Investment provides the overall context for Scion's science investment portfolio and signals the New Zealand Government's priorities for new investment through to 2025.*

[52] These are the science outcomes that Scion can directly influence that support and lead to the delivery of the industry targets.
[53] The terms of reference of these groups and their composition are available from Scion.



* Such as through site productivity, wood quality, consistency and uniformity and good forest health.

Figure 19: *An investment logic map (updated March 2016) that identified New Zealand forest grower R&D priorities and the design of the Growing Confidence in Forestry's Future research programme (originally prepared in 2012).*

5 Scion's investment priorities and allocation of core funding

Scion receives $17.73 million of CRI Core Funding (core funding) from the Government to strategically invest in science programmes that will support the achievement of its Statement of Core Purpose national outcomes. While up to a 15 year view is taken, core funding is allocated on an annual basis to reflect refreshed industry strategies, changes in government policies and priorities (such as the NSSI and increasing regional economic growth); science progress (internally and from domestic and international intelligence); and changes in the external operating environment.

Core funding is focussed on:

- Ensuring Scion's capability is aligned with the delivery of impact measures (KPIs) for each Intermediate Outcome (the IO Impact KPIs are summarised in the bottom row of Figure 17).
- Supporting activities where direct industry investment is unlikely until proof of concept is demonstrated and the risks are quantified.
- Alignment into the NSCs to generate 'additionality' through collaboration with challenge parties and cascade new knowledge and technologies from the NSCs to Scion's customers and stakeholders.
- Sustaining national databases and collections such as the National Forest Herbarium and Permanent Sample Plots (PSPs) in forests for research and genetic improvement purposes (see Table 5).
- Facilitating joint research with international partners (see Section 3, Strategic Initiatives).
- Growing industry co-investment.
- Improving the excellence and impact of Scion's science,

Scion has a well-defined process and criteria for allocating (and monitoring the performance of) core funding. Specifically:

- Allocations are made to science programmes, each of which contributes to the delivery of at least one Impact KPI and at least one IO.
- Investment is based on alignment with Scion's strategy, science excellence and impact (as per the NSSI), the balance of research and risk (including the portion allocated to Horizon 2 and 3 mid- to long-term science discovery) across the six IOs/Impacts and meeting requirements such as the stewardship of nationally critical capability or databases and collections.
- Core funding is segmented into three categories: (1) funds mapped into the NSCs or funds allocated to the maintenance of databases, collections or their underpinning infrastructure; (2) building future science capability (e.g. such as in Value Chain Optimisation) and (3) funds supporting Scion's strategic (H2/H3) science
- Up to 10% of Scion's total investment (within and between IOs) will be refreshed each year to provide for new opportunities, emerging science, collaborations and capability building.
- Flexibility is retained to reallocate core funding to address high priority industry challenges (e.g. to find solutions to red needle cast disease in radiata pine from mid 2012).
- The investment process and monitoring of portfolio 'health' is overseen by the Scion Executive Management Team, and, through the Chief Executive, is accountable directly to the Scion Board.
- Programmes are broken down to objectives under each Impact KPI in the Annual Operating Plan and progress in meeting them is reported monthly through Scion's scorecard. In addition, performance is checked quarterly by the Research and Investments Office and formally reviewed annually by the Scion Board. As well, internal science reviews are completed to varying degrees for all programmes to ensure they remain correctly targeted. From 2016, and post Scion's Four Year Rolling Review (2015), the Board's Strategic Advisory Panels will be constituted on an annual basis to provide in-depth review of specific areas of Scion's science and its commercialisation with experts in these fields.

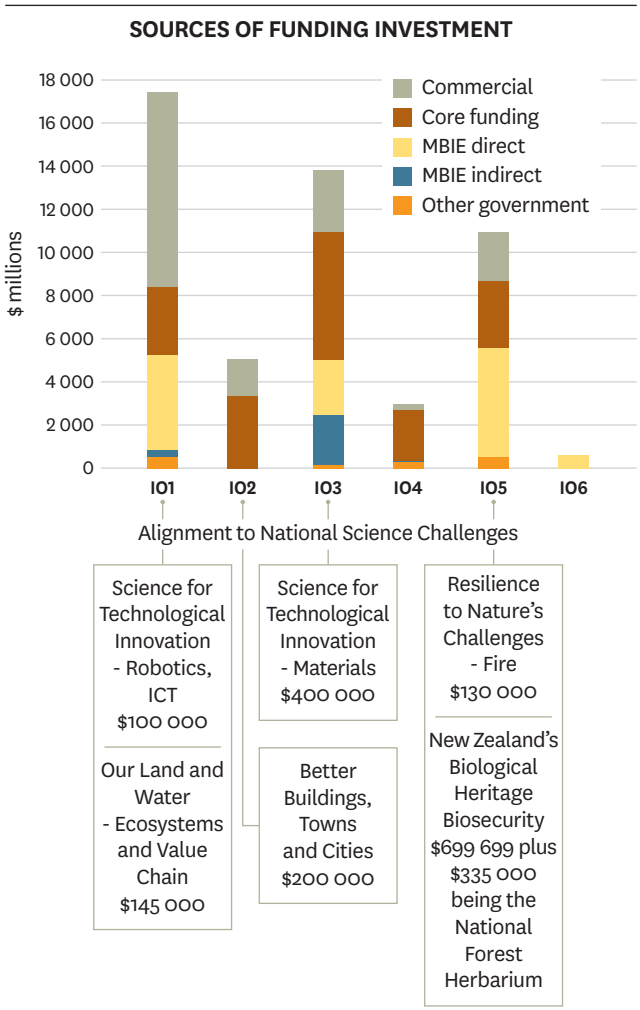


Figure 20: *Investment ($) directed to achieve each Intermediate Outcome (IO) and the investment Scion is making into the National Science Challenges.*

Investing in delivering Scion's strategic outcomes (Intermediate Outcomes)

In addition to core funding, Scion receives investment from the Ministry of Business, Innovation and Employment science investment funds both directly (contracts that Scion holds with MBIE) and indirectly where Scion is a sub-contractor to an MBIE contract. Investment is also received from other government departments such as the Ministry for Primary Industries and from commercial firms. All these investments are aligned to achieving Scion's strategic outcomes (IOs). The mapping of investment to these IOs is shown in Figure 20. Overlaps between investments and outcomes should be noted. For example, an investment into tree genetic improvement (linked to IO1) may also improve tree health and thus resistance to a biosecurity incursion (linked to IO5). Core funding is aligned to the IO where the investment has the largest impact. Figure 20 also indicates the value of core funding linked to the five NSCs Scion is engaged in (see Figure 14).

Changes to the allocation of core funding occur both between and within IOs (Figure 21). The latter are more substantial (up to 20%) as science programmes are adjusted for new findings from the research conducted at Scion (and the wider research community), policy and market changes and the priorities of firms. Programme leaders are encouraged to make changes as the year progresses rather than rely on the annual review. Core funding is also targeted to strategic development of capability at Scion, notably at present in Value Chain Optimisation, Forest Industry Informatics and Resource Economics (forest ecosystem services and natural capital assessment). Some core funding is aligned to the National Forest Herbarium and Database ($335,000), and, in 2016/17, the nationally significant Permanent Sample Plot (PSP) Database will receive $75,000 to help mitigate the earlier loss (2013) of MBIE contestable funding for alternative forest species research.

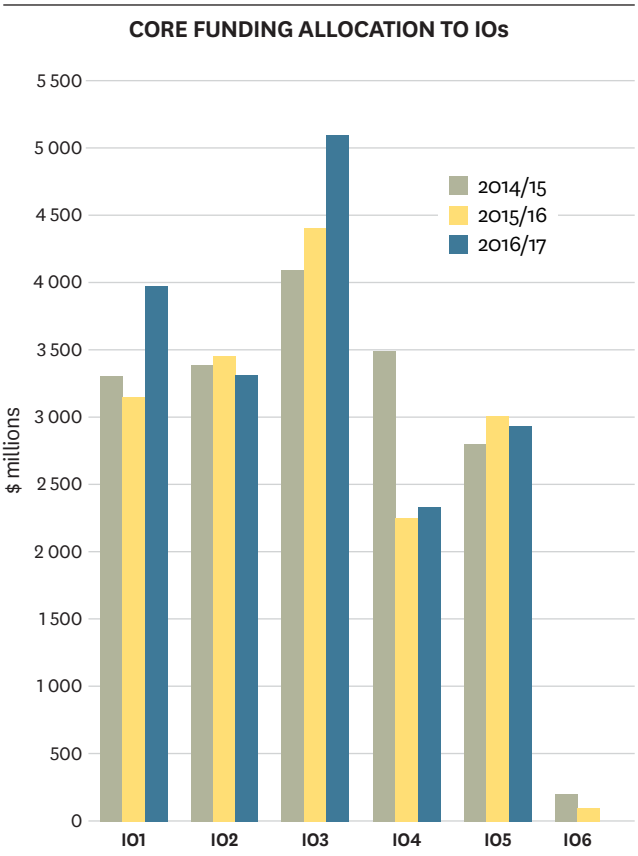


Figure 21: *Core funding allocation to IOs showing between year changes.*

The following section describes the Intermediate Outcomes, the approach underpinning delivery of each of these outcomes and the leading indicators (Impact KPIs) in delivering these outcomes.

Intermediate Outcomes and Impact Key Performance Indicators

Scion's IOs, and the underpinning approach to deliver these, are derived from ten key strategies developed by Scion's major stakeholder groups (described in Section 2). Specifically:

1. New Zealand Government's Business Growth Agenda: www.mbie.govt.nz
2. National Statement of Science Investment 2015-2025: www.mbie.govt.nz
3. The New Zealand Forest and Wood Products Industry Strategic Action Plan. The Wood Council of New Zealand: www.woodco.org.nz
4. New Zealand Forest Growers' 2015 Science and Innovation Plan: http://www.fglt.org.nz
5. The New Zealand Farm Foresters Association: www.nzffa.org.nz
6. *He Kai Kei Aku Ringa* The Crown Māori Economic Growth Strategy specifically focussing on realising greater value from Māori owned economic resources: www.tpk.govt.nz
7. Wood Processing Science and Innovation Plan; New Zealand Wood Processors and Manufacturers Association 2012: www.nzwpa.org.nz
8. MBIE and MPI Regional Growth Studies: www.mpi.govt.nz
9. National Policy Statements for Fresh Water Management: http://www.mfe.govt.nz/fresh-water/freshwater-management-nps and under consultation for Forestry.
10. NZ Energy Strategy: http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-strategies

Measuring progress against Scion's strategic outcomes

Progress in meeting the IO goals will be assessed through the achievement of nine leading performance indicators (Impact KPIs). The IOs are interdependent to varying degrees, as are the leading indicators. Thus, Impact KPIs contribute to one or more IOs as illustrated in Figure 22.

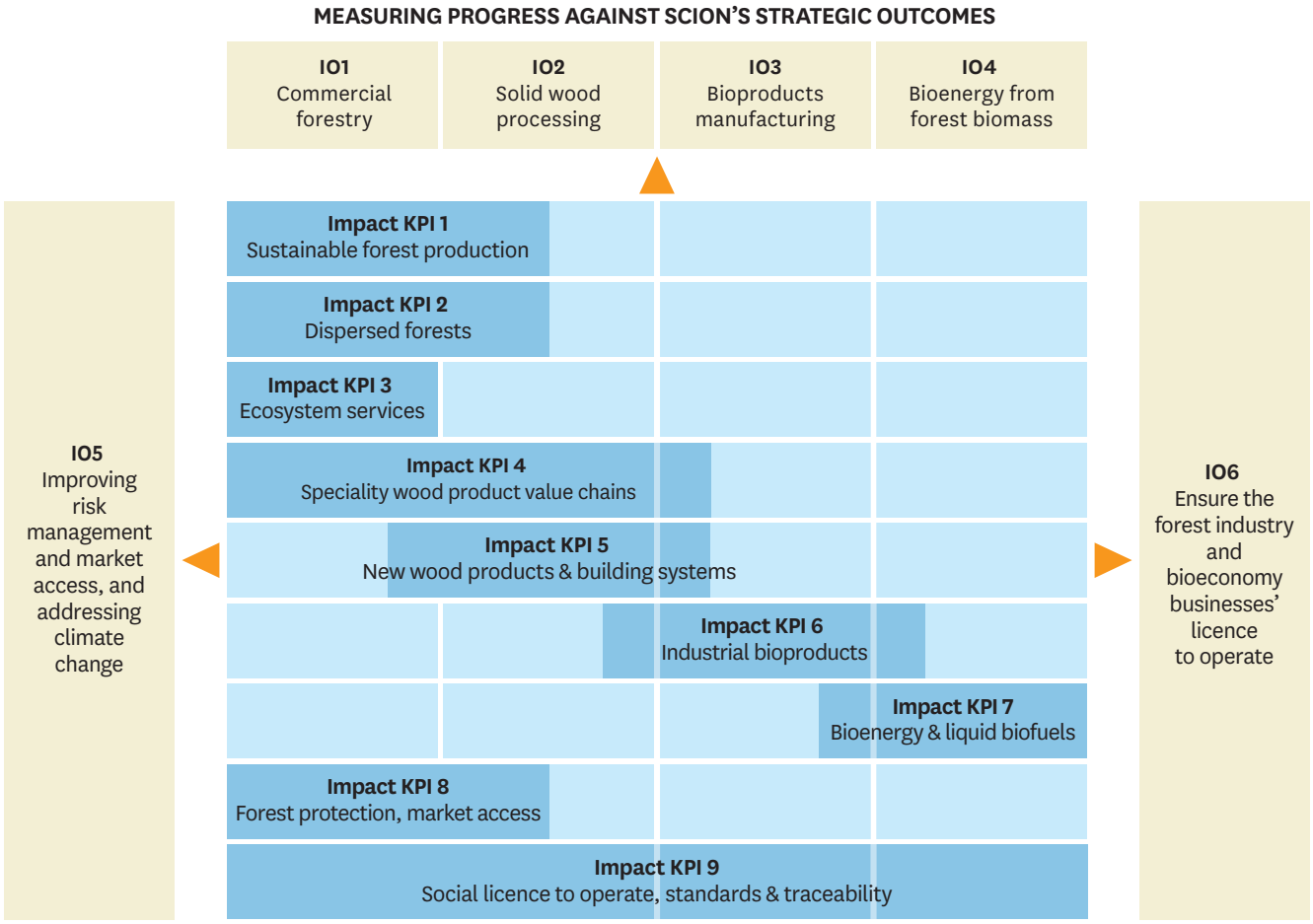


Figure 22: *Map of Impact KPIs against Intermediate Outcomes showing their relative contribution to outcomes and interdependencies. A strong indicator is shown in 'dark blue'; a secondary indicator is shown in 'light blue'.*

IO1

Maximise the value and profitability of commercial forests and their ecosystem services

By 2026, Scion will have provided technologies, tools and materials to support the industry to increase competitiveness of the commercial forest estate through at least a 50% increase in forest biomass productivity (Mean Annual Increment (MAI)) and at least $70 million per annum reduction in operational costs over 2010 values, leading to growth in planted area from its present 1.7 million hectares.

We will support forest growers, farm foresters, Māori, wood manufacturers and government in their ambitions to enhance the value created and derived from forestry, and to expand and diversify New Zealand's forests. Specific aims are to:

- Increase the volume, value and diversity of exports derived from New Zealand plantation forests.
- Enable increased investment in the forestry value chain by Māori.
- Encourage investment into wood processing by providing long-term security of supply for high quality wood.
- Enable through supply chain efficiencies, aggregation of woodlots, and/or distributed processing options the profitable and environmentally sustainable recovery of logs from steep country and small woodlots where at least 40% of the wood supply will be sourced in the near future.
- Expand forests onto otherwise under-utilised land and, in particular, support monetisation of the contribution that forests make to environmental and community well-being (ecosystem services).
- Develop new and improved systems for managing and encouraging forestry on marginal land to deliver environmental benefits and economic returns to the land owner.
- Enable higher and sustainable growth rate (MAI) to improve profitability of forestry along the value chain – from land use to market (Table 3 illustrates the impact of increasing MAI).
- Reduce the proportionately large cost of harvesting in the forest-to-mill forest-to-port supply chain.

300 Index	Site Index (m)	Rotation age (years)	Total recoverable volume (m^3/ha)	MAI (m^3/ha/yr)	Carbon sequestered (t/ha)	Stumpage ($/ha)	NPV with carbon ($/ha)
28	27.9	25	695	28.6	804	23 886	2 244
28	27.9	30	886	30.5	1 002	30 629	2 079
28	27.9	35	1 050	31.2	1 176	35 943	1 686
32	30.4	25	804	33.2	920	29 325	3 406
32	30.4	30	1 002	34.4	1 115	34 590	2 864
32	30.4	35	1 167	34.5	1 285	39 326	2 324

Table 3: *Impact of forest biomass accumulation rate (MAI) and age at harvest on returns by hectare (Stumpage and NPV at a discount rate of 8%) and carbon storage for a pruned radiata pine forest regime*[54].

Alignment to the National Science Challenges

- *Our land and water* – ascribing value to forestry to enhance the resilience of land and fresh water resources; understanding land-owners' decision-making and willingness to change land use to forestry and/or continue with forestry; and, describing and quantifying social licence to operate issues and community preferences for forestry as a land use (links to Impact KPI 9).
- *Science for technological innovation* – increasing use of 'big data', remote sensing, process automation and other precision technologies for productivity gains in forestry.
- *New Zealand's biological heritage* – improving forest biosecurity to avoid production loss; valuing ecosystem services to improve environmental performance (including protection and enhancement of biodiversity).

Impact KPI-1

Sustainably increase the productivity of New Zealand forests

By 2019, tools, novel forest management approaches and new plant material will be embedded into New Zealand's forests and forestry practices to support the industry's target to increase radiata pine MAI from an average of 20 m^3 ha^{-1} yr^{-1} to 35[2] m^3 ha^{-1} yr^{-1} [55] *and in a way that enhances the sustainability of forest growing in New Zealand.*

Leading indicators are:

- By 2017, Scion will have supported increased involvement of Māori stakeholders in radiata pine forest growing research programmes.
- By 2017, data gathered using new remote sensing technologies is being linked to traditional data systems, and this is being used by land owners and forest growers to inform management practices.
- By 2017, Scion will have trialled with forest growers an alternative method for in field forest measurement.
- By 2019, a model conifer species has demonstrated proof of concept achievement of sterility.
- By 2019, a phenotyping platform has been used to identify outstanding trees for at least one key trait leading to better site species matching and increased estate-level productivity for at least one end-user.
- By 2019, at least two major forest growers have changed their management practices and are applying new treatments designed to increase productivity of mid-rotation stands.
- By 2019, next generation genetics will have delivered new trees with an additional 15% genetic gain compared with the average improvement of 2012 deployed genetic seedlots.
- By 2020, 4 biotech tree lines with modified productivity traits are being evaluated by field trial and reported to stakeholders.
- On-going: The Forestry Library, Permanent Sample Plots (National Forest Tree Database) and Tree Genetic Archives remain viable and provide valuable information about the national forestry position for New Zealand.

[54] John Moore personal communication, May 2014: *Forecaster scenario analysis*.

[55] In Scion's 2014-19 SCI, the MAI improvement goal was 40 m^3 ha^{-1} yr^{-1}. Subsequent MAI results from Permanent Sample Plots and other data sources indicate that 35 m^3 ha^{-1} yr^{-1} would be a more realistic national average target.

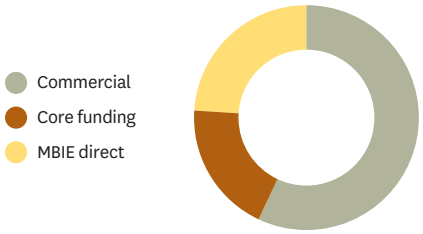
- On-going: The forest sector continues to adopt best practice remote sensing and analytical methodology developed by Scion.

Our key partners in delivery are: the New Zealand forest growers operating through the Forest Growers Levy Trust Board Inc., the New Zealand Forest Owners Association, New Zealand Farm Forestry Association and Māori operating through their forestry trusts and other entities; supported by research and technical partnerships with the Radiata Pine Breeding Company Ltd, ArborGen and Forest Genetics Ltd. The Ministry for Primary Industries is the primary government agency involved in this research; this work is also of high value to Ministry for the Environment and the Department of Conservation.

Outputs from this research are directly relevant to the goals of National Science Challenge *Our land and water*.

Technology transfer: Scion will continue to work in partnership with industry, commercial partners, government agencies and iwi. This includes jointly developing plans, project methodology, exemplars and together implementing the outcomes. An important technology transfer tool is the Forecaster™ DSS, used by most of the forest growers, in which we will embed the new technical outcomes.

Investment



Commercial $8.0, Core funding $2.6, MBIE direct $3.4. Total $14 (millions).

Alignment to National Science Challenges: $100,000 of Core funding aligned to *Science for technological innovation*.

Databases and Collections: National Forest Library, National Forest Tree Database (PSP) and Tree Genetic Archives are supported to the value of $1.65 million of which $75,000 is from Core funding.

Impact KPI-**2**

Extract value from forests and dispersed forest holdings

By 2019, tools developed by Scion and its partners will be used by New Zealand forest growers and harvesting companies to reduce harvesting costs, improve safety of tree extraction and improve supply chain logistics.

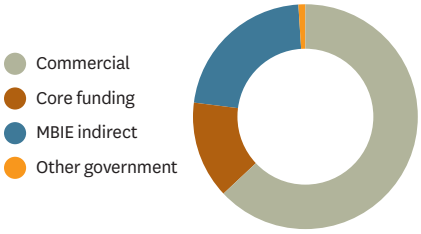
Leading indicators are:

- From 2017, significant progress will be made through an industry-led PGP programme in the design and commercialisation of modern harvesting tools, value chain approaches and labour productivity that will save the industry (by 2024) approximately $177 million per annum over 2016 costs.
- By 2018, Scion will have developed tools and models for the forest products value chain that will be in use to determine where to intervene in order to maximise benefits from the existing forest resource. This work will have created better connectivity between growers and processors, and between small-scale forest growers; and assessed options for achieving economically viable distributed processing
- Scion, in partnership with key collaborators, is developing and testing two robot prototypes to be deployed autonomously in the forest to undertake silviculture operations such as pruning and thinning. This objective is expected to be achieved in 5-10 years.

Our key partners in delivery are: The New Zealand forest growers operating through the Forest Growers Levy Trust Board Inc., the New Zealand Forest Owners Association, New Zealand Farm Forestry Association and Māori operating through their forestry trusts and other entities; research and technical partnerships with the FOA Research Committee and Universities of Canterbury and Auckland. While the Ministry for Primary Industries is the primary government agency involved in this research, this work is also of high value to the Ministry for the Environment and the Department of Conservation.

Technology transfer: Scion will continue to work in partnership with industry, government agencies and iwi. This includes jointly developing plans, project methodology and prototypes; and jointly implementing the outcomes. We will continue to work with our commercialisation partners to refine harvesting tools (such as CHIPS) and similar to facilitate uptake of research outcomes.

Investment



Commercial $0.8, Core $0.2, MBIE indirect $0.3, Other government $0.02. Total $1.32 (millions).

Impact KPI-**3**

Quantify the role of forests in increasing economic, environmental and social outcomes for New Zealand

By 2019, Scion and its partners will have compellingly demonstrated to key stakeholders (e.g. forest owners, Māori, regional councils, policy makers) the role of forests in the landscape through economic, environmental and social contributions to regional economies and provision of ecosystem services (e.g. timber, climate change mitigation, recreation).

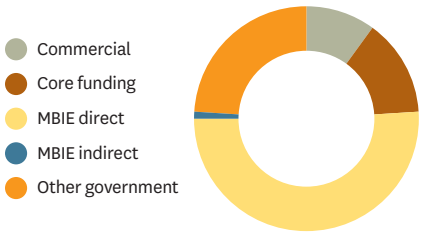
Leading indicators are:

- By 2017, at least two regional councils will be using Scion's evidence-based information that quantifies forests' economic and natural capital contributions to New Zealand's growth, regional development and environmental performance targets.
- By 2017, Scion's information and capability will have contributed to New Zealand's post COP21 Paris climate mitigation policy development and dialogue across primary industry sectors regarding land-use and supply chain complementarity.
- By 2019, at least two regional councils have integrated Scion's forest economics and ecosystem services approaches into landscape level planning for multiple land uses.
- By 2019, Scion's information will have contributed to New Zealand's national and international reporting obligations and the New Zealand Freshwater National Objectives Framework.
- By 2019, Scion is collaborating with Māori organisations to develop forestry options that meet their economic and social aspirations.
- By 2019, using adaptive governance approaches, the barriers and obstacles facing Māori in the development and implementation of alternative land uses will have been described and new governance approaches developed and tested with key agencies.

Our key partners in delivery are: the New Zealand forest growers operating through the Forest Growers Levy Trust Board Inc., the New Zealand Forest Owners Association, New Zealand Farm Forestry Association and Māori operating through their forestry and land holding entities, Tane's Tree Trust, the Northern Totara Working Group and local and regional authorities, and Department of Conservation (as a land owner). Supporting delivery of the above will be our research and technical partnership with Landcare Research and Te Kotahi Research Waikato University. The main government agencies involved with the above are the Ministry for Primary Industries, Ministry for the Environment and Department of Conservation.

Technology transfer: Scion will work in partnership with the key stakeholders including tangata whenua, regional councils and New Zealand Farm Forestry Association to develop business cases and research programmes. Key tools that will be used and continue to be developed with these stakeholders include MyLand, Forest Investment Finder and other tree and land use calculators.

Investment



Commercial $0.2, Core funding $0.3, MBIE direct $1.0, MBIE indirect $0.02, Other government $0.48. Total $2.0 (millions).

Alignment to National Science Challenges: $145,000 of Core funding aligned to *Our land and water.*

IO2

Increase the profitability of solid wood processing through customer solutions and supply chain innovations

By 2026, Scion has supported the industry in achieving 6% year-on-year growth in the export of wood products to an estimated target value of at least $6 billion per year.

We will support the industry and key stakeholders:

- Achieve operational efficiencies to enhance international competitiveness through the application of wood segregation technologies and improved supply chains.
- Develop new and enhanced engineered wood products to support export growth into high-value niche markets.
- Develop options to improve returns to growers and processors for low/industrial grade logs.
- Increase exports of wood products, based on Douglas-fir, eucalypts, cypresses and indigenous timbers into high-value niche applications.
- Increase the application of wood and wood-based products in building solutions to deliver greater economic, social and environmental outcomes.

Alignment to the National Science Challenge Better buildings, towns and cities – building systems, including sustainable wood and fibre-based systems and integrated energy and waste management.

Impact KPI-4

Facilitate new seed-to-market value chains for specialty wood products

By 2020, Scion and its partners will have provided tools, new product options and plant material that will have supported the aspirations of growers and manufacturers to invest in new manufacturing facilities and expand plantings of Douglas-fir, eucalypts, cypresses and indigenous species. This investment will reflect increased confidence in being able to secure the highest possible value for their products along the entire seed-to-market value chain.

Leading indicators of this are:

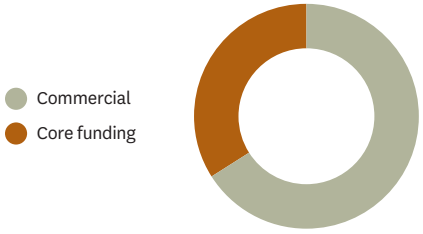
- By 2017, Scion will partner to identify and initiate the sustainable development of indigenous species that includes economic outcomes. Focus will be on partnerships with tangata whenua in the Northland, East Coast/Hawke's Bay, Bay of Plenty and central North Island regions.
- By 2017, Scion and iwi, tangata whenua and other partners will have identified the current and future economic opportunity for using some indigenous species, and have external investment supporting realisation of the commercial opportunity associated with those species. Particular focus will be given to support the economic and social development of Northland, East Coast/Hawkes Bay and central North Island.
- By 2017, Scion's technical outcomes will be used in the development of at least one market ready product from Douglas-fir or a eucalypt. This product will have international market potential.
- By 2018, Scion will have demonstrated to pre-commercial stage the potential to first, extract chemicals and second, formulate valuable compounds using a whole of tree approach for three species.
- By 2019, Scion will have provided tools, new plant material (e.g. germplasm) and competitive niche wood products that will increase the confidence of growers of Douglas-fir, eucalypts, cypresses, redwoods and indigenous species to increase plantings of these species.
- By 2019, solutions for novel pre drying/drying for three difficult-to-dry species have been identified then trialled at full-dimension material scale to produce dry, check/collapse-free full-size timber. Processing costs have been estimated. The information is being used by a partner company to establish the commercial feasibility of this new approach to drying.

Our key partners in delivery are: the New Zealand Forest Owners Association, New Zealand Farm Forestry Association, Māori operating through their forestry and land holding entities, Tane's Tree Trust, the Northern Totara Working Group, local and regional authorities and their economic development agencies, Ministry for

Primary Industries, Department of Conservation, Landcare Research, JNL, Southwood, Wood Engineering Technologies Ltd and the University of Canterbury.

Technology transfer: Scion will work in partnership with the key stakeholders including tangata whenua, regional councils and forestry and wood manufacturing companies to build business cases and exemplars to assist all parties make research-informed decisions as to how to best implement the findings from the programme within their businesses and operating context. Other key tools that will be used include Forest Investment Finder and tree growth calculators such as that for kauri.

Investment



Commercial $0.7, Core funding $0.3. Total $1.0 (millions).

Impact KPI-**5**

Expand opportunities for wood products and building systems

By 2020, Scion will have supported wood processing and manufacturing companies by delivering new value enhancing tools and technologies that assist them to meet their growth targets and encourage increased investment in wood-based manufacturing and more productive timber based construction techniques in New Zealand.

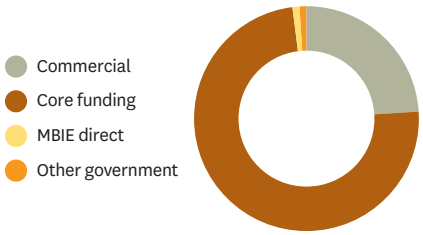
Leading indicators are:

- By 2017, Scion will have demonstrated to external investors proof of concept to enable at least one new modified wood product to compete in high-margin market segments.
- By 2018, Scion will have produced thermally modified wood samples from at least three species, large enough for market place testing. Durability, stability and structural performance have been assessed and a commercial feasibility explored. The information is being used by an investor company to establish the commercial feasibility of the modified wood process.
- By 2019, Woodscape has been upgraded to reflect both new products and new knowledge developed for current technologies. Assessments have been made to the business case stage, and for the development of a new or substantially enhanced wood manufacturing operation.
- By 2019, Scion will have progressed a novel wood modification that incorporates some of the key attributes identified in the business cases to a pre-commercial stage.
- By 2020, Scion, with *Better buildings, towns and cities* (National Science Challenge 11) science and industry partners, will have developed a platform to provide better performing, higher amenity built environments in terms of affordability, performance and sustainability. This platform addresses the wider impacts of intensive living on the urban environment.

Our key partners in delivery are: Wood Processors and Manufacturers Association of New Zealand and their members and affiliated groups, Standards New Zealand (MBIE), Ministry for Primary Industries, Windsor Engineering Ltd, Abodo, Furniture Association of New Zealand, Universities of Wurzburg, Gottingen and EU COST Actions. Callaghan Innovation, WEL Limited, Ministry of Business, Innovation and Employment (Building and Housing), Auckland University of Technology and *Better buildings, towns and cities* partners, BRANZ, Australian Tall Timber Buildings Hub.

Technology transfer: Scion will work in partnership with the key stakeholders in co-developing project plans and implementation strategies. In product development, Scion will develop exemplars including piloting of processes and products with industry partners and investors.

Investment



Commercial $1.0, Core funding $3.0, MBIE direct $0.05, Other goverment $0.05. Total $4.0 (millions).

Alignment to National Science Challenges: $200,000 of Core funding aligned to *Better buildings, towns and cities*.

IO3

Expand opportunities in the wood fibre, pulp, biopolymer, packaging and biochemical industries and from their biomass side streams

By 2026, Scion has supported existing and new industries to establish new bio-based manufacturing capacity for export and domestic markets worth at least $1 billion per annum more than 2011 values.

We will support the New Zealand wood and biomass processing and manufacturing industries and those with aspirations to build new enterprises and new value chains that:

- Enable the New Zealand packaging industry to continue to grow through providing world leading packaging systems in the face of increasing regulatory, performance and consumer pressures on both the packaging and the produce they contain. (This also supports the important food exporting industries in New Zealand.)
- Increase the value of co-products in wood, fibre and other biomass manufacturing operations (such as residues) to expand their product offerings, build new manufacturing enterprises and improve competitiveness of established industries.
- Support the He Kai Kei Aku Ringa Economic Strategy to increase value to Māori from new bio-based manufacturing opportunities.
- Give effect to the WPMA 2050 vision.
- Create new product options based on biomaterials to underpin the development of emerging or new materials-based manufacturing industries in New Zealand (such as biorefineries and 3D printing).
- Enable New Zealand to capture value from the emerging global market for biobased, renewable and high performance products by establishing global partnerships along new and existing value chains (bioeconomy).
- Develop environmental technologies to support a circular economy, bioprocessing technologies and utilisation of waste streams.
- Work with government, industry and universities to develop a viable roadmap for a New Zealand biobased (and ultimately circular) economy.
- Support development of new manufacturing feedstocks, processes and products and implement their commercialisation in alignment with National Science Challenge *Science for technological innovation*.

Alignment to the National Science Challenge *Science for technological innovation* – design, materials and manufacturing theme: lignin, bioplastics and fibre products.

Impact KPI-6

Develop new industrial bioproducts for existing and emerging manufacturing industries in New Zealand

By 2019, new capital investment will be occurring in new and existing manufacturing industries in New Zealand as Scion's developments in new high-value and performance focused products derived from forest materials and biomass side streams are being adopted.

Leading indicators are:

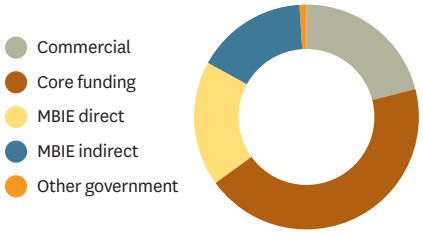
- By 2017, Scion will have identified two potential biochemical opportunities from hydrothermal processing of biomass.
- By 2017, Scion will have assisted at least three commercial packaging companies to examine the box performance and lifetime of their products using Scion's WHITE room.
- By 2017, Scion will have completed design and feasibility of a low cost easily deployed toilet for remote communities and aid activities.
- By 2018, Scion will have aligned a cluster of organisations (including industry, government and research organisations) to pursue an integrated biorefinery concept (combining bioenergy and bioproducts) and together have developed a joint roadmap.
- By 2018, a patented technology has been produced at industrial scale and partners have been found for commercial uptake.
- By 2018, at least six new polymeric material products with renewable content have been developed to prototype stage using existing (e.g. extrusion, injection moulding) and emerging technologies (e.g. 3D-printing or electrospinning).

- By 2018, a viable short rotation product specific bio-forestry model that significantly improves the economics of growing forests for fibre or chemicals has been developed in partnership with industry.
- By 2019, at least two of these polymeric material prototypes are incorporated in new product offerings by firms.
- By 2019, Scion will have assisted a commercial packaging company to develop boxes with improved performance in coolstores.
- By 2019, new high performance products (packaging, composites and new compounded materials containing biopolymers) developed by Scion in collaboration with commercial partners are supporting the development of new industries in New Zealand and providing direct revenue to New Zealand.
- By 2019, two lines of biotech trees will be harvested and processed to determine their viability as alternative biorefinery feedstock (production of high value chemicals and/or processability for fibre or bioenergy). The investment case will have been presented to potential commercialising parties. (Note: This objective also contributes to Impact KPI 7 – bioenergy.)
- By 2019, Scion will have developed processes to produce unique natural fibres that when used in Scion-developed packaging and wood composite applications show improved product performance over 2014 materials.
- By 2020, Scion and commercial partner(s) have developed a viable and New Zealand-specific biorefinery business case based on Scion-developed high value bioproducts and cost efficient technology platforms for commodity fibres and bioenergy.

Our key partners in delivery are: the Wood Processors and Manufacturers Association of New Zealand and their members and their affiliated groups, Biopolymer Network Ltd, Packaging Council of New Zealand, Alto, ExtrusionCo, Sonae Industria Ltd, Clariant New Zealand Ltd, ZESPRI Ltd, Altex, VITO, VTT, Fraunhofer, Momentive/ Hexion, Lawter, Norske Skog, PlasticsNZ, Lignotech, Oji, CHH Packaging, NZ Food Safety Centre, Innventia, Revolution Fibre Ltd, ArcActive, Fulton Hogan, Finewood, Lignotech, EU COST Actions, OpenBio, WNT Ventures Ltd, Terax 2013 Limited, Gates Foundation, Callaghan Innovation, Plant and Food Research, AgResearch and the Universities of Waikato, AUT, Canterbury, Auckland, Victoria and Massey.

Technology transfer: Scion has established close collaboration with several companies working within domestic and international markets to ensure market pull for all new products. This includes extensive international collaborations (both with industry and other research partners) to enable the global commercialisation of products and technologies developed. In product development, Scion will provide exemplars including piloting of processes and products in conjunction with industry.

Investment



Commercial $2.8, Core funding $5.9, MBIE direct $2.5, MBIE indirect $2.3, Other government $0.1. Total $13.6 (millions).

Alignment to National Science Challenges: $400,000 of Core funding aligned to *Science for technological innovation*.

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Increase New Zealand's energy security through the use of forest and waste biomass for bioenergy

By 2026, bioenergy's contribution to New Zealand's primary energy supply has increased to 9% (an increase of 24PJ over 2010 values), including 350 million litres of liquid biofuels.

In addition to the strategies described above, this outcome also aligns to the New Zealand Government Energy Strategy (www.med.govt.nz/energy-strategy) and the Bioenergy Association of New Zealand aspiration to supply more than 25% of New Zealand's energy needs and 30% of the country's transport fuels from processing wood-crops and converting organic by-products to energy by 2040 (www.banz.org.nz).

We will support:

- New Zealand industry, in particular wood fibre manufacturing operations, as they seek to increase use of bioenergy to 30% by 2022 equating to 270MW of new thermal bioenergy and 30MW of new electricity.
- New Zealand wood processors to develop 'drop-in' liquid biofuels and bioenergy products for industrial applications to enhance their product offerings and increase the value extracted from processing residues.
- Forest and land owners to explore options for using forests as an energy product or co-product.
- Energy companies as they work to increase the renewable content of their energy products.
- The development of industries working in a symbiotic way to develop mixes of products (including energy) and optimise use of other energy resources (e.g. geothermal energy and waste (now commonly termed biomass side streams)) to create lowest embodied energy use per unit product and greatest individual and collective value. This will directly support regional growth.
- The use of foresight and scenario planning tools to support the design of policies and practices that will increase the adoption of renewable energy technologies in New Zealand in order to meet greenhouse gas reduction, air quality and other environmental targets.

Impact KPI-7

Accelerate the use of bioenergy and liquid biofuels in New Zealand

By 2019, Scion will have identified the key barriers towards more widespread use of biomass for heat and the production of transport fuels and proposed solutions.

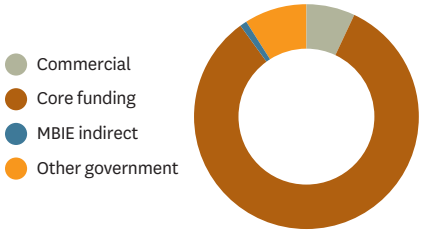
Leading indicators are:

- By December 2016, Scion will have developed an interim biofuels roadmap for consultation and stakeholder engagement.
- By 2017, Scion will have explored the potential for iwi to be involved in biomass derived energy options.
- By 2017, Scion will have assisted one company to re-evaluate its strategy towards bioenergy/biofuels implementation, and will have provided technical support towards the development of a commercial project.
- By 2017, Scion will have supported one biomass side stream-to-bioenergy commercial opportunity in New Zealand.
- By 2018, Scion will have supported a group of firms in one region to develop a value proposition, based on industrial symbiosis using wood energy, outlining the benefits/risks across economic, social and environmental criteria, enabling them to make an informed decision for action.
- By 2019, Scion will have identified, and reached national alignment, around the Implementation Roadmap for Biofuels in New Zealand. Technology barriers, acceleration options and policy interventions will be identified.
- By 2020, Scion and commercial partner(s) will have developed a viable and New Zealand specific biorefinery business case based on Scion's high value bioproducts and commodity (fibres and bioenergy) platforms

Our key partners in delivery are: the Wood Processors and Manufacturers Association of New Zealand, fuel distributors and their members and affiliated groups, including Oji Fibre Solutions, Norske Skog, regional councils, Industrial Symbiosis Kawerau, EECA, Z Energy, NZ Refining, KiwiRail, Air NZ, Bay of Connections, Advanced Biofuels Research Network, GNS, National Renewable Energy Laboratory, KIER and the Universities of Waikato, Canterbury, Auckland, Otago and Massey.

Technology transfer: Scion will continue to work in formal partnerships (e.g. Industrial Symbiosis Kawerau, Bay of Connections Energy group) to ensure approaches and methodologies employed are aligned to the needs of firms and their regions, including iwi, and implementation is maximised.

Investment



Commercial $0.2, Core funding $2.3, MBIE indirect $0.03, Other government $0.24. Total $2.77 (millions).

IO5

Protect and enhance market access and improve risk management in the forest industry including forest health and preparedness for biosecurity incursions, fire and climate change

By 2026, ensure forest growing and wood product companies can meet their export revenue targets and increase their forest value by minimising risks associated with pests (insects, pathogens, weeds) that are either established biosecurity incursions, or that present market access issues, and climatic factors such as fire and wind and the frequency of extreme events.

We will support the New Zealand forestry industry, Ministry for Primary Industries, Ministry for the Environment, Department of Conservation, land owners, rural authorities, regional councils, Māori, rural fire authorities and other key stakeholders to:

- Reduce the likelihood of new pest incursions and improve our readiness for, and the effectiveness of, pest eradication programmes.
- Reduce the impact of established pests, weeds and wildings.
- Reduce impacts of rural fire on forests, communities and infrastructure through risk reduction, readiness, response and recovery approaches.
- Improve resilience to climate change and extreme weather events including wind.
- Sustain nationally important technical capability in biosecurity and fire, and nationally significant collections relating to forest plants, insects and fungi.
- Reduce risk of trade restrictions to our forest produce markets due to biosecurity concerns.
- Develop strategies to minimise the impact of diseases on amenity and culturally significant species.

Alignment to the National Science Challenges:

- *New Zealand's biological heritage* – protecting our primary sectors and natural ecosystems by reducing the potential for pest establishment and increasing New Zealand's ability to overcome biosecurity issues.
- *Resilience to nature's challenges* – improving New Zealand's ability to reduce the impact of fire and of wind.

Impact KPI-8

Ensure New Zealand forests are resilient to current and future natural threats

By 2021, new tools and technologies will have been developed to quantify and mitigate impacts from the increasing risk to New Zealand's forests from pests, fire and wind, and climate change, and will have been adopted by forest industries, land owners, and central and regional government.

Leading indicators are:

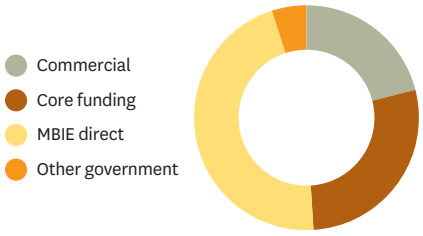
- By 2017, there will be examples for policy makers and forest growers using Scion's knowledge of climate change impacts and resultant implications that provide guidance in managing risk and adapting to impacts of climate change.
- By 2017, a strategy has been developed with the NSC *Resilience to nature's challenges*, MBIE and rural fire stakeholders to secure ongoing funding for the Rural Fire Research programme to remain viable.
- By 2018, the Ministry for Primary Industries has adopted a validated helicopter spot spraying protocol for pest eradication.
- By 2018, Rural Fire Authorities have adopted activity restriction triggers for high fire risk activities and implemented these within their strategic fire management plans.
- By 2018, Scion will have supported the forest industry's licence to operate as FSC certified through research that underpins minimisation of pesticide use in forests, including development of improved tools for managing spread of conifers beyond the forest boundary.
- By 2018, options to reduce the impact of Phytophthora on radiata pine, kauri and one horticultural species have been identified.
- By 2018, Scion will have developed new molecular tools, and field tested at least one, to enable early identification resulting in more timely and appropriate response to unwanted forest pests or pathogens.

- By 2018, Scion will have developed a dynamic decision support tool that enables rapid screening of potential pest species to improve industry and MPI's readiness to respond to future unknown incursions.
- By 2019, Scion will have identified radiata pine germplasm with improved drought resistance.
- By 2019, research pathways towards the development and implementation of low spread or sterile genotypes of Douglas fir have been identified and alternative mechanisms to reduce seed production from existing Douglas fir stands have been trialled.
- By 2019, new tools have been used for pest detection or targeted spraying in at least one pest eradication or pest management operation.
- On-going: The National Forest Herbarium and the Forest Health Collections and Databases remain viable and provide valuable information on the national forestry position for New Zealand.

Our key partners in delivery are: the forestry industry operating through the Forest Growers Levy Trust Board Inc., forestry companies, the New Zealand Forest Owners Association (FOA), New Zealand Farm Forestry Association, regional and local councils, Māori groups, land owners, Ministry for Primary Industries, Department of Conservation, Ministry for the Environment, Ministry of Foreign Affairs and Trade, Stakeholders in Methyl Bromide Reduction (STIMBR), port authorities, wood processors, New Zealand Fire Service Commission, New Zealand Defence Force, New Zealand Rural Fire Authorities, Rural Fire Research Advisory Committee (RFRAC), AgResearch, Landcare Research, Plant and Food Research, University of Canterbury and Lincoln BioProtection Centre.

Technology transfer will be achieved through Scion's close working relationship with the above associations, government entities and industries. Scion will continue as part of the above teams (e.g. RFRAC, FOA) to jointly develop the annual work plans and ensure effective implementation.

Investment



Commercial $2.3, Core funding $3.1, MBIE direct $5.0, Other government $0.5. Total $10.9 (millions).

Databases and Collections: National Forest Herbarium and National Forest Health Collections and Database are supported to the value of $835,000 of which $335,000 is from Core funding.

Alignment to National Science Challenges: $130,000 of Core funding aligned to *Resilience to nature's challenges* and $699,699 to *New Zealand's biological heritage*.

IO6

Ensure the forest industry and bioeconomy businesses' licence to operate

Scion, through the provision of tools, technologies and regulatory compliance frameworks (such as standards and traceability) and the use of citizen science and foresight will support the New Zealand forest industry and firms in the bioeconomy sector in addressing freedom to operate issues (both social and technical) and thereby ensure access to domestic and international markets.

Impact KPI-9
Sustain New Zealand forest industry and bioproduct manufacturers' licence to operate

This is an underpinning domain of science with broad impact across the forestry, forest products and industrial bioproducts sectors. Its purpose is to understand the factors influencing (and likely to influence) community and key stakeholders' perception and acceptance of technologies and practices in the sectors Scion works with. Current examples include genetic modification and new breeding technologies, drones, steepland harvesting and use of chemicals (e.g. herbicides for forest weed control, methyl bromide for log fumigation, CCA wood preservatives). This is supported by associated development of technology (such as for product traceability in supply chains) and up-to-date standards which incorporate new innovations (e.g. engineered wood products, bioadhesives, natural wood preservatives, bioproduct authenticity) and account for different market needs. To ensure that effective progress is made against this Intermediate Outcome, the following Impact KPI essentially summarises the activities that will be undertaken. Progress against these objectives will be reported as a narrative.

Dimensions of 'licence to operate' science include industry and firm reputation; the changing nature of work (machine learning, robots); workers' safety and capabilities, verifiable environmental performance, product traceability and modern standards; and anticipating long-term change.

By 2019, Scion has supported the industry to enhance its social licence to operate.

Leading indicators are:

Human factors; health and safety and workforce development

- By 2017, Scion will have tested new approaches with FISC and forest industry stakeholders to improve Health and Safety practice and performance.
- By 2020, Scion will have implemented a Learning Review process with key agencies (FISC) specifically designed to develop an understanding of human action(s) in context in order to facilitate the development of a learning culture and to improve organisational and individual resilience in high risk environments (harvesting).

Social acceptance of new technologies and industry practices

- By December 2016, the benefits and risks of genetic modification research will have been quantified and presented to the forest industry, government and other key stakeholders for an informed decision on its future.
- By 2019, Scion and its research partners will have supported the implementation of the National Environmental Standard for plantation forestry.
- On-going: Increase engagement and financial support from stakeholders in evaluating the benefits and risk of biotech for forestry and associated industries.

Fit-for-purpose standards

- On-going: Support wood products and bioproducts industries to grow and develop by addressing standards that create artificial barriers to products accessing markets or applications.
- On-going: Support the New Zealand export industry by developing new options for bioproducts such as packaging to enhance acceptance of New Zealand products in international markets.

Product traceability and verification

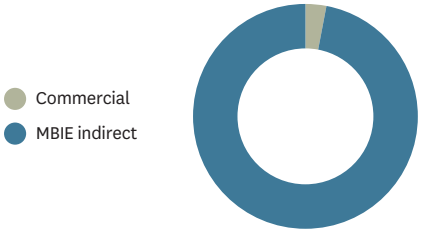
- On-going: Development of technologies and IT systems that allow wood, wood fibre, packaging and industrial bioproducts to be traced within the value chains they are transacted in and for their source to be verified.
- On-going: Support industry to meet environmental compliance for regulators and customers.

Our key partners in delivery are: the forest industry operating through the Forest Growers Levy Trust Board Inc., the New Zealand Forest Owners Association (FOA),

special stakeholder focus groups such as Stakeholders In Methyl Bromide Reduction (STIMBR), Ministry for Primary Industries, Ministry of Foreign Affairs and Trade, port authorities, Wood Processors and Manufacturers Association of New Zealand, ESR, Forest and Wood Products Australia, Forest Industry Safety Council (FISC), Worksafe ACC, Plant and Food Research, NZ Centre for Food Safety, food manufacturers, industrial bioproducts manufacturers, EU and ISO Standards bodies, and Biopolymer Network Ltd.

Technology transfer will be achieved through the close working relationship that Scion has with the above associations, government entities and industries. Scion will continue as part of the above teams (e.g. STIMBR, FOA, WPMA, New Zealand Packaging Council) to jointly develop the annual work plans and ensure effective implementation.

Investment



Commercial $0.02, MBIE direct $0.61. Total $0.63 (millions).

6 Scion's supporting strategy

In this section, other elements of Scion's strategy (Figure 12, page 22) that support the achievement of SCI targets are presented.

Develop a customer-focussed and high-performance culture

Scion's "People, Performance and Culture (PPC) Plan 2016-2021"[56] outlines the people and cultural requirements necessary for Scion to achieve its Statement of Core Purpose. Each year, objectives are set to achieve the following outcomes:

- Build a high performance culture aligned to Scion's values.
- Develop organisational leadership and succession depth; and 'fit for purpose' workforce capability through planning and tailored learning and development programmes.
- Attract, recruit and retain top talent.
- Ensure a zero-harm, safe workplace and compliance and in particular with the Health and Safety at Work Act 2015 (effective from 4 April 2016), Hazardous Substances and New Organisms Act (HSNO) 1995.
- Develop Scion's tikanga and capacity to engage effectively with Māori, increase collaborations with the Māori research community, increase outreach into the wider Māori community and with key stakeholder agencies such as Te Puni Kokiri, Ministry for Primary Industries and Ministry of Business, Innovation and Employment.
- Align remuneration and reward to the achievement of the Key Performance Indicators.
- Implement systems and administration support to achieve organisational efficiency and consistency in people management.

Over the SCI planning period, Scion intends to:

1. Fully embed a health and safety culture and ensure Scion is at best practice with respect to health and safety.
2. Build depth in leadership succession and organisational resilience, particularly at Level 4 (e.g. research leaders), through a development programme tailored for Scion's Future Leaders cohort.
3. Undertake more intensive workforce planning using tools adapted from the pan-CRI HR Managers' group to ensure Scion has the capabilities it requires for the future and that this takes into account capabilities held by other CRIs and coordinated through the National Science Challenges.
4. Invest in staff secondments into firms that are customers and/or partners of Scion and support exchange placements of Scion staff with international partners established through L&G5.
5. Increase the number of short-term visitors and sabbaticals to host international experts in fields of high importance to Scion's success; and grow the number of post-graduate students working on Scion initiated topics through its collaborations with New Zealand tertiary institutes.

Grow organisational productivity through smart processes and systems

A comprehensive plan is in place to enhance Scion's facilities, information technology (IT) systems and equipment as follows:

Facilities: A 10-year infrastructure development plan, comprehensively reviewed and updated in 2012, is designed to bring laboratory, office facilities and IT up to the standards required for a twenty-first century research organisation, addressing deferred maintenance and building new plant and equipment to enhance the uptake of Scion's technologies. This plan was further enhanced in 2015 by completing a building master plan to ensure Scion's buildings will be fully optimised in the future. Key considerations included bringing staff closer together and improving our ability to interact effectively with industry and the public. In short, the delivery of the plan will support the creation of an effective innovation ecosystem. This process will involve the modernisation and refurbishment of laboratory, office facilities and infrastructure and development of containment facilities consistent with the Environmental Protection Authority specifications to support extension of biological material development and enhancement while also bringing tenants closer and inviting the public to see both science in action and our industry offerings.

Over the SCI planning period Scion plans to:

1. Undertake a major rebuild/refurbishment of an innovation hub including facilities showcasing science and our industry, a timber engineering laboratory and associated pilot scale facilities and forest protection laboratories (estimated CAPEX is $16m). (see page 25 and Figure 15).
2. Complete office refurbishments to improve space utilisation and reduce Scion's environmental footprint (e.g. greenhouse emissions and water).
3. Ensure all facilities and laboratories continue to comply with health and safety 'best practice' requirements.

Systems: IT-based financial and human resource management systems, application of IT systems to improve data management and local, national and international collaboration are critical to Scion's future success. Scion works closely with other CRIs to adapt best ideas and ensure IT systems are 'fit for purpose', are affordable over the long-term, are secure and take account of the very rapid innovation occurring in this sector.

Over the SCI planning period Scion intends to:

1. Develop capabilities and infrastructure to enable exploitation of 'big data' and improve access and reuse of data held by Scion (L&G8).
2. Enhance technology and knowledge transfer through effective information management, web delivery technologies and science data management planning. This supports Scion's

[56] The Remuneration & Organisation Committee of the Scion Board oversees the development and implementation of this Plan.

strategy to grow productivity through smart processes and systems (L&G2).
3. Upgrade cyber security and Scion's IT system's resilience.
4. Provide collaboration tools (such as enhanced video conferencing and SharePoint) to enable Scion to foster national and international science collaborations.
5. Increase pan-sector or pan-CRI collaboration or shared services opportunities in areas where there is a clear scientific or commercial advantage for Scion.

INFORMATION SYSTEMS PLAN ALIGNMENT

FINDINGS	CONCLUSIONS	WORK PROGRAMME
CORE PURPOSE PRINCIPLES Data management and re-use Technology and knowledge transfer to end-users	Continue to support organisational process improvement via the Scion Way	**INFORMATION MANAGEMENT** 1. L&G8 Research data repository development 2. SharePoint - document and records management, workflow and reporting 3. Integrated data architecture 4. SIDNEY re-development
ENVIRONMENTAL SCAN Digital transformation Government ICT strategy and action plan Impacts of nexus of forces – social, mobile, cloud and data Cyber security risk eResearch 2020 - National Research Data Programme	Opportunities to transform capability and services through cloud adoption	**APPLICATIONS AND REPORTING** 1. Enhancements to purchasing, chemical and equipment management 2. Organisational planning and reporting system 3. Opportunity and proposal management 4. Service management system 5. Sample management system
CUSTOMER FOCUSSED AND HIGH PERFORMING Health and safety focus Values and brand Customer centric	Support for external interactions and collaborations	
STRATEGIC FRAMEWORK - PRIORITIES FOR 2016 Value chain optimisation Accelerated commercialisation International partnerships Site master plan Partnerships with Māori	New skills and tools to support data intensive and data driven science ('big data')	**COMMUNICATION AND COLLABORATION** 1. Messaging, presence, desktop VC, voice with external sharing 2. Project team spaces 3. Technologies for the modern workplace
SCIENCE PROGRAMMES Data intensive programmes: GCFF, HTHF, forest genetics, VCO Growth in new lab facilities and remote sensor generated data (e.g. disk scanner and UAV outputs)	Leverage existing investment in systems to support process improvements and efficiency gains	
SCION WAY PROGRAMME (L&G2) Projects, reporting, opportunities and proposals		**INFRASTRUCTURE** 1. Cyber security improvement programme 2. Business continuity and disaster recovery 3. Leveraging cloud based services (communications, storage and processing)
SCIENCE BIG DATA (L&G8) Advanced science data management and data analytics Integrating Phenotypic Datasets	Support customer centric solutions in new workspaces	

Figure 23: *Scion's IT plan is aligned to achieve Core Purpose Outcomes and SCI targets.*

Scion's commercial-scale box room facility.

Science equipment and pilot plant and scale-up facilities

Scion's plan is to purchase equipment that enables core science to be undertaken efficiently and to a high standard; and, in niche areas, to provide competitive advantage (e.g. testing equipment for industrial product development, remote sensing technology for forest mensuration and surveillance; and nursery technologies). This is complemented by a plan to install pilot scale infrastructure to support market assessment and de-risk commercialisation of technologies arising from Scion's programmes. A recent example is Scion's commercial-scale box room test facility, or WHITE room, which is unique to New Zealand and integral to the expansion of the packaging research programme. Where applicable, Scion will be seeking industry co-investment in the plant as part of its plan to support the scale-up of technologies for industry adoption.

Over the SCI planning period Scion plans to:

1. Continue its programme to develop pilot plant infrastructure to scale-up and de-risk the commercialisation of Scion (and partners') technologies. (Much of this work will be integrated with the refurbishment of the timber engineering laboratory and innovation hub development.)
2. Purchase equipment and systems that improve storage of science materials; the identification and tracking of samples; support the pilot scale evaluation of industrial bioproducts and support the effective application of remote sensing technologies by forest managers.

Final allocation of CAPEX and re-investment of surpluses is subject to Board approval of the final business cases for each initiative.

Improve knowledge and technology translation[57]

Technology translation at Scion occurs through a wide range of channels and mechanisms including secondments of staff into firms (and vice versa); workshops, hui and development of training material; hosting visitors to Scion and visits to companies; Scion's website, multi-media tools, media releases, trade articles, Scion's newsletter *Scion Connections*; and software decision support tools.

To further improve technology translation, Scion plans to:

1. Work with sector 'change' champions and adapt 'best practice' from other industries, such as the dairy industry and international thought leaders such as VTT (L&G5).
2. Apply techno-economic models to ensure all technologies optimally align with user needs and enable 'best packaging' of technology for end-users.

[57] The term 'technology translation' (rather than transfer) explicitly acknowledges the importance of user engagement in the process of introducing new knowledge, technologies and practices that enable change in individuals, communities or industries.

3. Upgrade Scion's website and extend circulation of *Scion Connections* newsletter; put more tangible products in the hands' of our customers and customise communication channels within Māoridom. This work is being informed by the refresh of Scion's marketing and communication plans in 2015.
4. Use its 'big data' Learning and Growth (L&G) initiative (L&G8) to improve the sharing, analysis and interpretation of very large data sets.

Collaborations to form best research teams

Scion collaborates extensively nationally and internationally to form the best possible teams to deliver its science and innovation outcomes. Scion has established a wide array of relationships and collaborations with universities, CRIs and international research entities. Examples are shown in Table 4. Of particular significance over the planning period will be the formation of a host of new relationships through the National Science Challenges.

EXAMPLES OF SCION PARTNERSHIPS DOMESTICALLY AND INTERNATIONALLY

RELATIONSHIP	PARTIES INVOLVED	FOCUS AREAS
Product Accelerator	Universities of Auckland, AUT, Massey, Victoria and Waikato; GNS, Scion, MBIE	Technology support for NZ companies in a national 'NZ-Inc' approach
IUFRO	MPI; leading forest research organisations	Forest genetics; biosecurity and management
Sustainable Land Use Alliance (SLUA)	AgResearch, Plant & Food Research (PFR), Landcare Research; Scion	Sustainable management of soils and land
Better Border Biosecurity (B3)	AgResearch, PFR, Landcare Research; Scion, MBIE	Primary industry pre- and post-border biosecurity
Bioresource Processing Alliance (BPA)	AgResearch, Callaghan Innovation, PFR, Scion, universities, MBIE	Bioprocessing technology for new products, process efficiency gains, and waste re-use and reduction
Canterbury University	School of Forestry, other faculty	Forest biosecurity, silviculture, mechatronics
Waikato University	Bay of Plenty Tertiary partnership	Postgraduate programmes, executive education
Massey University	School of Design, College of Science	Industrial design and packaging technologies (including with new materials)
VTT (Finland)	VTT (Australia)	Forest industry and new bioeconomy science and technology solutions
Fraunhofer Institute (Germany)	IGB, UMSICHT, ICT	Bioeconomy
VITO (Belgium)	Scion, advanced manufacturing firms	Global sustainability challenges through adaption and co-invention of technology (lignin, UAVs)
Korean Institute for Bioenergy Research (KIER)		Thermochemical technologies for wood-to-biofuels
Cluster CLIB2021	>500 companies/institutes in Europe	Bioeconomy, industrial biotechnology, green chemistry

Table 4: *Examples of Scion partnerships domestically and internationally.*

Scion plans to:

1. Work closely with the teams in the NSCs and ensure these function efficiently, are well-supported by project management tools and reporting systems (i.e. the Scion Way) and challenge milestones are met on schedule.
2. Continue to nurture the alliances and relationships shown in Table 4, while seeking ways to improve their operational efficiency.
3. Support the growth of the entities in which it is a shareholder such as Biopolymer Network Ltd[58] (Scion owns one third of the shareholding), which has an exciting pipeline of technologies coming through to market realisation, including Zealafoam™ a light weight, compostable product for fresh food packaging.
4. Develop its international network (as described earlier) through the L&G5 reinvestment initiative. Agencies with world leading capability and technologies that are synergistic

[58] See http://www.biopolymernetwork.com for background about the company and its bio-based solutions.

SCION'S DATABASES AND COLLECTIONS OF NATIONAL SIGNIFICANCE

DATABASE/COLLECTION	DESCRIPTION
National Forest Culture Collection	An internationally registered living collection of almost 5,000 fungal specimens (including a few bacteria and lichens) stored in culture. The collection supports diagnostic services and a broad range of fundamental and operational pathology research. Over 150 specimens a year are lent to New Zealand and overseas researchers. The collection includes some pathogenic fungi from overseas, which are stored in a containment facility.
National Forest Herbarium and Database	This nationally significant database and collection specialises in plants significant to plantation and indigenous forestry in New Zealand and includes a wide range of native and amenity species. This is the only database and collection held by Scion that was supported by the Research Infrastructure (Backbone) Investment Fund.
National Forest Insect Collection	An internationally registered collection of forest insects from New Zealand and overseas containing about 150,000 specimens dating back to 1948. The collection supports diagnostic services for FOA and MPI, along with fundamental taxonomic research carried out at Scion and other organisations.
National Forest Mycological Herbarium	An internationally registered collection of almost 5,000 dried fungal specimens and plant material containing fungi. The earliest collections date back to late 1800s from Sweden. This collection serves the same purpose as the culture collection.
National Forestry Library	The National Forestry Library contains publications, in a variety of formats, relating to forestry and wood processing research over the last 75 years. It represents the collected published heritage of forestry and related industries in New Zealand.
National Wood Performance Archive	Over 60 years of records of wood durability and performance across four sites in New Zealand, including the 'Graveyard' on Scion's campus. The archive is the reference for standard and building code development, evaluation of wood products developed in New Zealand and overseas and establishment of durability classification for timber grown in New Zealand and overseas.
Permanent Sample Plot Database	An internationally unique database of sites that are used to measure growth and development of plantation forest trees across New Zealand.
Tree Genetic Archive	A living collection of genotypes across a range of indigenous and exotic species for the purposes of gene conservation, archival history and germplasm resources.
Wood Fibre Refining Facility	This is a small-scale industrial facility capable of processing wood to produce fibre and pulp. It is used extensively to test operational scenarios for New Zealand's pulp and fibre production companies. It is the largest such test operation in the Southern Hemisphere.

Table 5: *Scion's databases and collections of national significance.*

and complementary to Scion, such as VTT (Finland), VITO (Belgium), Fraunhofer (Germany), the Japanese Forest Research and Products Institute (JFFPRI), Forest Products Innovation (Canada) and Australian companies involved in the forest industry will be a priority in this endeavour.

Improve accessibility to Scion's databases and collections

Scion has stewardship of the resources of national significance listed in Table 5.

These collections, databases and research assets will continue to be maintained to a high standard (as finances allow) enabling public access and re-use of the data. The annual cost of sustaining databases and collections is circa $1.3 million per annum, with $500,000 of this provided through core funding. Where appropriate and robust cyber security can be applied, improve public access to and reuse of forestry data generated and/or held by Scion will be provided. Enhancing the integration of various sets through 'big data' methods and analytics (L&G8) – such as the Permanent Sample Plot (PSP) and science (e.g. genetics, wood quality) databases – in order to provide more value to forest growers and generate a services income stream to sustain these data sets is the near-term priority.

Pan-CRI shared services

Scion participates in several pan-CRI initiatives intended to improve effectiveness of delivery on our core purpose and greater efficiency with consequent cost savings. Joint action, as well as benchmarking and implementation of best practice across participants, are key elements.

The pan-CRI procurement forum complements the all-of-government procurement reforms through which Scion is accessing IT, vehicle, energy and other savings. Scion also participates in the pan-CRI insurance collective.

Through the 'umbrella' coordination of Science NZ, all CRIs have adopted the Snaphire software system as their standard tool for recruitment. Other outcomes from the CRI human resources group include consistency in career progression opportunities, job band descriptors and capability planning tools. Pan-CRI benchmarking and sharing best practice in health and safety, inaugurated in autumn 2015, is providing valuable insights on where gains can be made by individual CRIs.

7 Financial performance and reinvestment

1. Financial projections and performance

Scion's updated financial projections through to June 2021 are summarised in Table 6. Financial performance indicators are included in Table 7. Associated consolidated cash flow and balance sheet details are presented in Tables 9 and 10.

Scion is budgeting to grow revenues by 1.9% in 2016/17 to $50.032 million and achieve an Operating Profit (EBIT) of $2.054 million (Table 6). This represents a 7.1% return on equity (RoE) before reinvestment. Reinvestment of $1.465 million will generate a tailored RoE of 4.3% (Table 8). Future revenues are projected to increase at 2.4% to 3% annually. Risks to achieving these financial targets are the ongoing fiscal constraints on government expenditure, increased contestability for science funding, the transition to Science Strategic Investment Funding (the replacement for core funding) and the possibility of a 'shock' in global markets.

PROJECTED STATEMENT OF FINANCIAL PERFORMANCE FOR THE FIVE YEARS ENDING 30 JUNE 2021

	30/06/2016 $000	30/06/2017 $000	30/06/2018 $000	30/06/2019 $000	30/06/2020 $000	30/06/2021 $000
REVENUE						
Core Funding	17,733	17,733	18,176	18,558	18,929	19,298
Other Crown Revenue	12,628	13,466	13,803	14,093	14,375	14,655
Commercial and Other	18,716	18,833	19,302	19,850	20,744	21,698
Total Revenue	49,077	50,032	51,281	52,501	54,048	55,651
OPERATING EXPENDITURE						
Personnel	24,746	26,255	26,780	27,315	28,271	29,176
Other Operating Costs	20,659	20,158	20,641	20,939	21,326	21,766
Total Operating Expenditure	45,405	46,413	47,421	48,254	49,597	50,942
SCION MARGIN	**3,672**	**3,619**	**3,860**	**4,246**	**4,451**	**4,709**
Loss on disposal of Fixed Assets	(20)	0	0	0	0	0
Movement in Intangible Asset Value	39	0	0	0	0	0
Restructuring Costs	(100)	(100)	(100)	(100)	(100)	(100)
EBIT-R*	**3,591**	**3,519**	**3,760**	**4,146**	**4,351**	**4,609**
Reinvestment	(1,370)	(1,465)	(1,600)	(1,750)	(2,250)	(2,900)
EBIT	**2,221**	**2,054**	**2,160**	**2,396**	**2,101**	**1,709**
Net Interest Income/(Expense)	363	275	160	81	76	105
PROFIT BEFORE TAX	**2,584**	**2,329**	**2,320**	**2,478**	**2,177**	**1,814**
Tax	(865)	(734)	(673)	(718)	(631)	(526)
GROUP PROFIT AFTER TAX	**1,719**	**1,596**	**1,647**	**1,759**	**1,546**	**1,288**
PROFIT ATTRIBUTABLE TO SHAREHOLDERS	**1,719**	**1,596**	**1,647**	**1,759**	**1,546**	**1,288**

**EBIT-R is EBIT before reinvestment*

Table 6: *Projected Statement of Financial Performance for the five years ending 30 June 2021.*

EFFICIENCY	Forecast 2016	Target 2017	Target 2018	Target 2019	Target 2020	Target 2021
Operating margin	14.0%	12.3%	12.7%	13.0%	12.2%	11.2%
Operating margin per FTE	$24,168	$20,569	$21,808	$22,830	$21,728	$20,316
RISK:	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Quick ratio	2.36:1	1.76:1	1.12:1	1.01:1	1.08:1	1.19:1
Interest coverage	N/A	N/A	N/A	N/A	N/A	N/A
Operating margin volatility	22.9%	12.6%	5.5%	5.0%	4.4%	4.2%
Forecasting risk	1.7%	1.4%	1.2%	0.3%	0.0%	(0.0)%
GROWTH/INVESTMENT:	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Adjusted before reinvestment	8.0%	7.1%	7.1%	7.4%	7.4%	7.6%
Adjusted return on equity	5.0%	4.3%	4.3%	4.4%	3.7%	3.0%
Revenue growth	4.3%	1.9%	2.5%	2.4%	2.9%	3.0%
Capital renewal	0.7x	2.1x	2.5x	1.6x	1.2x	1.1x

Table 7: *Projected Financial Performance Indicators for the five years ended 30 June 2021.*

2. Reinvestment of surpluses

Scion's reinvestment portfolio underpins its strategy through Learning and Growth (L&G) initiatives (see Figure 12, page 22). Business investment cases for each L&G are reviewed by the Board as part of the annual refreshing of Scion's strategy and SCI, and preparation of the Annual Operating Plan.

Initially, these incorporated significant 'internal facing' investment to support leadership development and culture change, the design and adoption of systems and processes to improve organisational productivity (the Scion Way); catch-up on a backlog of building repairs and maintenance; and improving Scion's capability to engage effectively with Māori.

In 2016/17, with the exception of smart systems and processes (L&G2), reinvestments are all external facing initiatives (see Table 8) that support Scion's strategy and forest industry stakeholders' goals:

1. Part fund the Scion Chair of Sustainable Forest Management at the Waiariki Bay of Plenty Polytechnic L&G1,
2. Accelerate commercialisation (L&G4);
3. International S&T collaborations to speed-up innovation in forestry, solid wood and wood fibre processing and manufacturing firms producing industrial bioproducts (L&G5);
4. Enhance technology translation through secondments and via schools (L&G6);
5. Grow the Māori economy through improved communication and regional hui to meet directly with iwi (L&G7); and
6. 'Big data' informatics capability (L&G8).

A brief rationale was provided earlier (Section 3) for these strategic initiatives. Levels of investment in each L&G and the aggregate impact on RoE are shown in Table 8. It is important to note the significant ramp-up in investment into L&G4 from 2019/20 when Scion's major Capex programme is forecasted to end. At this stage the growth in reinvestment can be sustainably matched with the rate of reinvestment. This strategic intent is fully consistent with the recommendations

	2017		2018		2019		2020		2021	
Reinvestment project ('000)	RoE	EBIT	RoE	EBIT	RoE	EBIT	RoE	EBIT	RoE	EBIT
L&G 1 - A customer focused culture	40	(0.1%)	50	(0.1%)	50	(0.1%)	0	0.0%	0	0.0%
L&G 2 - Productivity through smart systems	100	(0.3%)	0	0.0%	0	0.0%	0	0.0%	0	0.0%
L&G 3 - A safe modern workplace	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
L&G 4 - Accelerate commercialisation	700	(1.9%)	870	(2.2%)	1070	(2.6%)	1770	(4.1%)	2420	(5.4%)
L&G 5 - International S&T collaborators	150	(0.4%)	150	(0.4%)	150	(0.4%)	150	(0.4%)	150	(0.3%)
L&G 6 - Enhance technology translation, secondments	75	(0.2%)	80	(0.2%)	80	(0.2%)	80	(0.2%)	80	(0.2%)
L&G 7 - Engage Māori, build Māori economy	75	(0.2%)	100	(0.3%)	75	(0.2%)	75	(0.2%)	75	(0.2%)
L&G 8 - Big data, industry informatics	325	(0.9%)	350	(0.9%)	325	(0.8%)	175	(0.4%)	175	(0.4%)
Future initiatives - Opex	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total reinvestment	1,465	(3.9%)	1,600	(4.1%)	1,750	(4.3%)	2,250	(5.3%)	2,900	(6.5%)
Tax	-410	1.1%	-448	1.1%	-490	1.2%	-613	1.5%	-812	1.8%
PROFIT IMPACT REINVESTMENT	1,055	(2.8%)	1,152	(2.9%)	1,260	(3.1%)	1,620	(3.8%)	2,088	(4.7%)
Initial target ROE		7.1%		7.1%		7.4%		7.4%		7.6%
Revised ROE target after impact of reinvestment		4.3%		4.3%		4.4%		3.7%		3.0%

Table 8: *Summary of strategic learning and growth (L&G) initiatives 2016/17 to 2020/21, underlying (target) ROE and tailored rate of return. Allocations from 2016/17 are indicative.*

in Scion's 2015 Four Year Rolling Review and is essential for Scion to achieve its aspirational goal of 25% of revenues in 2025 from licensing, sale of technology and equity dilution (see Figure 4 and Appendix 4). Thus, Scion will continue to operate within the guidelines of the CRI Balance Sheet review and retain flexibility to reduce expenditure if revenue growth is less than planned.

3. Cash position, balance sheet structure and dividends

Scion is forecasting end-of-year cash balances in the range of $11.1 million (June 2016) to $1.7 million (June 2019) over the five-year planning period (Table 9). This is judged to be prudent given the ongoing revenue uncertainty with MBIE core and contestable funding; and proposed innovation centre including modernisation of the aging (circa 1950s) wood engineering laboratories and test facilities (scheduled to commence in 2016/17 and estimated to cost $15-$17 million). The combination of reinvestment of surpluses of $1.4-$2.9 million per annum and capital renewal ($5.0-$10.9 million per annum) means Scion net assets are forecast to grow by $7.8 million to $44.1 million over the planning period (Table 10).

SCION GROUP (NEW ZEALAND FOREST RESEARCH INSTITUTE LIMITED) PROJECTED STATEMENT OF CONSOLIDATED CASHFLOWS FOR THE FIVE YEARS ENDED 30 JUNE 2021

	30/06/2016 $000	30/06/2017 $000	30/06/2018 $000	30/06/2019 $000	30/06/2020 $000	30/06/2021 $000
CASHFLOW FROM OPERATING ACTIVITIES						
CASH RECEIVED FROM OPERATIONS						
Crown	30,296	31,099	31,979	32,651	33,304	33,953
Other Clients	19,000	18,572	19,181	19,726	20,618	21,569
Interest	324	348	160	81	76	105
TOTAL CASH RECEIVED FROM OPERATIONS	**49,620**	**50,020**	**51,320**	**52,458**	**53,999**	**55,627**
CASH DISBURSED ON OPERATIONS						
Personnel	5,004	26,204	26,833	27,368	28,323	29,226
Suppliers	16,536	17,900	17,764	18,140	18,964	20,017
Interest on debt	0	0	0	0	0	0
Taxation	1,082	721	734	703	660	561
TOTAL CASH DISBURSED ON OPERATIONS	**42,622**	**44,825**	**45,330**	**46,210**	**47,947**	**49,804**
PROJECTED NET CASHFLOWS FROM OPERATIONS	**6,998**	**5,195**	**5,989**	**6,248**	**6,052**	**5,823**
CASHFLOW FROM INVESTMENT ACTIVITIES						
Purchase of investments	(400)	(200)	0	0	0	0
Purchase of fixed assets	(3,067)	(8,651)	(10,750)	(6,850)	(5,350)	(4,850)
Purchase of intangibles	(182)	(120)	(150)	(150)	(150)	(150)
NET CASH RECEIVED/(DISBURSED) FROM INVESTING ACTIVITIES	**(3,649)**	**(8,971)**	**(10,900)**	**(7,000)**	**(5,500)**	**(5,000)**
CASHFLOW FROM FINANCING ACTIVITIES						
Increase in term debt	0	0	0	0	0	0
Repayment of term debt	0	0	0	0	0	0
TOTAL CASH DISBURSED ON FINANCING ACTIVITIES	**0**	**0**	**0**	**0**	**0**	**0**
NET INCREASE (DECREASE) IN CASH	**3,349**	**(3,776)**	**(4,911)**	**(752)**	**552**	**823**
Exchange Rate effect	0	0	0	0	0	0
Opening cash balance	7,744	11,093	7,317	2,406	1,654	2,206
CLOSING CASH BALANCE	11,093	7,317	2,406	1,654	2,206	3,029

Table 9: *Projected Statement of Consolidated Cash flows for the five years ended 30 June 2021.*

SCION GROUP (NEW ZEALAND FOREST RESEARCH INSTITUTE LIMITED) PROJECTED CONSOLIDATED BALANCE SHEET AS AT 30 JUNE 2016, 2017, 2018, 2019, 2020, 2021

	30/06/2016 $000	30/06/2017 $000	30/06/2018 $000	30/06/2019 $000	30/06/2020 $000	30/06/2021 $000
CURRENT ASSETS						
Short term investments and cash	11,093	7,317	2,406	1,654	2,206	3,029
Debtors	6,015	6,061	6,182	6,306	6,432	6,561
Prepayments	531	546	546	546	546	546
Inventory	380	380	380	380	380	380
TOTAL CURRENT ASSETS	**18,019**	**14,304**	**9,515**	**8,886**	**9,564**	**10,516**
LESS CURRENT LIABILITIES						
Creditors	4,721	4,978	5,077	5,179	5,282	5,388
Personnel liabilities	2,242	2,332	2,379	2,426	2,475	2,524
Income in advance	1,484	1,241	1,241	1,241	1,241	1,241
Provision for tax	272	285	224	239	210	175
TOTAL CURRENT LIABILITIES	**8,719**	**8,836**	**8,922**	**9,086**	**9,209**	**9,329**
NET WORKING CAPITAL						
INVESTMENTS						
Investments in subsidiaries & associates/intangible assets	343	343	343	343	343	343
Intangible assets	565	550	550	550	550	550
TOTAL INVESTMENTS	**908**	**893**	**893**	**893**	**893**	**893**
FIXED ASSETS						
Fixed assets	28,942	34,446	40,968	43,520	44,511	44,967
Biological assets	466	466	466	466	466	466
TOTAL FIXED ASSETS	**29,408**	**34,912**	**41,434**	**43,986**	**44,977**	**45,433**
TERM LIABILITIES						
Provision for staff liabilities	1,392	1,452	1,452	1,452	1,452	1,452
Deferred tax liability	1,957	1,957	1,957	1,957	1,957	1,957
Term debt	0	0	0	0	0	0
TOTAL TERM LIABILITIES	**3,349**	**3,409**	**3,409**	**3,409**	**3,409**	**3,409**
PROJECTED TOTAL NET ASSETS						
REPRESENTED BY						
Share capital	17,516	17,516	17,516	17,516	17,516	17,516
Retained earnings b'fwd	16,971	18,690	20,286	21,933	23,692	25,238
Revaluation reserve	61	61	61	61	61	61
Current profit (loss)	1,719	1,596	1,647	1,759	1,546	1,288
PROJECTED CLOSING SHAREHOLDERS FUNDS	**36,267**	**37,863**	**39,510**	**41,269**	**42,815**	**44,103**

Table 10: *Projected Statement of Consolidated Balance Sheet for the five years ended 30 June 2021.*

8 Performance monitoring and reporting

Scion's strategic indicators, measures and targets are presented in Tables 11 and 12, respectively. These comprise CRI generic and Scion specific indicators (Table 11) and progress in achieving the strategic priorities outlined in Section 3 (Figure 12). Because some indicators constitute a 'bundle' of measures these will be traffic lighted (green, orange, red) and supported by qualitative (and, as appropriate, quantitative) information in Scion's quarterly Shareholder reports; and public six-monthly and annual reports. The latter will incorporate financial reports consistent with the accounting policies described in Appendix 5. Financial indicators reported quarterly are presented in Table 7.

	INDICATOR NAME	MEASURE	FREQUENCY	2016 FORECAST	2017 TARGET
CRI GENERIC INDICATORS	End user collaboration	Revenue per FTE ($) from commercial sources	Quarterly	$65,670	$62,817
	Research collaboration	Percentage of peer reviewed publications with collaborators	Quarterly	70%	75%
	Technology and knowledge transfer excellence	Number of commercial/customer reports per Scientist FTE	Annually	2.2	2.5
	Science quality	Mean journal impact factor	Annually	2.6	2.8
	Financial indicator	Revenue per FTE ($)	Quarterly	$172,200	$166,885
	Stakeholder engagement	Relevant funding partners and other end users (number and %) that have a high level of confidence that Scion sets research priorities relative to the forest industry and biomaterials sector	Biennial	MBIE survey n>30; >85%	MBIE survey n>30; >85%
		National and international research providers (%) who have a high level of confidence in Scion's ability to assemble the most appropriate research team	Biennial	>85%	>85%
		Relevant end-users (%) who have adopted knowledge and/or technology from Scion	Biennial	>90%	>90%
SCION STRATEGIC INDICATORS	Māori economic development	Partnerships (number and value) established with Māori entities to support economic development through the forest industry	Quarterly	n>5; >$1.0m	n>5; >$1.0m
	Accelerated commercialisation	Technologies in Scion's pipeline (number and co-investment ($)); projects that progress to the business case stage (case studies)	Quarterly	25 & $600k; Cases ≥4pa	25 & $600k; Cases ≥4pa
	Internationalisation	Joint research and technology development programmes and staff exchanges with Scion's international strategic partner organisations	Six monthly	<5 1	<5 1
	People and culture	Staff recruitment and retention (quality and days to fill); leadership development (assessment); good employer (EEO rating); health and safety; and internal staff satisfaction survey (biennial)	Annual and Biennial	Qualitative <50 days EEO rating 0 Zero harm	Qualitative <50 days EEO rating 0 Zero harm
	Organisational productivity	Development and application of the Scion Way 'best practice' suite (internal evaluation; ratio overheads (O/Hs): total revenue (%))	Annual	O/Hs <20% 100%	O/Hs <20% 100%

Table 11: *Scion's performance monitoring scorecard indicators and measures.*

Scion's internal Annual Operating Plan includes additional science output, health and safety; and social responsibility measures. Most of these measures have been tracked over at least five years and therefore provide insights into trends of organisational operational effectiveness and efficiency.

Progress in achieving the strategic priorities will be commented on and 'traffic-lighted' in the scorecard similar to that shown in Table 12.

SCIONS' STRATEGIC INITIATIVES OUTCOMES SCORECARD

PRIORITY	OUTCOME	RATING (% ACHIEVED)
Value chain optimisation	Capability built in VCO and market analyses	90%
	Application of VCO tools improves Scion science and investment	35%
	Industry-policy steering group confirms priorities and associated project outputs enable productivity gains in forests, through logistics and via processing	40%
Accelerate commercialisation and technology uptake	Pipeline management of Scion products and services at best practice	60%
	"Game changing" technologies licensed-commercialised: · Woodforce (Wood plastic pellets) · TERAX® (Biosolids processing) · UAV LiDAR (Remote sensing)	 50% 30% 5%
International networks	Projects agreed with selected partners: · Europe (VTT, VITO, others) · North America (FPInnovations, University of Manitoba (Canada)) · Asia (FRRI (Japan), target companies) · Australia (FWPA, CSIRO, companies) · South America (Chile, Brazil)	 50% 20% 20% 70% tbc
	Technologies adapted or co-invented for NZ industry through international network	10%
Regional hubs and development	The new Innovation Centre Building on Scion's campus at its Te Papa Tipu Innovation Park is fully tenanted and postgraduate students and joint projects increase through the Tertiary Sector Alliance	20%
	Scion's future footprint at the University of Canterbury is confirmed and new opportunities arise from this and the university's Innovation precinct and the Lincoln and other hubs	10%
	Scion contributes to the delivery of Regional Growth Study Action Plan targets related to the forest industry, manufacturing of bioproducts, sustainable land-use and water quality	20%
Partnerships with Māori	Partnerships with iwi (including with 'cooperating clusters') enable increased economic returns for Māori through the forest industry	30%
	Surveys of the effectiveness of communication and technology transfer to iwi confirm improvement and is supported by examples of technology adoption-better practice	30%

Table 12: *Scions' strategic initiatives outcomes scorecard (ratings will be shown as estimated percentage completion of the actions described in Section 3).*

9 Concluding comments

The forest industry has a big role to play in growing New Zealand's exports, supporting regional economies, assisting Māori attain their economic and cultural aspirations, meeting New Zealand's 2030 greenhouse gas emission reduction target; and improving water quality and other environmental outcomes (e.g. steepland erosion).

Export earnings from forest and wood products have grown strongly in recent years, albeit the near term is more challenging despite a more favourable NZ:US exchange rate because of the slowdown of the Chinese economy and as global over-capacity in pulp processing plants is worked out. Growth in the Indian and other export markets is partially offsetting these conditions. Domestically strong and rising housing starts, driven more now by population growth in Auckland than the Christchurch post-earthquake rebuild, is assisting the solid wood sector. This sector is also benefiting from the higher productivity of new and modernised solid wood processing plants; the steady uptake of engineered wood products and increased use of prefabricated building systems.

The COP21 Paris Climate Agreement will boost the growth of markets for renewable materials, 'green' chemicals and bioenergy products. Increased use of biomaterial and bioenergy products, derived in part or fully from forest biomass, by advanced manufacturing firms will directly support the Government's Business Growth Agenda goal of lifting the ratio of exports to gross domestic product to 40% by 2025[59]. Importantly, both New Zealand's energy security and greenhouse gas emissions profile can be improved through the increased use of forest biomass and waste streams.

With New Zealand's annual log harvest growing from the present 30 million m^3 to 34-36 million m^3 over the next decade more attention must be paid to ensuring the long-term security of log supply. This requires a multi-pronged approach to lifting the competitiveness of forestry as land-use, lowering forest operation and other supply chain costs; and increasing the capacity of mills to pay higher log prices. The latter requires a deep understanding of how to grow and sustain competitive advantage in high-margin export markets for products from radiata pine. The 2013 WoodScape study[60] confirmed the importance of increasing New Zealand wood processing competitiveness through product innovation (especially from mill residues), greater log conversion efficiency, market development and supply chain coordination. Development of wood processing in New Zealand, as is currently occurring in the central North Island, reduces forest growers' high exposure (circa 70% in 2013/14) to the Chinese log market and enhances economic opportunity in regions such as Northland[61], the Bay of Plenty, East Coast and Otago-Southland.

There are synergies here because establishing up to 1,000,000 hectares of new forest by 2030 would help offset 28% of New Zealand's greenhouse gas emissions by 2030 and attract new investors into wood processing and other parts of the forest value chain. The 2020+ outlook for a global shortfall in softwood (long wood fibre) supply; strengthening carbon prices; new markets for forest-based ecosystem services (such as biodiversity); and, imposition of nutrient limits to improve waterways and estuaries are all positive drivers for forestry as a land use. However, there are immediate opportunities for forest growing research to improve forestry returns through the application of new genetic technologies, improved tree nutrition, matching genotypes to sites, and reducing foliar diseases. Through these means, volume growth of forests could be doubled over the next 20 years to 35 tonnes of biomass per hectare per year while concurrently improving wood uniformity and stiffness[62].

Afforestation includes developing commercial scale and export returns from non-radiata forestry species. There is growing market demand for durable (non-treated) timber and other tree derived products such as honey and oils; and the potential to realise up to $285 million revenue per annum from New Zealand's privately owned indigenous forests[63]. Alternative species also mitigate the vulnerability of New Zealand plantation forests to biosecurity and climate change risk.

Māori have a strong interest in the use of indigenous species and have an increasing role in all areas of forest industry development. Scion plans to continue to strengthen and establish further partnerships with Māori trusts and incorporations with significant forest assets and large areas of under-utilised land with good potential for forestry[64].

[59] See http://www.mbie.govt.nz/info-services/business/business-growth-agenda for detailed information about the Government's business growth agenda. Sourced 24 May 2016.

[60] Jack, M., Hall, P., Goodison, A., & Barry, L. (2013). *WoodScape Summary Report*. Rotorua, New Zealand: Scion. http://www.woodco.org.nz/images/stories/pdfs/woodscape/woodscapesummaryreportfinal1_web.pdf

[61] Knuckey, S., Schoefisch, U., Leung-Wai, J., Hall, M., & Sakalia, P. (2015). *Tai Tokerau Northland Growth Study: opportunities report*. Auckland: MartinJenkins & Associates/ Sakalia Enterprises Prepared for MBIE & MPI. http://www.mbie.govt.nz/info-services/sectors-industries/regions-cities/regional-growth-programme/pdf-image-library/Tai Tokerau Regional Growth Study.pdf.

[62] Forest Owners Association. (2012). *New Zealand forestry science and innovation plan*. http://www.forestvoice.org.nz/docs/foaforestgrowingstrategy240112v15.pdf

[63] KPMG. (2013). *Indicative value analysis of New Zealand's privately owned indigenous forests*. Report to MPI. Auckland New Zealand: KPMG. Retrieved 24 May 2016 from: https://www.mpi.govt.nz/document-vault/711

[64] Ministry for Primary Industries. (2013). *Growing the productive base of Māori freehold land*. Wellington, New Zealand. Retrieved 24 May 2016 from: https://www.mpi.govt.nz/document-vault/4261

Scion is well positioned with forest industry stakeholders and manufacturing firms; the National Science Challenges and international science partners. The innovation hub proposed for the Rotorua Sala Street campus and Scion's science plan and reinvestment initiatives are all designed to exploit changes in the external operating environment and maximise opportunities for the forest industry and industrial bioproducts. Partnerships with Māori and strategic relationships with government departments are established.

With these foundations in place and a favourable unfolding of the external operating environment, Scion is confident it can deliver the science outcomes and impact, and financial and other targets set out in this SCI.

Appendix 1 Forest growing

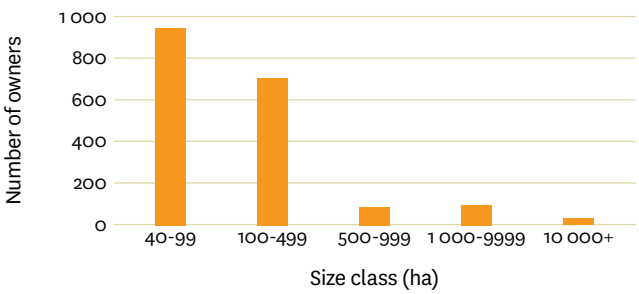
NATIONAL EXOTIC FOREST ESTATE STATISTICS 2014

Area and standing volume statistics	As at 1 April 2014
FOREST AREA	
Net stocked area (ha)	1,746,500
Harvested area awaiting replanting (ha)	44,642
Total forest area	1,791,142
GROWTH CHARACTERISTICS	
Standing volume (000 m³)	493,723
Average standing volume (m/ha)	283
Area-weighted average age (years)	16.8
AREA BY SPECIES	
Radiata pine (ha)	1,572,200
Douglas-fir (ha)	105,200
Cypress species (ha)	9,900
Other softwoods (ha)	23,000
Eucalyptus species (ha)	23,800
Other hardwoods (ha)	12,400
RADIATA PINE AREA BY TENDING REGIME	
Pruned with production thinning (ha)	196,300
Pruned without production thinning (ha)	651,000
Unpruned with production thinning (ha)	35,100
Unpruned without production thinning (ha)	689,800

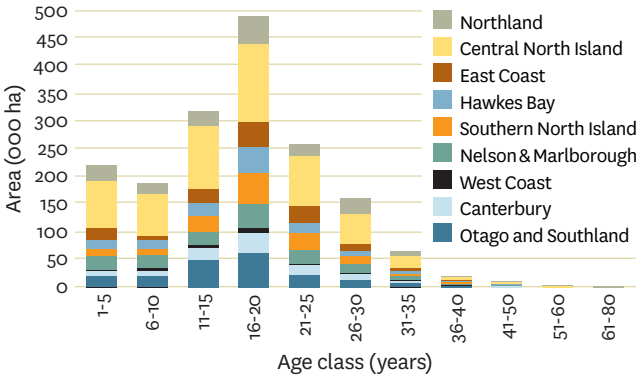
Planting statistics	Year Ended 31 December 2013
NEW PLANTING	
Total estimated new planting (ha)	3,500
Restocking (ha)	40,867

Harvesting statistics	Year Ended 31 December 2014
HARVESTING	
Area clear felled – all species (ha)	46,001
Area clear felled – radiata pine (ha)	42,986
Volume clear felled – all species (000 m³)	23,437
Volume production thinned – all species (000 m³)	244
Total volume removed – all species (000 m³)	23,681
Average clear fell yield – all species (m/ha)	515
Volume clear felled - radiata pine (m³/ha)	22,331
Average clear fell yield – radiata pine (m³/ha)	519
Area-weighted average clear fell age for radiata pine (years)	28.9

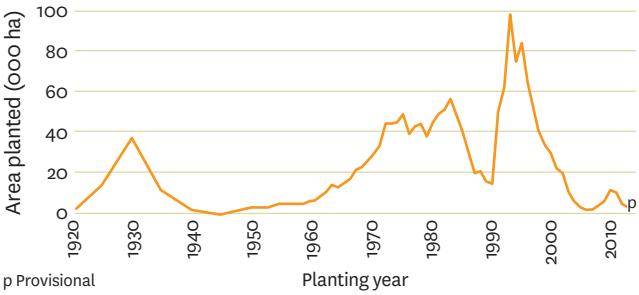
NUMBER OF FOREST OWNERS BY NATIONAL SIZE CLASS, AS AT APRIL 2014



FOREST AREA BY AGE CLASS AND WOOD SUPPLY REGION, AS AT 1 APRIL 2014

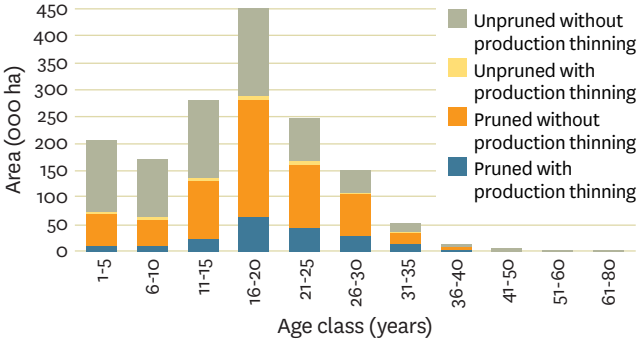


NEW FOREST PLANTING 1920 - 2014 (PROVISIONAL)

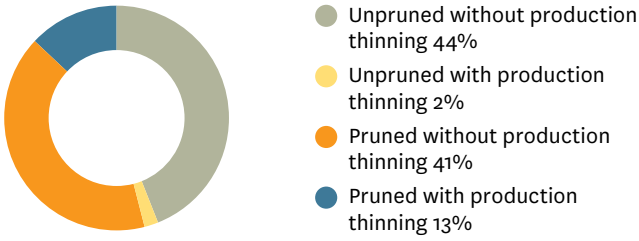


p Provisional

RADIATA PINE FOREST AREA BY AGE CLASS AND TENDING REGIME, AS AT 1 APRIL 2014



RADIATA PINE BY TENDING REGIME - 2014



These tables and figures are sourced from the MPI (Ministry for Primary Industries) report *National exotic forest description as at 1 April 2014*.

Appendix 2 Forest products and exports

FORESTRY PRODUCTION

VOLUME	Year ended 31 December 2014	2015	% Change
Panel products (m³)	1,860,462	1,881,734	1%
Export logs (m³)	16,561,107	15,440,689	-7%
Pulp (tonnes)	1,427,184	1,437,938	1%
Paper and paperboard (tonnes)	725,569	726,673	0%
Sawn timber (m³)	3,971,000	4,008,000	1%
Total roundwood removals (m³)	29,388,000	28,964,000	-1%

Source: MPI

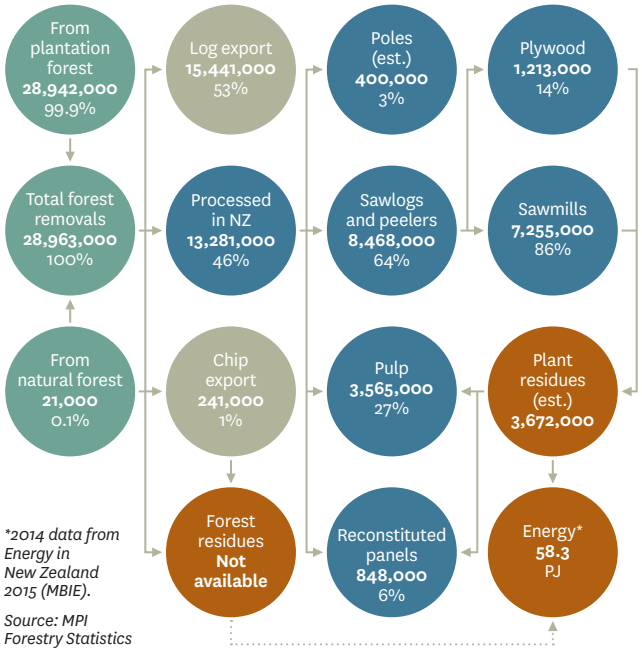
FORESTRY EXPORTS

VALUE (NZ$)	Year ended 31 December 2014	2015	% Change
Panel products	367,087	439,203	20%
Logs and poles	2,268,611	1,998,110	-12%
Pulp	618,841	674,240	9%
Paper and paperboard	297,046	n/a	
Sawn timber and sleepers	736,484	828,085	12%
Woodchips	44,773	60,549	35%
Other	427,608	n/a	
Total	4,760,450		
QUANTITY			
Panel products (m³)	784,621	731,623	-7%
Logs and poles (m³)	16,561,107	15,440,689	-7%
Pulp (tonnes)	894,684	936,983	5%
Paper and paperboard (tonnes)	349,928	n/a	
Sawn timber and sleepers (m³)	1,708,008	1,787,016	5%
Woodchips (BDU)	229,825	249,713	9%

Source: MPI

LOG FLOW IN THE NEW ZEALAND FOREST INDUSTRY

Volumes in m³ roundwood equivalent, year ended 31 December 2015

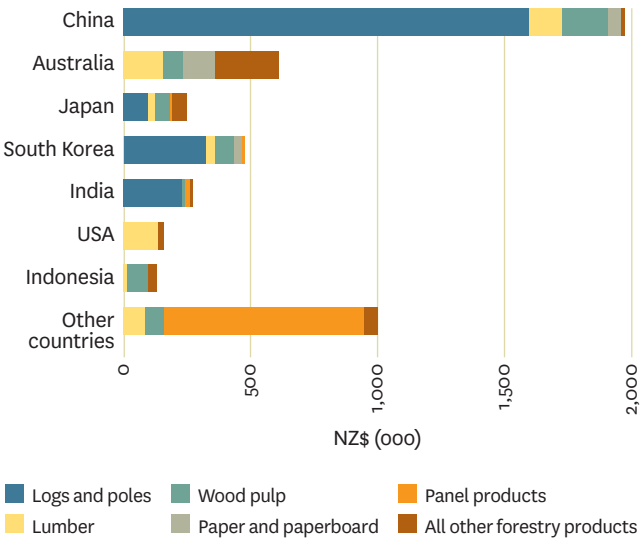


**2014 data from Energy in New Zealand 2015 (MBIE).*

Source: MPI Forestry Statistics

EXPORT PRODUCT VALUE BY DESTINATION 2014

For year ended in December 2014



Note: Excludes re-exports. Newsprint data 12 months ending June 2010
Source: Statistics NZ
Reproduced from "2014 Facts & Figures New Zealand Plantation Forest Industry", Forest Owners Association

MBIE (Ministry of Business, Innovation and Employment) and MPI (Ministry for Primary Industries)

Appendix 3 The forest industry and Scion in 2025

By 2025, the New Zealand forest industry is strongly capitalising on the global economic, environmental and societal changes described in the previous sections.

The planted area of forests has expanded to 2.1 million hectares (including 0.3 million hectares of previously under-utilised Māori land) from the 2015 area of 1.7 million hectares. Compared to now, these plantations include a more diverse range of species (including indigenous), have genotypes matched to the environments they are most suited to (such as East Coast forests' exposure to severe drought owing to the effects of climate change); and the first commercial plantings of some new breeding technology/GM herbicide tolerant and sterile trees are growing well.

Replacement and new forest plantings average 70,000 hectares per year. Owners of radiata pine forests achieve 10-25% productivity gains by optimising tree genetics to particular environments and sites and the use of clones; and the uniformity of these forests at harvest are 25-40% greater than those planted in early 2000. Bio-stimulant, -control and -protection technologies have boosted the vigour and survival of seedlings, nutrient efficiency and resilience of forests and restricted weeds. More forests are co-cropping – ginseng and medicinal herbs; and the viability of a 'high protein' insects farming business is being explored by a Māori Trust.

Remote sensing for forest management is normal; harvesting, pruning and other operations are fully mechanised and almost 50% of all forest operations are automated; trees are fully traceable and segregated for their best use and highest value in the supply chain. Surveillance systems, utilising machine learning and sensor networks embedded in forests, detect fire, pests and disease threats. Such systems are at an early stage and are joined into New Zealand's pre-emptive biosecurity risk management.

Wood processors and other industries have consolidated into internationally competitive clusters and are integrated across the value chain to exploit synergies in forest biomass flows, enable specialisation and grow the total value from all components of a log. Distributed manufacturing plants are being constructed or planned in regions such as Taranaki and Canterbury to utilise non-structural logs, bark and in some cases stumps.

Māori are co-investors with offshore investors in wood processing, and directly manage some 25% of forests and own 50% of the land on which forests are grown. Geothermal energy provides significant competitive advantage to central North Island and Northland wood processors. More than 80% of logs are processed onshore. This is a result of low emissions energy and water availability, together with at least 65% log conversion rates and profitable products from saw- and pulp mill residues.

A large-scale (2 million m^3 log input) state-of-the-art biorefinery mill has been established in the central North Island. Its wood fibre supply is underpinned by special purpose forests, with an eight-year rotation and MAI of 40 m^3 hectare per annum. These forests have been established for energy, green chemical and other purposes and are sometimes established in high wind-risk areas.

The COP21 Paris Climate Agreement of 2015 has shifted the strategic mindset of New Zealand business to adapt to, and manage, the risks of a new climate reality and sustainably use natural capital. New Zealand, as part of the five-year ratchet mechanism, has increased its 2015 commitment from an 11% reduction by 2030 to 30%. The 2016 removal of the 2:1 subsidy in the Emission Trading Scheme (ETS) and close-off of 'hot air' carbon markets, and deforestation from 2008, have contributed to the uncapped carbon price for NZ Units rising to \$30/tonne CO_2e. Forecasts are for this to reach \$50/t by 2030.

The global accord to decarbonise economies has strongly boosted the development of bioproducts from forest biomass. Customer demand is accelerating for new wood-based composites, plastics, natural preservatives; packaging that doubles food shelf life; green chemicals and renewable energy products, including a 'drop-in' biodiesel for heavy transport operators and a marine biofuel that lowers the emissions (including sulphur) of ships. By 2030, Air New Zealand expects to be utilising a drop-in jet fuel from a large biofuel plant co-located at the Ngawha geothermal wood processing site, and a new manufacturing plant for PHA derived from radiata pine lignin is co-located with the new central North Island biorefinery. Heavy emitting industries in New Zealand are annually purchasing more than \$500m of carbon credits from new and regenerating forests with significant environmental co-benefits.

Automobile and homeware companies have extensively adopted Sonae's Woodforce® technology (originally licensed from Scion in 2011) into their cars and products to exploit its light weight, strength and reusability. Prefabricated wood construction utilising a range of engineered wood technologies (produced to tight specifications) dominates the housing market; has a 25% share of the commercial building sector; and earns \$1 billion in exports. Scion's dewatered wood technology is the preferred substitute for hardwood in three ASEAN economies.

Forestry is a key enabler for land owners meeting water quality standards, such as nitrogen discharge allowances, within major river and lake catchments. Different forest species are being designed into landscapes to make best use of the topography, maximise the value of ecosystem services (such as mānuka for honey and oil), and with sufficient scale to optimise forest operations and harvesting. Value chains are no longer viewed in isolation but rather for complementarities that exploit the respective strengths of industries. For example, dairy farmers use 40,000 tonnes of molasses (sugar) by-product from a new high-performance pulp technology (part of the new biorefinery described earlier). Joined up sector thinking also makes best use of

regional infrastructure – roading, ports and services – and increases the resilience of regional economies.

Scion is New Zealand's 'shop window' to the world's leading biomaterial-renewable futures research institutes; is a strategic partner with several multi-nationals that have a large influence on wood-wood fibre and 'wood-food-fed' value chains. There is a waiting list of firms seeking space at Scion's Innovation Hub. About a third of the 750,000 annual visitors to The Redwoods (Whakarewarewa Forest) stop in to see Scion science in action.

More than 25% of Scion's revenues are derived from commercialisation; it has international eminence for thought leadership and science quality (H-index > 100). Fifteen per cent of Scion's staff are of Māori descent, 20% of staff are involved in ICT work and its value chain economics, systems and design capability is national leading.

Scion's strong customer-focussed culture and agility attracts the early partnering of investors and firms to co-develop and exploit intellectual property; fosters business model innovation; and helps to sustain the forest industry and firms' social licence to operate. Skills in manufacturing via 3-D printing; an array of pilot plants; office and lab work environments that foster ingenuity and cross-discipline fertilisation of ideas; a top echelon of PhD students (some from the Waiariki Bay of Plenty Polytechnic, formed in 2016; some from the University of Waikato Centre of Freshwater Excellence established at Scion in 2017 and others from world-leading offshore partners such as VITO and Fraunhofer); and staff secondments into firms and iwi organisations are all contributing to Scion's success and reputation as a great place to work.

The New Zealand public holds the forest industry in high esteem for its environmental integrity, innovativeness and socially responsible corporate leadership. Companies regularly report 'zero' harm to their staff; and top talent preferentially seek careers in forest-related firms.

Appendix 4 Business policies

Scion aims to remain a high quality, financially viable research organisation with an exemplary international reputation, while providing relevant outputs to the highest standards of professionalism and maintaining prudent business practices.

Below is a brief summary of Scion's business policies.

Statutory requirements policy

Scion will operate in accordance with relevant legislative requirements, including the Crown Research Institutes Act 1992, Companies Act 1993, and the Crown Entities Act 2004. In doing so, Scion will undertake business according to the following commitments.

Policy on acquisitions, mergers and divestments

Scion will strive to continuously add value to its activities and improve the net worth of the company and its shareholders. It will ensure that all new investments within core business, expansions of core business and diversification away from core business, will ordinarily provide shareholders with additional economic value commensurate with the risks involved. Scion will seek shareholder consent where the value of the proposed acquisition or divestment is greater than 30% of the total assets (taken as a whole) or $5 million whichever is the lesser.

Business strategies

In order to achieve its Statement of Core Purpose, Scion will:

- Adopt a 'customer centric' approach to develop strong long-term partnerships with key stakeholders in the firms, representative bodies, iwi and government agencies working with and supporting the forest industry.
- Establish collaborative relationships with research providers both within New Zealand and overseas to enhance the impact and quality of Scion's science.
- Build public understanding of the implications of our science and the economic, social and environmental value it creates.
- Seek early commercial investment to support the development and uptake of Scion invented technologies.
- Reinvest operating surpluses to develop Scion's research capabilities, infrastructure, collaborations and to accelerate the rate of innovation along the wood-fibre value chain.

Human resources policies

Scion aims to be a good employer and provide a zero harm, safe workplace. It will recruit people whose competencies match the requirements to achieve its strategy and vision. The organisation's policies and procedures aim to ensure equal opportunity for all, that people are developed to their full potential, achieve an appropriate 'work-life' balance and that there is compliance with all employment, health and safety and associated legislation. Scion will remunerate staff on the basis of performance and the company's ability to pay through a combination of organisational and individual merit based payments. A competency-based appraisal system and objective performance output measures will be applied to assess both individual and team performance.

Intellectual property policies

The primary goal of the Intellectual Property (IP) management policies is to ensure that the interests of both the Crown and Scion and any client IP with which Scion is entrusted are protected, that knowledge and expertise are managed appropriately, the health of the IP portfolio is monitored continuously, and technological innovations are commercialised effectively.

Risk policy

Scion has risk management and compliance processes in place and operating effectively across the organisation. The risk management framework identifies, classifies, reports on and mitigates business risk. Risk reporting is undertaken on a six-monthly basis to the Scion Board or as a risk arises.

Accounting policies

Scion will manage cash prudently and ensure that any surplus cash is invested within delegations approved by the Board. New Zealand equivalents to International Financial Reporting Standards approved by the New Zealand Institute of Chartered Accountants for the measurement and reporting of profit and financial position have been adopted by Scion. (Refer to Appendix 5.)

Dividend policy

The Scion Board will detail in a submission to shareholding Ministers, within three months of the end of each financial year:

- The amount of dividend (if any) recommended to be distributed to the shareholders.
- The percentage of tax-paid profits that the dividend represents.
- The rationale and analysis used to determine the amount of any dividend.

Treatment of land claims

Scion monitors the progress of, and will seek to provide input as appropriate into, land claims or other matters affecting the land occupied by Scion in Rotorua.

Two land claims affecting the Rotorua campus currently exist:

- Ngati Whakaue – covering the total site.
- Ngati Wahiao – covering the southern end of the site.

Appendix 5 Statement of accounting policies

Reporting entity

New Zealand Forest Research Institute Limited is a Crown Research Institute registered under the Companies Act 1993. The registered office is Te Papa Tipu Innovation Park, 49 Sala Street, Rotorua. The financial statements consists of New Zealand Forest Research Institute Limited and its subsidiaries (the Group).

New Zealand Forest Research Institute Limited (the Company) is a reporting entity for the purposes of the Financial Reporting Act 2013. It is domiciled and incorporated in New Zealand and is wholly owned by the Crown.

The Financial Statements of New Zealand Forest Research Institute Limited for the year were authorised for issue in accordance with a resolution of the directors on the date as set out on the Statement of Financial Position.

The activities of New Zealand Forest Research Institute Limited include a range of research and development programmes aimed at using plant-based renewable resources and waste streams to create new materials, energy sources and environmentally sustainable products and processes.

New Zealand Forest Research Institute Limited trades as Scion and these names have identical meaning in this report.

Summary of significant accounting policies

a) Basis of preparation

The financial statements have been prepared in accordance with generally accepted accounting practice in New Zealand (NZ GAAP) and the requirements of the Companies Act 1993 and the Financial Reporting Act 2013. The financial statements have also been prepared on a historical cost basis, except for forestry assets, derivatives, carbon credits and certain heritage assets that have been measured at fair value.

The financial statements are presented in New Zealand dollars and all values are rounded to the nearest thousand dollars ($000).

b) Statement of compliance

The financial statements have been prepared in accordance with NZ GAAP. They comply with New Zealand equivalents to International Financial Reporting Standards, and other applicable Financial Reporting Standards, as appropriate for profit-oriented entities. The financial statements comply with International Financial Reporting Standards (IFRS).

c) Basis of consolidation

The consolidated financial statements comprise the financial statements of the Group and its subsidiaries as at 30 June. Control is achieved when the Group is exposed, or has rights, to variable returns from its involvement with the investee and has the ability to affect those returns through its power over the investee. Specifically, the Group controls an investee if and only if the Group has:

- Power over the investee (i.e. existing rights that give it the current ability to direct the relevant activities of the investee)
- Exposure, or rights, to variable returns from its involvement with the investee, and
- The ability to use its power over the investee to affect its returns

When the Group has less than a majority of the voting or similar rights of an investee, the Group considers all relevant facts and circumstances in assessing whether it has power over an investee, including:

- The contractual arrangement with the other vote holders of the investee
- Rights arising from other contractual arrangements
- The Group's voting rights and potential voting rights

The Group re-assesses whether or not it controls an investee if facts and circumstances indicate that there are changes to one or more of the three elements of control. Consolidation of a subsidiary begins when the Group obtains control over the subsidiary and ceases when the Group loses control of the subsidiary. Assets, liabilities, income and expenses of a subsidiary acquired or disposed of during the year are included in the statement of comprehensive income from the date the Group gains control until the date the Group ceases to control the subsidiary.

All intra-group assets and liabilities, equity, income, expenses and cash flows relating to transactions between members of the Group are eliminated in full on consolidation.

A change in the ownership interest of a subsidiary, without a loss of control, is accounted for as an equity transaction. If the Group loses control over a subsidiary, it:

- Derecognises the assets (including goodwill) and liabilities of the subsidiary
- Derecognises the carrying amount of any non-controlling interests
- Derecognises the cumulative translation differences recorded in equity
- Recognises the fair value of the consideration received
- Recognises the fair value of any investment retained
- Recognises any surplus or deficit in profit or loss
- Reclassifies the parent's share of components previously recognised in OCI to profit or loss or retained earnings, as appropriate, as would be required if the Group had directly disposed of the related assets or liabilities.

d) Associate companies

These are companies in which the group holds substantial shareholdings but does not have control and in who's commercial and financial policy decisions it participates.

Associate companies have been reflected in the consolidated financial statements on an equity accounting basis which shows the Group's share of surpluses in the Consolidated Statement of Comprehensive Income and its share of post-acquisition increases or decreases in net assets, in the Consolidated Statement of Financial Position.

e) Intangible assets

Intangible assets acquired separately are capitalised at cost and those acquired from a business combination are capitalised at fair value as at the date of acquisition. Following initial recognition, the cost model is applied to the class of intangible assets.

The useful lives of these intangible assets are assessed to be either finite or indefinite.

Where amortisation is charged on assets with finite lives, this expense is recognised in profit and loss.

Intangible assets created within the business are not capitalised and expenditure is charged to profit and loss in the year in which the expenditure is incurred.

Intangible assets are tested for impairment where an indicator of impairment exists, and in the case of indefinite life intangibles, annually, either individually or at the cash generating unit level. Useful lives are also examined on an annual basis and adjustments, where applicable, are made on a prospective basis.

A summary of the policies applied to the Group's capitalised intangible assets is as follows:

	Software
Useful lives	Finite
Method used	4 years – Straight line
Type	Acquired
Impairment test/Recoverable amount testing	Amortisation method reviewed at each financial year-end; Reviewed annually for indicators of impairment

Gains or losses arising from de-recognition of an intangible asset are measured as the difference between the net disposal proceeds and the carrying amount of the asset and are recognised in the profit and loss when derecognised.

Carbon credits. New Zealand emission reduction units (NZU's) are recognised when the Group controls the units, provided that it is probable that economic benefits will flow to the Group and the fair value of the units can be measured reliably. Control of the NZU's arises when the Group is entitled to claim the NZU's from the government.

NZU's are initially measured at fair value on entitlement as an intangible asset unless the Board have determined they are held for sale, in which case they would be recorded at fair value as inventory.

Following initial recognition, the intangible asset is measured at fair value when the Board of Directors consider there is an active market for the sale of NZU's. NZU's determined as held for sale at recognition and recorded as inventory, are subsequently measured at the lower of cost and net realisable value.

The liability arising from the deforestation of eligible land is measured using the market value approach. A liability exists and is recognised on pre-1990 forests if the land use changes from forestry.

f) Biological assets

Biological assets consist entirely of tree plantations which are measured at fair value less any point of sale costs. Gains and losses arising on initial recognition or change in fair value, less estimated point of sale costs, are included in profit and loss in the period in which they arise.

The fair value of tree plantations is determined by an independent valuer.

The valuation method for immature trees is the net present value of future net harvest revenue less estimated costs of owning, protecting, tending and managing trees. For mature trees fair value is deemed to be the net harvest revenue value.

g) Property, plant and equipment

All items of property, plant and equipment are valued at the cost of purchase from the Crown as at 1 July 1992 adjusted for subsequent additions at cost, disposals, depreciation and impairment. Plant and equipment are recorded at cost less accumulated depreciation. Land and capital work in progress are recorded at cost. Some library books have been identified as heritage assets and are recorded at fair value as determined by an independent valuer. Valuations are obtained every five years or more often where circumstances indicate that a significant change in fair value has occurred.

Expenditure incurred on property, plant and equipment is capitalised where such expenditure will increase or enhance the future benefits provided by the asset. Expenditure incurred to maintain future benefits is classified as repairs and maintenance.

When an item of property, plant and equipment is disposed of the difference between the net disposal proceeds and the carrying amount is recognised as a gain, or loss, in profit and loss.

Depreciation is provided for using the straight-line method to allocate the historical cost, less an estimated residual value, over the estimated useful life of the asset.

The useful lives of the major classes of assets have been calculated as follows:

Buildings and Land Improvements	40–60 years
Plant and Equipment	4–15 years
Furniture and Fittings	10 years
Motor Vehicles	3–7 years
Library Books and Periodicals	20 years

h) Recoverable amount of non-current assets

At each reporting date, the Group assesses whether there is any indication an asset may be impaired. Where an indicator of impairment exists, the Group makes a formal estimate of recoverable amount. Where the carrying amount of an asset exceeds its recoverable amount the asset is considered impaired and is written down to its recoverable amount.

Recoverable amount is the greater of fair value less costs to sell and value in use. It is determined for an individual asset, however, if the asset's value in use cannot be estimated to be close to its fair value less costs to sell, and it does not generate cash inflows that are largely independent of those from other assets or groups of assets, it is determined for the cash-generating unit to which the asset belongs.

In assessing value in use, the estimated future cash flows are discounted to their present value using a pre-tax discount rate that reflects current market assessments of the time value of money and the risks specific to the asset.

i) Trade receivables

Trade receivables are initially recognised at fair value and subsequently valued at amortised cost less impairment allowance.

Collectability of trade receivables is reviewed on an ongoing basis. Debts that are known to be uncollectible are written off when identified. An allowance for doubtful debts is raised when there is objective evidence that it is probable the Group will not be able to collect the debt. Financial difficulties and payment defaults without explanation are considered objective evidence of impairment.

j) Inventories

Consumable stores are valued at the lower of cost, on a weighted average price of stock on hand, and net realisable value.

Nursery stocks are valued at lower of cost or net realisable value. Changes in net realisable value are recognised in the profit and loss account in the period in which they occur.

k) Research costs

Research costs are expensed in the period incurred.

l) Provisions and employee benefits

Provisions are recognised when the group has a present obligation (legal or constructive) as a result of a past event, it is probable that an outflow of resources embodying economic benefits will be required to settle the obligation and a reliable estimate can be made of the amount of the obligation.

Provisions are measured at the present value of management's best estimate of the expenditure required to settle the present obligation at the Statement of Financial Position date using a discounted cash flow methodology.

(i) Wages, Salaries and Annual Leave

The liability for wages, salaries and annual leave recognised in the Statement of Financial Position is the amount expected to be paid at balance date. Provision has been made for benefits accruing to employees for annual leave in accordance with the provisions of employment contracts in place at balance date.

(ii) Long Service Leave

The liability for long service leave is recognised and measured as the present value of expected future payments to be made in respect of services provided by employees up to the reporting date using the projected unit credit method. Consideration is given to expected future wage and salary levels, experience of employee departures, and periods of service. Expected future payments are discounted using market yields at the reporting date on national government bonds with terms to maturity and currencies that match, as closely as possible, the estimated future cash outflows.

(iii) Defined Benefit Plan

The defined benefit plan is unfunded. The cost of providing benefits under the defined benefit plan is determined using the projected unit credit actuarial valuation method. Actuarial gains and losses are recognised in the profit and loss account in the period in which they arise.

The defined benefit liability recognised in the Statement of Financial Position represents the present value of the defined benefit obligations.

Long service leave and defined benefit plan provisions are based on an actuarial valuation.

m) Leases

The determination of whether an arrangement is or contains a lease is based on the substance of that arrangement at inception date.

Group as a Lessee

Operating lease payments, where the lessors effectively retain substantially all the risks and benefits associated with ownership of the leased items, are included as an expense in the profit and loss in equal instalments over the lease term.

Group as a Lessor
Leases in which the Group retains substantially all the risks and benefits of ownership of the leased asset are classified as operating leases. Initial direct costs incurred in negotiating an operating lease are expensed as incurred.

n) Cash and cash equivalents
Cash and short-term deposits in the Statement of Financial Position comprise cash at bank and in hand and short-term deposits with an original maturity of three months or less.

For the purposes of the Statement of Cash Flows, cash and cash equivalents consist of cash and cash equivalents as defined above, net of outstanding bank overdrafts.

o) Goods and Services Tax (GST)
All items in the financial statements are stated net of GST, with the exception of trade receivables and payables, which are inclusive of GST invoiced.

p) Foreign currencies
Functional and presentation currency
Both the functional and presentation currency of New Zealand Forest Research Institute Limited and its subsidiaries is New Zealand dollars.

Transactions and balances
Transactions in foreign currencies are initially recorded in the functional currency by applying the exchange rates ruling at the date of the transaction. Monetary assets and liabilities denominated in foreign currencies are retranslated at the rate of exchange ruling at the Statement of Financial Position date.

Non-monetary items that are measured in terms of historical cost in a foreign currency are translated using the exchange rate as at the date of the initial transaction. Non-monetary items measured at fair value in a foreign currency are translated using the exchange rates at the date when the fair value was determined.

q) Revenue recognition
Research Revenue
Research revenue from both Government and commercial sources is recorded when earned based on the percentage of work completed. Percentage of work completed is based on management judgement, after considering costs incurred and other contracted commitments. Work completed but not invoiced is recorded as accrued revenue while work invoiced but not completed is recorded as revenue in advance.

Government revenue includes revenue received from the Ministry for Science and Innovation in the form of Core Funding, Public Good Science and Technology investment, and Preseed Accelerator Fund programmes. Funding includes both devolved and milestone related programmes. Government revenue has only been recognised after all appropriate conditions have been met.

Sale of Goods
Revenue is recognised when the significant risks and rewards of ownership of the goods have passed to the buyer. Risk and reward are considered passed to the buyer at the time of delivery.

Interest Revenue
Interest revenue is recognised when earned based on applicable interest rates applied to the Group's cash deposit balances.

r) Taxation
The income tax expense charged to the profit and loss includes both the current year's provision and the income tax effects of temporary differences calculated using the liability method.

Tax effect accounting is applied on a comprehensive basis to all temporary differences. A debit balance in the deferred tax account, arising from temporary differences or income tax benefits from income tax losses, is only recognised if it is probable there will be taxable profits available in the future against which the deferred tax asset can be utilised.

Subsequent realisation of the tax benefit is subject to the requirements of income tax legislation being met.

s) Borrowing costs
Borrowing costs are recognised as an expense when incurred except for those borrowing costs determined as directly attributable to the acquisition, construction or production of a qualifying asset (i.e. an asset that necessarily takes a substantial period of time to get ready for its intended use or sale).

t) Interest-bearing loans and borrowings
All loans and borrowings are initially recognised at the fair value of the consideration received net of issue costs associated with the borrowing.

After initial recognition, interest-bearing loans and borrowings are subsequently measured at amortised cost using the effective interest method. Amortised cost is calculated by taking into account any issue costs, and any discount or premium on settlement.

For the purpose of valuing bank borrowings, the bank interest rate is taken as the discount rate. As such the bank borrowings are carried at the value of the debt with the bank.

u) Trade and other payables
Trade and other payables are carried at amortised cost and due to their short term nature they are not discounted. They represent liabilities for goods and services provided to the Group prior to the end of the financial year that are unpaid and arise when the group becomes obliged to make future payments in respect of the purchase of these goods and services. The amounts are unsecured and are usually paid within 60 days of recognition.

1.2 Significant accounting judgements, estimates and assumptions

a) Revenue recognition

Revenue is recognised based on the percentage of work completed on a project basis. Percentage of work completed is based on management judgement after considering such things as hours completed, costs incurred, milestones achieved, costs to complete and actual results to date.

b) Heritage assets

The Group holds several heritage assets which have significant value due to being both rare, and having importance to the nation. Where a heritage cost can be measured reliably they are revalued at least every five years and included as part of property plant and equipment.

Due to the nature of some heritage assets, management does not believe they can be valued reliably. These assets have been identified and disclosed. Details of heritage assets can be found in note 10 and 21.

c) Biological assets

The Group's biological assets consist of tree plantations. These are valued at the net present value of future net harvest revenue less estimated costs of owning, protecting, tending and managing trees. The valuation process includes several judgements and estimations around discount rates, future costs, and future prices. Management used the experience of a registered forestry valuer to reduce the risk of misstatement resulting from these judgements and estimates.

d) Defined benefit scheme

The Group operates an unfunded defined benefit plan. Significant assumptions used involving the plan include the discount rate and future salary increases as set out in the notes to the financial statements. Management used the experience of a registered actuary to reduce the risk of misstatement resulting from these judgements and estimates.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