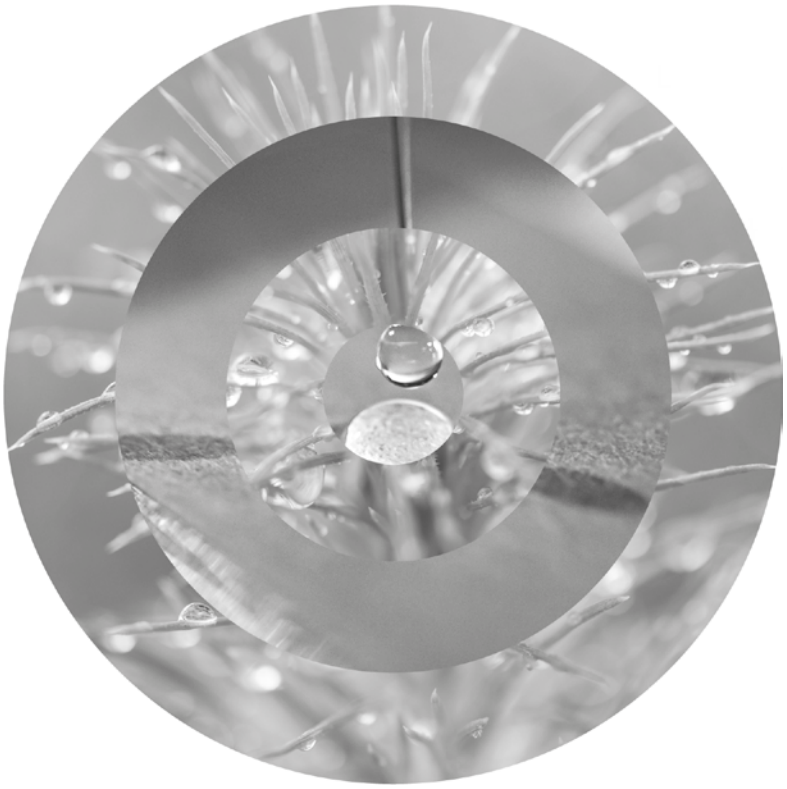
SCION™
FORESTS ■ PRODUCTS ■ INNOVATION

Statement of Corporate Intent
2017-2022

Prosperity from trees *Mai i te ngahere oranga*



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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 3010
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), Steve Wilson (2016).
Executive Management	Chief Executive, Julian Elder; General Manager Research and Investments, Russell Burton; General Manager Manufacturing and Bioproducts, Elspeth MacRae; General Manager Forest Science, Alison Stewart; Chief Financial Officer and Company Secretary, Rob Trass; General Manager People, Culture and Safety, vacant; General Manager Business Development and Commercialisation, vacant.
Staff	301 full-time-equivalent staff at four sites: Rotorua (277), Christchurch (22), Wellington (1), Dunedin (1), as at 31 May 2017.
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 $36,385 million at 30 June 2016.

Shareholdings

COMPANY	COMPANY TYPE	SCION SHAREHOLDING %
Te Papa Tipu Properties Limited	A land-holding subsidiary	100.00
Biopolymer Network Limited	An incorporated joint venture	33.30
WQI Ltd (Trading as Solid Wood Innovation)	An MBIE-industry partnership in wood processing. WQI Limited is in voluntary liquidation.	5.95
Terax Limited Partnership	A limited partnership to commercialise the Terax technology	50.00
Terax (2013) Limited	The General Partner in Terax Limited Partnership	50.00
Sala Street Holdings Limited	Holds Scion's 50% share in both Terax (2013) Limited and Terax Limited Partnership	100.00

Contents

Chair and Chief Executive overview

We are pleased to present Scion's 2017-2022 Statement of Corporate Intent (SCI). In formulating this SCI we considered the 2025 Business Growth Agenda targets, the National Statement of Science Investment (NSSI), the Conservation and Environment Science Roadmap signals and the replacement of Core funding with Strategic Science Investment Funding from July 2017, New Zealand's 2030 Nationally Determined Contribution commitment to the COP21 Paris Climate Agreement, implementation of the 2014 National Framework for Freshwater Management by territorial authorities and the regional growth study action plans.

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 $14 billion of sales annually. As well, ecosystem services worth at least $800 million per annum are produced. These are vital in addressing climate change and managing land within environmental limits.

We also accounted for Scion's key stakeholder priorities – forest growers, wood processors, government departments and local government – and the importance of supporting Māori economic development through forestry and wood processing by partnering with them.

Our strategic review confirmed increasing demand for wood and wood products driven by the move to renewable circular economies. The bioeconomy is seen internationally as providing an important opportunity for industrial renewal. 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[1]. In New Zealand a substantial increase in 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 in delivering our water quality goals. 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[2].

Scion continues to build capability and excellence in forestry research to maximise the socio-economic outcomes to benefit New Zealand in the near, medium and long term. Areas of focus include increasing the profitably of and confidence to invest in forestry as a land use, markedly improving the rate of genetic improvement of *Pinus radiata* (and alternative species), lowering the cost of forestry operations and logistics, monetising forest ecosystem services (such as for carbon sequestration) and growing the capacity of processors to deliver higher-margin solutions for their customers. The latter includes Scion taking a serious relook at the future of log manufacturing in regions where large scale (>1 m tonnes of log in) are not viable due to transport costs. Additive manufacturing, distributed processing and new 'brownfield' options to add value to currently unused parts of the tree – could all contribute to the renaissance of manufacturing at small- to mid-scale in regions outside of the central North Island.

SECTOR CO-BENEFITS AND COMPLEMENTARITY

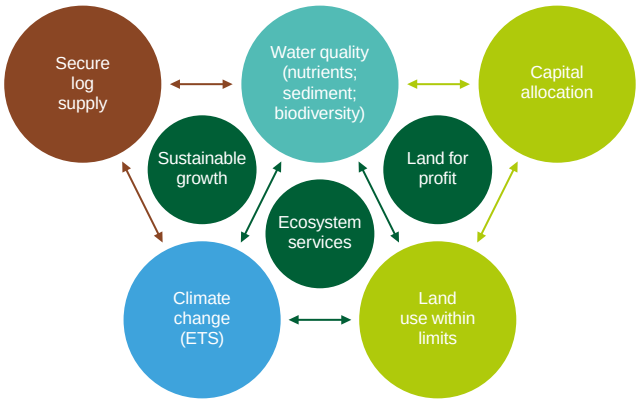


Figure 1: *Linkages that support sector complementarity and resilient regional economic growth*[3].

[1] 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

[2] 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

[3] 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.

Achieving new swimmable water quality limits and afforestation 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. Achieving sustainable land use through increased tree planting supports the COP21 Paris Agreement by reducing greenhouse gas emissions and at the same time improves log supply security and enhances ecosystem benefits. For these reasons Scion is stepping up its focus on smart, spatial integration of land use to exploit complementarity between land uses, such as forestry and dairy. This research will help land owners to improve the sustainability of land management and, in time, will encourage capital into higher performing infrastructure and manufacturing assets.

This global foresight, gathering of market intelligence and systems thinking at different spatial scales and across value chains is a strong feature of Scion's modus operandi and is embedded into the design of the 2017-2022 science and innovation plan. Our planning is structured to deliver to seven Impact Areas (IA) as follows:

IA1:	Increase value from plantation forested land.
IA2:	Increase the resilience of forests to biotic and abiotic risks.
IA3:	Licence to operate and standards across the forest industry value chain.
IA4:	Diversify forests and local manufacturing to support regional growth.
IA5:	Increase the use of wood and fibre products in the built environment.
IA6:	Manufacture and apply biorefinery products from wood fibre, waste and other materials.
IA7:	Use more forest biomass to improve New Zealand's energy security and reduce emissions.

These impact areas collectively span the value chain and are inter-dependent.

We are evolving Scion's business model to increase Scion's financial resilience and grow science excellence and impact. For example, we are working 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.

In parallel with this we are re-investing surpluses into Learning and Growth (L&G) initiatives in order to diversify revenue and make Scion a great place to work. Reinvestment of $2.0 million is proposed for 2017/18 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 Toi Ohomai Institute of Technology[4], grow the Māori economy via forestry, exploit the potential of 'big data' tools at Scion and with other parties, and prepare for and embed benefits from infrastructural changes.

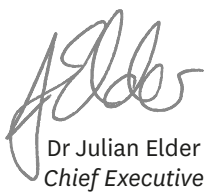
In 2018, we will commence construction of innovation hub offices within our main science buildings and refurbishment of our 1950s laboratories and pilot plant facilities. We will also be improving the public's access to our science. The three-year development, the largest at Scion for many years, will cost an estimated $18 million. Once completed Scion will have scope from 2020/21 to reduce capital expenditure and increase reinvestment into accelerating commercialisation.

Scion's financial projections to June 2021 are founded on prudent revenue growth, tight control of costs and retention of balance sheet flexibility to handle 'shocks'. Revenue for 2017/18 is budgeted at $54.3 million, and earnings before interest and tax and after reinvestment is budgeted at $2.0 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, 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 meet its potential for New Zealand and fulfil our vision of *Prosperity from trees*.

Scion envisages a future where forestry as a renewable resource will be pivotal to New Zealand's economic, environmental and social wellbeing. We will gain a respected position of thought leadership opening up pathways for existing forests and processors and for new forests and processors. As partners with industry organisations and iwi we will grow and transform the forest industry to expand and enrich regions across New Zealand and enrich and expand sectors such as building and construction, biomaterials and advanced manufacturing. And, in this future low-carbon bioeconomy we have helped develop, trees will also be part of the landscape as major contributors to addressing climate change and achieving sustainable land use.

Tony Nowell CNZM
Chair



Dr Julian Elder
Chief Executive

[4] Toi Ohomai Institute of Technology came into being on 1 May 2016 through the merger of the Waiariki Institute of Technology and Bay of Plenty Polytech.

1. 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). At the same time, earnings from forest-related technologies are expected to grow to at least $2 billion per annum by 2022[5]. 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[6]. Total forestry related exports were $5.1 billion for the year ending June 2016[7]. MPI forecasts export earnings to grow at 4-5% per annum to $6.4 billion by 2021.

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.

Total sales in the forest growing to consumer value chain (see insert 'The New Zealand Forest Industry' for a description) exceeds $14 billion per annum[8]. This includes exports ($5.14 billion for the year to June 2016) and sales from design, construction, furniture manufacture, resins, carbon, kilns and other forest industry services (for example, harvesting equipment). Exports of pulp, paper, wood manufactured products and logs represent New Zealand's third largest merchandise export earner[9]. The forest industry generates high value per full-time worker (on average about $215,000 of GDP/FTE in the Bay of Plenty[10] region) and about four to six '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

World-wide the forest industry is in the midst of a transformation 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 2)[11].

New Zealand's commercial forests

New Zealand's 1.7 million hectares of commercial forests have a standing volume of 503 million m³ of timber as at 1 April 2016. 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 39,948 hectares of replanting and 3,000 hectares of new planting occurred in 2015. The net stocked forest area decreased by 13,000 hectares from 1 April 2015. Some 45,342 hectares were harvested in the year to April 2016, representing an average age of 29.1 years and average clear fell yield of 552 m³ per hectare. Almost 1.0 million hectares are FSC certified.

(Source: Ministry for Primary Industries report *National exotic forest description as at 1 April 2016).*

Even with proactive and unified action on the COP21 Paris Climate Agreement average global temperatures in 2050 are projected to be 1.5-2.7°C warmer than in 2016. Extreme

[5] Wood Council of New Zealand Inc. (2012). *New Zealand Forest and Wood Products Industry Strategic Action Plan.* Retrieved 23 April 2014 from http://www.woodco.org.nz
[6] Ministry for the Environment. (2014). *New Zealand's Greenhouse Gas Inventory 1990-2012.* http://www.mfe.govt.nz/sites/default/files/media/Climate%20Change/ghg-inventory-1990-2012.pdf
[7] Ministry for Primary Industries. (2016). Situation and outlook for primary industries. December 2016.
[8] Scion. (2012). Internal report of estimates in total annual sales in the forest industry value chain.
[9] Ibid, reference 5.
[10] John Galbraith personal communication, May 2012.
[11] Winston, A. (2014, April). Resilience in a hotter world. *Harvard Business Review*: 56-64.

weather events (floods, wild fires, high winds) and biosecurity outbreaks will be more frequent, and food and water security concerns will intensify[12],[13].

Figure 2: *Macro drivers of change in the forest industry.*

With a world population expected to be about 9 billion (currently 7 billion)[14] 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.

These global drivers are reshaping the New Zealand economy and precipitating very large public and private sector investment into technology with a smaller environmental footprint. Energy, water and food security are much more pressing issues in Europe, the Americas and Asia than in New Zealand. Nations within these regions generally have far less natural resources per capita than New Zealand and have started transitioning to a more energy-efficient, bioeconomy[15] future through the installation of biorefineries, land use change and prioritising 'green economy' research and development investment (e.g. Malaysia, Korea). Industry 4.0[16], such as via additive manufacturing utilising 3-D printing and the internet, is transforming how and where goods are produced. This may offer siginifcant opportunities for regional development in New Zealand.

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[17] and use of precision breeding via 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 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 (i.e. Aichi Biodiversity Targets), 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.

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.*

[12] International Panel on Climate Change (2014). *Climate change 2014: Impacts, adaption, and vulnerability.* Retrieved 24 April 2014 from http://www.ipcc.ch/report/ar5/wg2

[13] Royal Society of New Zealand (2016) *Climate change implications for New Zealand*. Retrieved 20 April 2016 from https://royalsociety.org.nz/what-we-do/our-expert-advice/all-expert-advice-papers/climate-change-implications-for-new-zealand

[14] United Nations. (2004). *World population to 2300*. http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf

[15] 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*. http://www.ec.europa.eu/research/participants/data/ref/fp7/132093/b-wp-201301_en.pdf

[16] Industry 4.0 is the merging of real production with the virtual world – a world in which information technology is fully incorporated into production processes. See http://www.din.de/en/innovation-and-research/industry-4-0/what-is-industry-4-0

[17] 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.).

Significant trends for Scion science and technology

The preceding overview 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 can be summarised as:

1. **Climate action** to mitigate and adapt to rising GHG emissions by transitioning to renewable, low carbon substitutes for petroleum products; the 'greening' of business and requirement to verify 'forest to consumer' environmental (and social) footprint. (The COP21 Paris Agreement, bans on illegal logging and move towards increased transparency of the social responsibility exercised by business adds momentum to this.)

2. **Industry 4.0 and renaissance of manufacturing** in regions enabled by information communication technology (ICT). 'Big data', smart connected products and automation are disrupting traditional manufacturing business models.

3. **Precision technologies and systems** that support improvements to resource use efficiency, worker safety and the productivity of forestry and tree manufacturing, through automation, sensors, robots and machine learning, are dramatically changing workforce skill requirements.

4. **Natural resource limits and sustainable use of land:** Tougher to achieve ecosystem limits are being regulated for GHG emissions, biodiversity and water quality (i.e. the cost of externalities are internalised to their source). This is increasing the focus on new technologies such as for precision breeding (e.g. gene editing). Industrial biotechnology, combined with 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'.

   Associated with this are:
   a. **Land-use integration at different scales (enterprise, catchment, district)** and exploitation of complementarities between the supply chains for different land enterprises (e.g. pastoral livestock and forestry).
   b. **Development of the circular economy** through new recyclable materials, life economics, smart packaging, and closed loop manufacturing. Growth of synthetic foods, sourcing of ingredients from insects and production of proteins via plants.

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. **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.

7. **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.

8. **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. Improved energy storage systems, smart grids and zero-energy buildings.

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

The forest industry and Scion in 2025 - a preferred future[18]

By 2025 the New Zealand forest industry is strongly capitalising on the global economic, environmental and societal changes described in the previous sections and is summarised in Figure 3.

[18] 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.

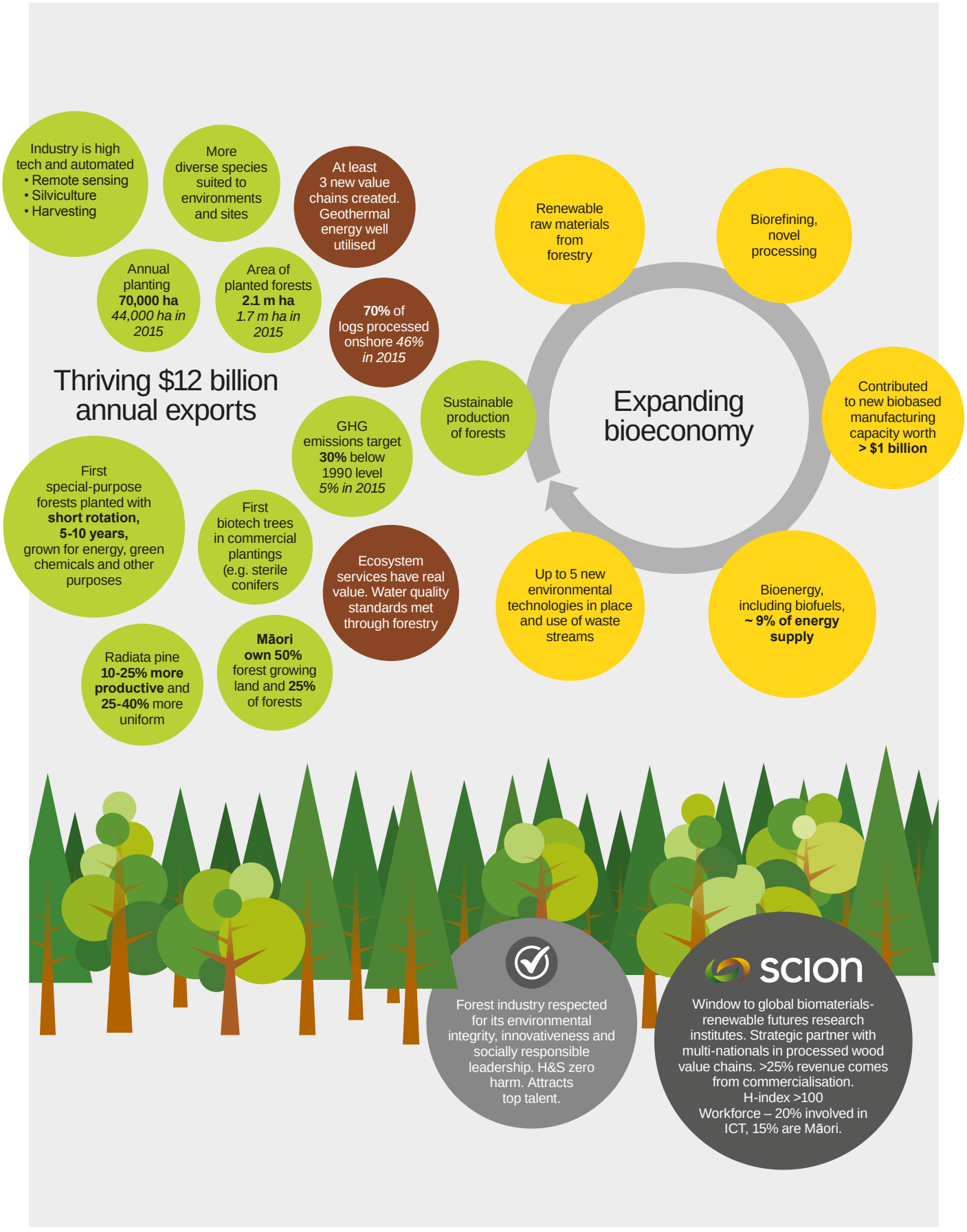


Figure 3: *Vision of the forest industry and Scion in 2025.*

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)[19]: 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:

- Increasing the proportion of logs processed onshore from circa 50% to at least 70% and lifting the conversion rate by 5% on all logs processed
- 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 through product diversification and using all of the tree (e.g. bark, stumps).
- Transforming the use of wood in building systems such as through a suite of engineered wood products, new methods for fastening, fitting and insulation; and 'natural' coatings and adhesives.
- 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 (FOA), in its Science and Innovation Plan[20] 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/m³ of log harvested. In recent years the circa 30 million m³ 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)[21] whose purpose is to provide "superior radiata pine germplasm to its shareholders and customers in Australasia". The RPBC undertakes commercial *Pinus radiata* tree breeding and licensing of germplasm to nurseries; and purchases research into radiata pine tree breeding and the development of superior genetics for its shareholders and customers.

Farm foresters and woodlot owners[22]**:** The New Zealand Farm Forestry Association (FFA) has a diverse membership drawn from circa 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.

Wood processors and manufacturers[23]**:** 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 New Zealand[24]; the Timber Industry Federation[25], and New Zealand Building Industry Federation[26].

The WPMA adopted a 2050 vision "ReNewing New Zealand (Figure 4) 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.

[19] Wood Council of New Zealand Inc. (2012). *New Zealand Forest and Wood Products Industry Strategic Action Plan.* Retrieved 23 April 2014 from http://www.woodco.org.nz

[20] Forest Owners Association. (2012 and updated April 2016). *New Zealand Science and Innovation Plan*. Wellington, New Zealand. Retrieved on 19 April 2016 from http://www.nzfoa.org.nz

[21] See http://www.rpbc.co.nz

[22] Farm Forestry Association http://www.nzffa.org.nz

[23] See http://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.

[24] See http://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.

[25] See http://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.

[26] See http://bifnz.co.nz The BIFNZ represents the supply chain of the building industry and represents the interests of its member to government on important policy issues that affect the construction sector.

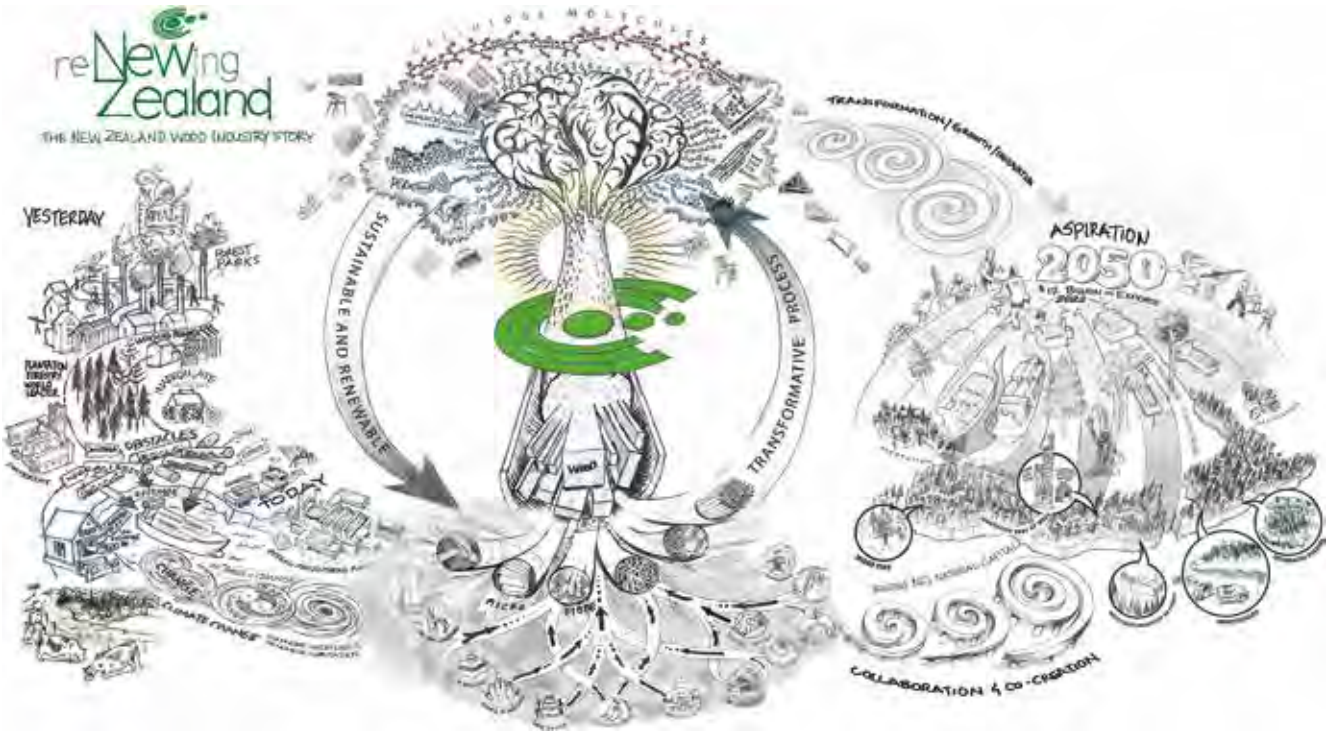


Figure 4: *The Wood Processors and Manufacturers' Association 're**New**ing **Zealand**' 2050 vision shows the transition pathway envisaged to achieve a high value, integrated, technologically advanced and low environmental impact industry.*

Factors common to the FOA (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[27] 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[28].
- Up to 100,000 investors in smaller-scale forestry during the 1990s are unlikely to reinvest for a second rotation (starting circa 2015-2020). Recruitment of a new cohort of investors into forests is required.
- Processing a log onshore generates at least a two-fold increase in GDP compared to a raw log export. Improving the competitiveness of domestic wood processing is critical to the industry meeting its growth aspirations and potential for New Zealand.
- 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[29]. 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 15) to grow the Māori economy through forestry. Māori have more than $2 billion of assets in forestry[30] 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:

[27] Provisional estimates of tree stock sales and forest planting in 2013. Source: http://www.mpi.govt.nz

[28] Monge, J. J., Parker, W. J. and Richardson, J. W. 2016. Integrating forest ecosystem services into the farming landscape: A stochastic economic assessment. *Journal of Environmental Management* (in press).

[29] Monge, J. et al. (2016). Identifying complementarities for the dairy and forestry industries in the central North Island. Available at https://www.waikatoregion.govt.nz/council/policy-and-plans/plans-under-development/healthy-rivers-plan-for-change/technical-alliance/technical-alliance-documents

[30] Nana, G., Stokes, F., & Molano, W. (n.d.). *The asset base, income, expenditure and GDP of the 2010 Māori economy.* Wellington, New Zealand: Māori Economic Taskforce. http://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

- 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[31].

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 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"[32].

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[33] 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 5.

Regional growth studies and their respective action plans have been released for Northland, Bay of Plenty, East Coast, Manawatu/Whanganui, West Coast and Southland. These are overseen by MBIE and MPI (or another nominated lead government agency such as the Department of Conservation for the West Coast) and coordinated with local agencies

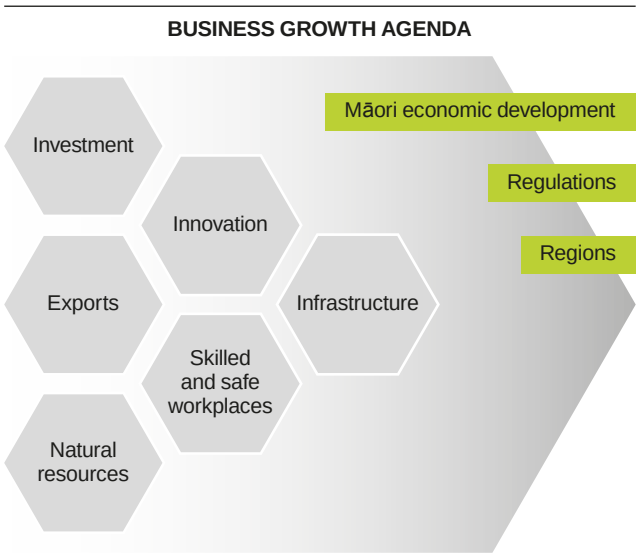


Figure 5: *The New Zealand Government Business Growth Agenda framework aligns directly to the forest industry and industrial bioproducts sectors Scion works with.*

such as Bay of Connections for the Bay of Plenty region[34]. The action plans identify and prioritise forestry and wood processing as the best opportunities for economic growth in several of these regions.

Callaghan Innovation[35] 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.

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"[36]. The NSSI indicates the direction for changes in investment. The 11 National Science Challenges, announced on 1 May 2013[37], and still being operationalised, sit within this overarching investment plan. As described in more detail later (Section 3 page 22), the challenges provide new impetus to connect science providers to tackle 'big' national problems through 'stretchy'

[31] Te Puni Kokiri. (2013). *Discussion document: Te Ture Whenua Māori Act 1993 Review Panel*
[32] Te Puni Kōkiri. (2012). *Māori Economic Development Panel discussion document*. http://www.tpk.govt.nz/_documents/medp-discussiondocfinal-2012.pdf
[33] *Business Growth Agenda – Towards 2025*. http://www.mbie.govt.nz/info-services/business/business-growth-agenda/towards-2025
[34] Bay of Connections http://www.bayofconnections.com/growth-programme
[35] Callaghan Innovation; http://www.callaghaninnovation.govt.nz
[36] Ministry of Business, Innovation & Employment. (n.d.). http://www.mbie.govt.nz/info-services/science-innovation/national-statement-science-investment
[37] Ministry of Business, Innovation & Employment. (n.d.). *National Science Challenges*. Retrieved 18 March 2014 from http://www.mbie.govt.nz/info-services/science-innovation/national-science-challenges

horizon 2 and horizon 3 science. Scion is participating in six of the challenges and these will increasingly impact Scion's science strategy and investment.

Conservation and Environment Science Roadmap: The Roadmap[38] published in February 2017 identifies six broad themes for New Zealand's areas of scientific endeavour in the areas of conservation and environment science over the next 20 years.

Local government: Local government owns 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[39] relevant to the forest industry include integrated land and freshwater management, nutrient and contaminant management, hazard management 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[40] and energy development[41]. 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.

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 5). This is complemented by regional growth study action plans, which identify the best prospects for lifting growth in "sub-performing" regions, and the Māori Economic Development strategy.

Scion's response

With this strategic and operating context in mind, Scion has evolved its strategy and associated science and innovation plan, described in the next sections, 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.

[38] http://www.mfe.govt.nz/sites/default/files/media/About/conservation-and-environment-science-roadmap.pdf
[39] Envirolink. (n.d.). Research Strategy. Retrieved 18 March 2014 from http://www.envirolink.govt.nz/Research-Strategy
[40] 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
[41] Bay of Connections. (2011). *Bay of Plenty Energy Strategy.* http://www.bayofconnections.com/downloads/Energy_Strategy_December_2011.pdf

2. Scion's purpose and business model

Statement of Core Purpose

Scion's Statement of Core Purpose (SCP), adopted in October 2010, defines Scion's 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 beneficial environmental and social outcomes for New Zealand"[42]. 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.

A rich legacy of achievements and adaption to keep at the leading edge of change has built Scion's reputation as a world-leader in forest industry science and innovation. Scion has developed a distinct multi-disciplinary capability that spans 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, the emerging bioeconomy and to broader social issues such as securing licence to operate and Māori economic development. 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. As illustrated in Figure 6, the foundations for this 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. This is supported by a customer-focussed culture and values (Figure 7) that ensure customers and stakeholders needs and opportunities are well defined and new knowledge and technology is delivered in a manner that best suits their requirements and able to be readily adopted into the relevant value chains.

[42] The full Statement of Core Purpose is available at www.scionresearch.com/scp

SCION'S BUSINESS MODEL CANVAS

OUR PARTNERS ARE:

The stakeholders along the forest industry and biomaterials manufacturing supply chain

Māori involved (or wishing to be) in the forest industry and with bioproducts

Investors that align to delivery of our core purpose

National and international science and innovation entities that strengthen Scion's customer offering

OUR RELATIONSHIPS WITH THEM ARE TO:

Build quality partnerships with the stakeholders along the supply chain including firms in New Zealand and offshore

Foster collaborations with national and international researchers and selected institutes

Nurture partnerships with Māori consistent with Treaty of Waitangi principles and enable economic development

OUR RESOURCES DELIVER:

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

PROBLEMS WE SEEK TO SOLVE ARE:

Grow New Zealand forest industry exports to $12 billion by 2022

Enable New Zealand's natural capital to be used within ecosystem limits

Find new ways to create value and increase profit for customers and their shareholders

Diversify customers' product portfolios through new product offerings

Enable regional development and growth

WE DELIVER OUR PRODUCTS BY:

Partnering with stakeholders along the supply chain to identify the technology based barriers to achieving their target outcomes

Building the best user-investor-technical partnerships to develop and implement the solutions

OUR CUSTOMERS IN NEW ZEALAND AND OFFSHORE ARE:

Forest growers

New Zealand wood processors converting logs into solid wood products and providing residues to pulp and paper mills

Manufacturers deploying wood fibres and other biomaterials (non-food) to design, invent/or create value-added products

Land owners seeking to sustain and grow value from their land through forestry

Māori as landowners and investors

OUR COSTS ARE INCURRED IN:

Staff remuneration and growing Scion's scientific capability

Operating and maintaining the Rotorua campus infrastructure and leased facilities at other sites

Building national and international partnerships to access new ideas, talent, technologies and markets for New Zealand

Transferring technology to customers (industry, firms, public agencies), including through commercialisation

WE SECURE OUR REVENUE THROUGH:

CRI Strategic Science Investment Funding

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)

Collaboration with other research providers including CRIs, universities and international research institutes and companies

Selling contract services to customers

Licensing and selling intellectual property

Partnerships with Māori entities

Figure 6: *Scion's business model canvas.*

Figure 7: *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.

SOURCES OF CAPITAL FOR COMMERCIALISATION

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 8: *Examples of Scion's technology commercialisation pipeline.*

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 and improve Scion's financial resilience. Achieving this requires ongoing culture development, strong technology platforms with distinct and protected IP; and new sources of 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 9). This differentiates Scion internationally 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. For example, the key influencers in the value chain for commercialising Scion's wood plastic pellet technology (Woodforce[43]) are intermediaries such as the original equipment manufacturers (OEM) as well as are the final users (e.g. an automobile maker). To support the need to understand value chain design and performance, Scion has established a Value Chain Optimisation Team. All market-facing research programmes incorporate a value chain dimension and market assessment.

Environmental concerns are requiring the development of effective policies for regulators and solutions for resource

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

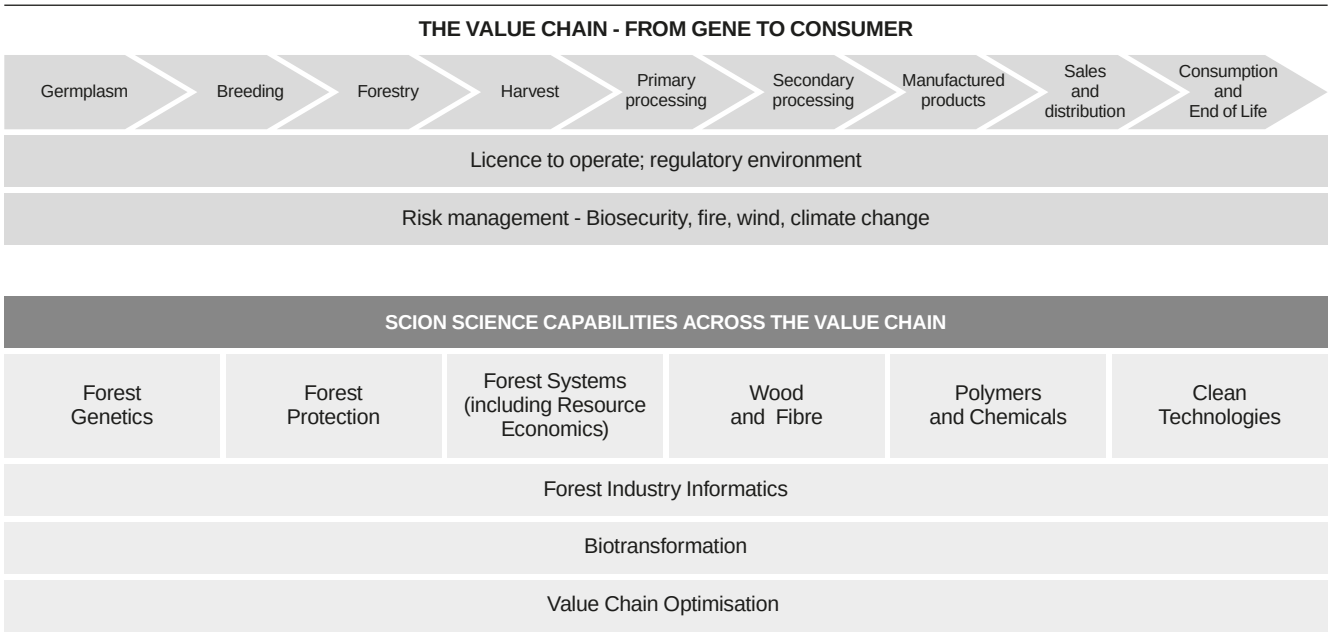


Figure 9: *Scion has capabilities across forestry value chains, which is rare internationally and a competitive strength in providing market solutions for customers.*

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. This 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 is strongly aligned to industry priorities and future aspirations, for example, the industry's goal of more than doubling sector export revenues to $12 billion by 2022. Assessing and illustrating the impact of Scion research is of critical importance to demonstrating the return on investment delivered. Methodologies as illustrated in Figure 10 are used to assist in doing this.

Innovation hubs to enable Scion's business model

Working closely with industry, policy agencies and investors is central to Scion's modus operandi. Scion is developing an innovation hub on its Sala Street Campus. The 10-year Campus Master Plan, adopted in 2015, 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). Construction for this major development will commence in 2018. 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 at NIWA's campus in Riccarton, Christchurch. After many years of co-location with the School of Forestry at the University of Canterbury, the shift to NIWA was made in 2017 gaining access to more space and facilities and deepening links with NIWA's expertise in climate, water and meteorological sciences. The Riccarton site will allow Scion to continue the links with the Lincoln hub development.

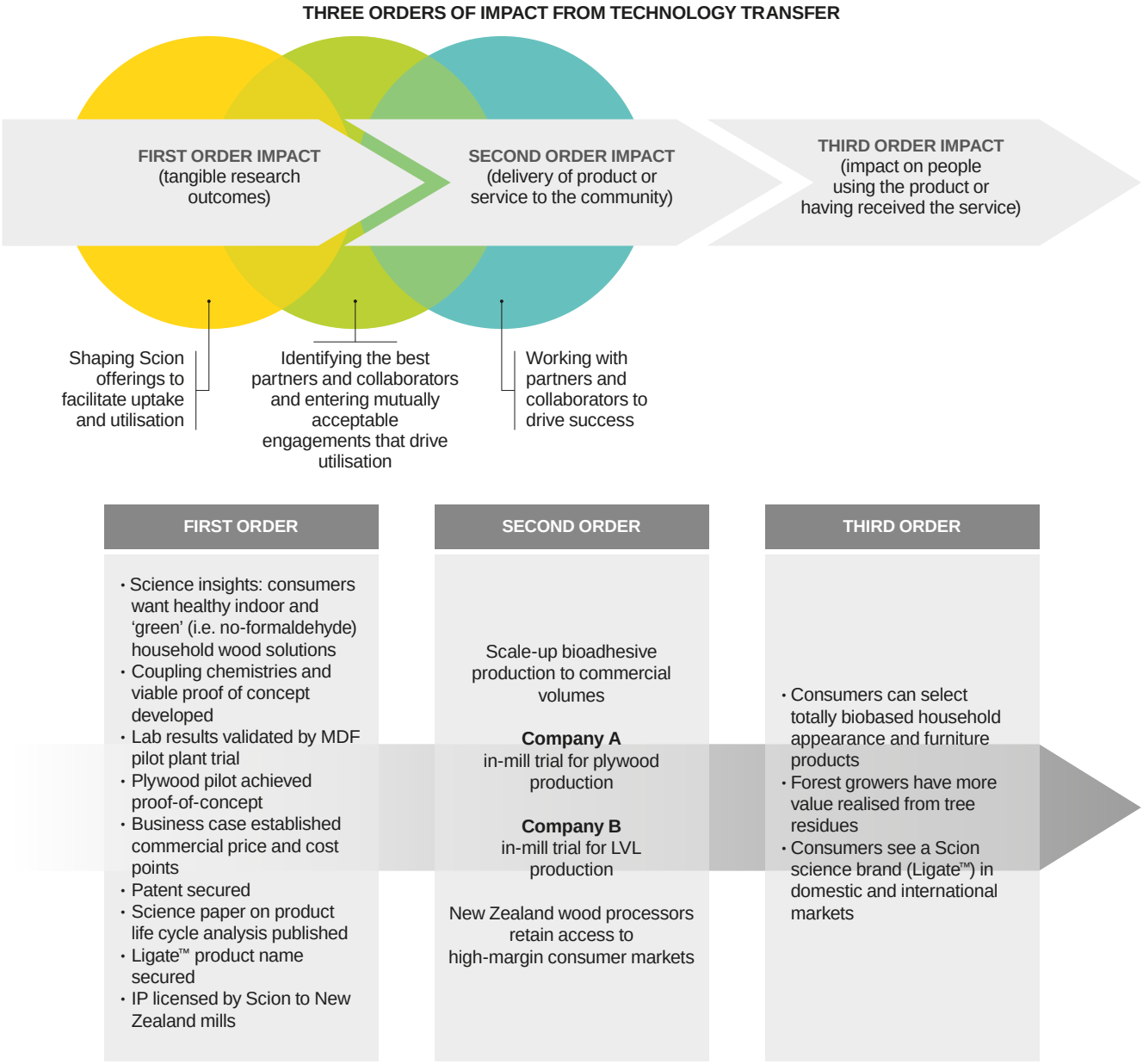


Figure 10: *Quantifying the impact of Scion science and technology. (Adapted from Mathou, N. 2015 and illustrated with Scion's bioadhesive technology platform.) (Note IP has not yet been licensed to New Zealand mills but scale up has occurred.)*

3. Scion's strategy and priorities

Scion's 2017-2022 strategy builds on the foundations laid in previous years and is formatted in the balanced scorecard approach as shown in Figure 11. The goal of the strategy is to deliver the science and technologies required by Scion's stakeholders to address their critical challenges and priorities (described in Section 2). In particular, the strategy seeks to:

1. Meet shareholders' requirements and assist all parts of the forest industry value chain and the biomaterials sector to achieve its long-term potential and contribution to New Zealand.
2. Meet customers' needs by delivering innovative, readily applied science outputs from seven areas of impact.
3. Develop excellence in (and systems to support) business processes.
4. Invest in Learning & Growth (L&G) initiatives where Scion needs to develop greater or new expertise, facilities, networks and partnerships; and secure a licence to operate in order to deliver the strategy.

The strategy map provides the foundation for preparing Scion's annual operating plan. This is the year-by-year execution of the strategy by ensuring specific objectives are completed for each dimension of the strategy during the financial year concerned. Monitoring and reporting to the Board is via a monthly scorecard with performance indicators that mirror the strategy. The process for preparing the monthly scorecard has been 'automated' through the Scion Way processes and system.

Expected income and reinvestment in 2017/18 is overlaid on the strategy map to illustrate the relative scale of each science impact area.

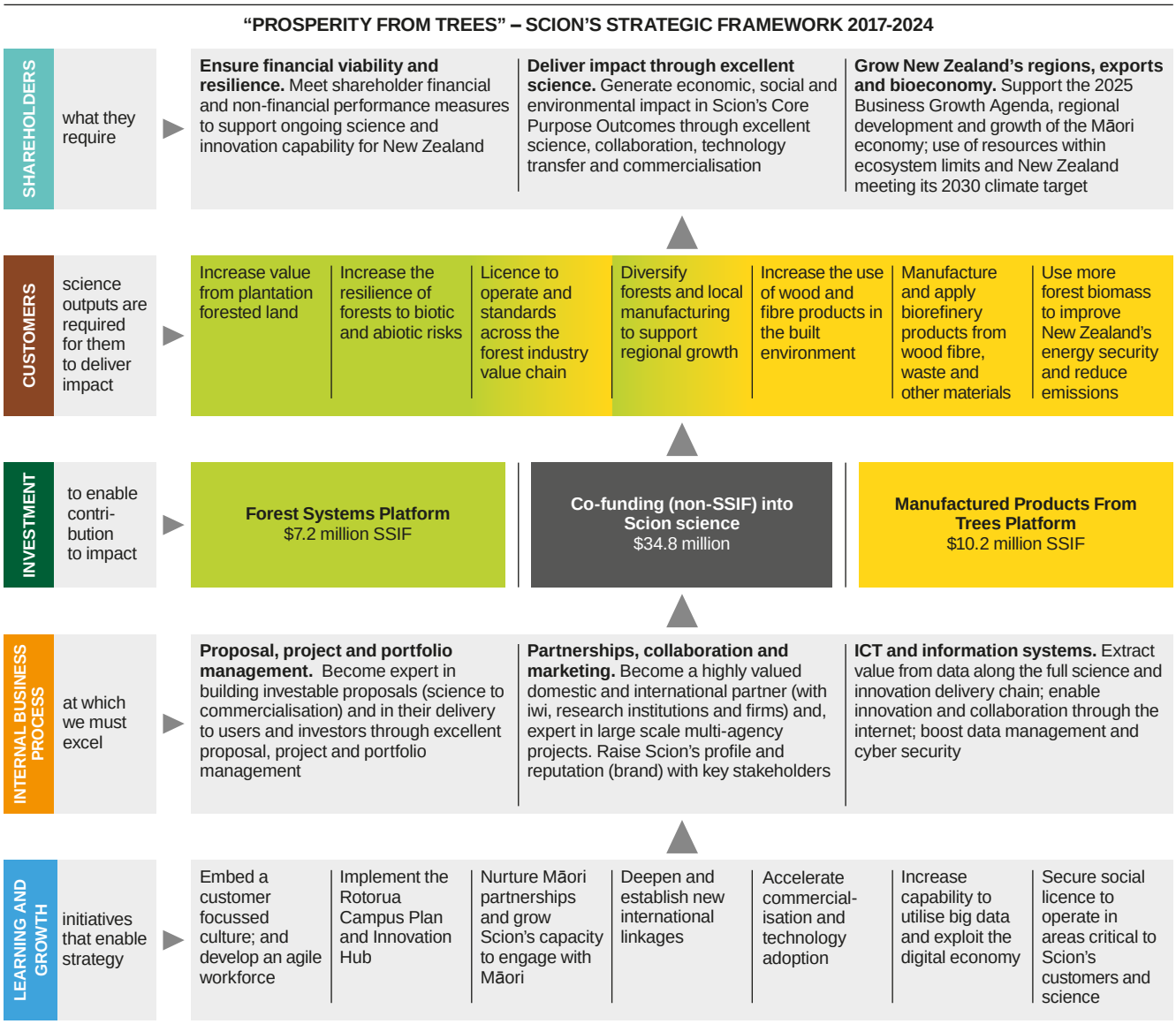


Figure 11: *Scion's strategy mapped in a balanced scorecard format.*

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 (2011-2014) - to increasing the alignment and impact of its research through more effective transfer and commercialisation of technology, building national and international collaborations, working in partnership with Māori and supporting regional development as illustrated in Figure 12. 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.

Strategic priorities

Scion's strategic initiatives over the 2017-2022 period are described below, noting some commenced several years prior to the current SCI (e.g. National Science Challenges were first announced in 2013; the building on value chain and informatics capability started in 2013). The actions remaining to fulfil these initiatives are described. Some initiatives are supported by the reinvestment of Scion surpluses; others are enabled by SSIF. Progress in achieving the strategic priorities will be commented on and 'traffic-lighted' in the scorecard similar to that shown in Table 1.

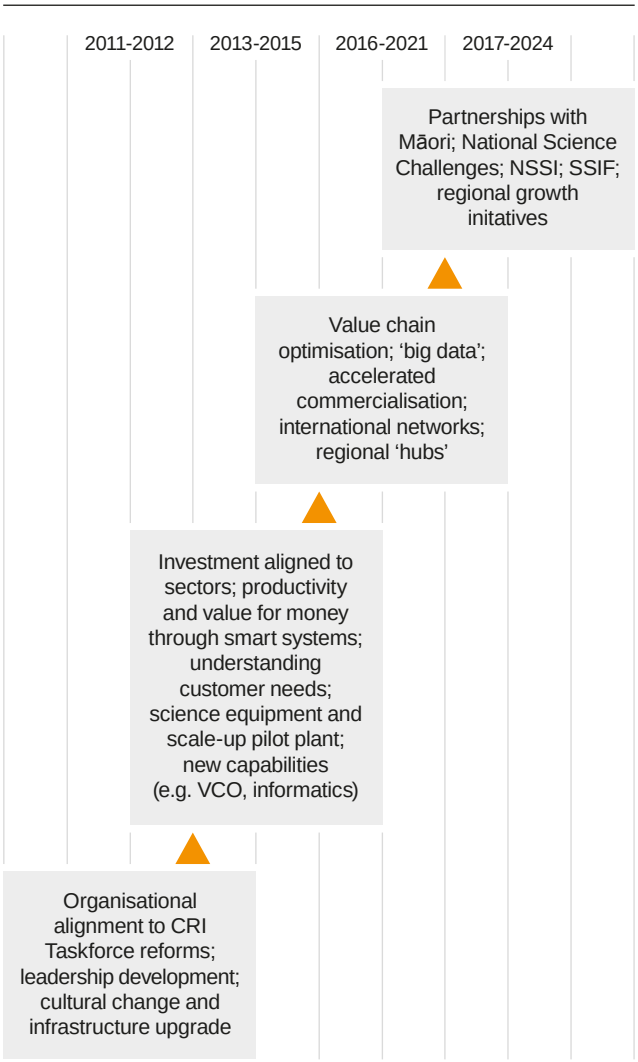


Figure 12: *Evolution of Scion's strategy and implementation priorities.*

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[44]. 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 established a Value Chain Optimisation (VCO) science team with specialist, quantitative analysis and translation expertise in value chain research and market analysis (see Figure 9).

The focus for 2017-2020 is to:

1. Identify the best means for forest growers and suppliers of equipment and information systems to make gains in operational efficiency in forest operations (e.g. tree thinning), harvesting and log logistics.
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 (e.g. via Impact Area 4 "Diversify forests and local manufacturing to support regional growth").
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

Scion has set an aspirational target to secure 25% of its revenues from commercialisation by 2025. As well as increasing financial resilience, more effective commercialisation of Scion's technologies will increase research impact and the competitive positions of the licensing and/or purchasing companies. In addition to lead

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

SCION'S 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% 10%
	Technologies adapted or co-invented for New Zealand industry through international networks	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 1: *Scion's strategic initiatives outcomes scorecard (ratings shown are estimated percentage completion of the actions described in this section).*

technologies TERAX® (reducing municipal wastes), Woodforce (Sonae-Arauco; wood plastics[45]) and Ligate™ (a bioadhesive), Scion has established other technology platforms (e.g. biotech trees, thermal modification and dewatering of wood) and an associated pipeline of more than 40 product concepts. 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 as well as technologies that contribute to 'smaller-scale, incremental gains' in forest and mill productivity.
3. Seeking new sources of investment for technology commercialisation.
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.

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

5. Developing staff expertise in technology commercialisation.
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. It also 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 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; develop foresight on global science and market trends to assist long-term planning of Scion science investment.
2. Providing seed investment to develop the best opportunities; support staff exchanges and secure external funding.

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 six of the NSCs as illustrated on this page.

During the SCI planning period, Scion expects to:

1. Commence service delivery to all of the NSCs shown in Figure 13.
2. Keep the forest industry and the industrial bioproducts manufacturing sector 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 building innovative, energy efficient, smart prefabricated homes in 'Building better homes, towns and cities' NSC.

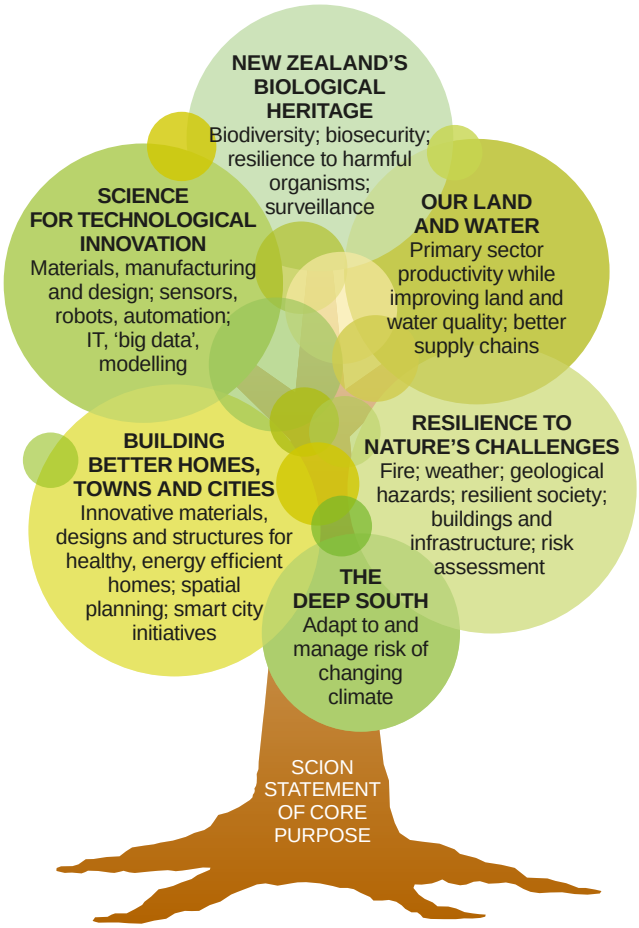


Figure 13: *The six National Science Challenges most aligned to Scion's core purpose*

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.

During the planning period Scion expects to:

1. Fully tenant the stage I innovation hub office space and generate synergies between the 27 companies already located in the Te Papa Tipu Innovation Park.
2. Work closely with the Rotorua Lakes Council, Bay of Plenty Regional Council and Industrial Symbiosis Kawerau (ISK)[46] to undertake the initiatives Scion is identified for as either the lead for or contributor to actions for the Bay of Plenty Regional Growth Study.
3. Work closely with Toi Ohomai Institute of Technology and

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

the University of Waikato to foster joint initiatives such as support for a Professor of Sustainable Forestry at Toi Ohomai and boosting the number of postgraduate students studying at Scion.

Figure 14: *Concept drawing of the 'Innovation Centre Building' scheduled for staged construction to commence in 2018.*

Priority 6. Partnerships with Māori

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[47]. 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). Scion's Te Papu Tipu Māori Plan (Figure 15) addresses these primary issues. This is executed through Scion's Māori Partnership Plan which draws together all of the 'threads' of work with Māori into an overarching annual operating plan. Progress in implementing the Māori Plan is assessed regularly by the Scion Board and its Māori Advisory Panel (Ngā Rangatira Rōpu).

Scion's priorities to grow the Māori economy through forestry 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. Opportunities to involve Māori in the commercialisation of Scion science will be sought.
2. Developing communication channels within Māoridom to improve their uptake of Scion research outputs such as those generated by the "Growing Confidence in Forestry's Future" programme.
3. Customising technology translation to best meet Māori needs through a partnership approach.

These initiatives align fully with *He Kai Kei Aku Ringa*[48], the strategy developed by the Crown Māori Economic Growth Partnership.

[47] 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

[48] 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

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

IA1 Increase value from plantation forested land

IA2 Increase the resilience of forests to biotic and abiotic risks

IA3 Licence to operate and standards across the forest industry value chain

IA4 Diversify forests and local manufacturing to support regional growth

IA5 Increase the use of wood and fibre products in the built environment

IA6 Manufacture and apply biorefinery products from wood fibre, waste and other materials

IA7 Use more forest biomass to improve New Zealand's energy security and reduce emissions

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 15: *Scion's Te Papa Tipu Māori Plan.*

4. Scion's science and innovation plan

The Strategic Science Investment Fund (SSIF) Platforms and science impact areas are primary organising elements in Scion's science and innovation plan 2017-2024 (Figure 16).

The plan defines the areas of impact as:

IA1:	Increase value from plantation forested land.
IA2:	Increase the resilience of forests to biotic and abiotic risks.
IA3:	Licence to operate and standards across the forest industry value chain.
IA4:	Diversify forests and local manufacturing to support regional growth.
IA5:	Increase the use of wood and fibre products in the built environment.
IA6:	Manufacture and apply biorefinery products from wood fibre, waste and other materials.
IA7:	Use more forest biomass to improve New Zealand's energy security and reduce emissions.

Consider for example, the problem facing New Zealand's solid wood processors – they "must recover more value and innovate to improve their viability" (i.e. the third box from right hand side, bottom row, Figure 16) and thus their capacity to pay for trees (a driver for increasing the security of log supply to mills). The logic from here is as follows:

- The Manufactured Products from Trees Platform is focussed on increasing the value earnt per tree via new products, use of all of the tree (e.g. bark, stumps), improved processing efficiency and new manufacturing methods (e.g. 3-D printing); and by developing improved standards that make it easy for certified wood products and building systems to be adopted by the construction sector.
- To deliver this research, Scion requires specialist infrastructure, such as wood drying kilns and wood preservative treatment pilot plant, and an accelerated decay facility. The science activities undertaken will include: investigation of alternative pre-fabrication systems to improve building affordability; methods to increase the use of wood tall buildings via new types and improved engineered products and the design and development of wood-fibre products for healthy, quiet interiors and flooring. The environmental 'footprint' and whole of life cost of these products and system solutions will also be assessed.
- Success with these science activities will generate outputs that will "Increase the use of wood and fibre products in the built environment" (Impact Area 5) and support up-to-date standards that allow quick and inexpensive sign off of building designs and stages of its construction (i.e. Licence to operate and standards across the forest industry value chain; (Impact Area 3)).
- In time, these gains will increase the market share wood enjoys in the built environment.

The impact areas are described in similar detail in Section 5. Each involves science targets that can be delivered within a 3-5 year horizon. Each impact area has 1-3 impact measures (Key Performance Indicators (KPIs)) by which progress towards impact area achievement is gauged.

Securing industry and policy agency input into the science programmes for each impact area is a high priority for Scion. In recent years, intervention logic mapping workshops have been used to facilitate this.

As well, Strategic Advisory Panels[49] to the Scion Board provide independent and expert perspectives on science quality, user impact and Māori and assist with strategy formulation as required for specific fields of science, commerce or iwi development.

[49] The terms of reference of these groups and their composition are available from Scion.

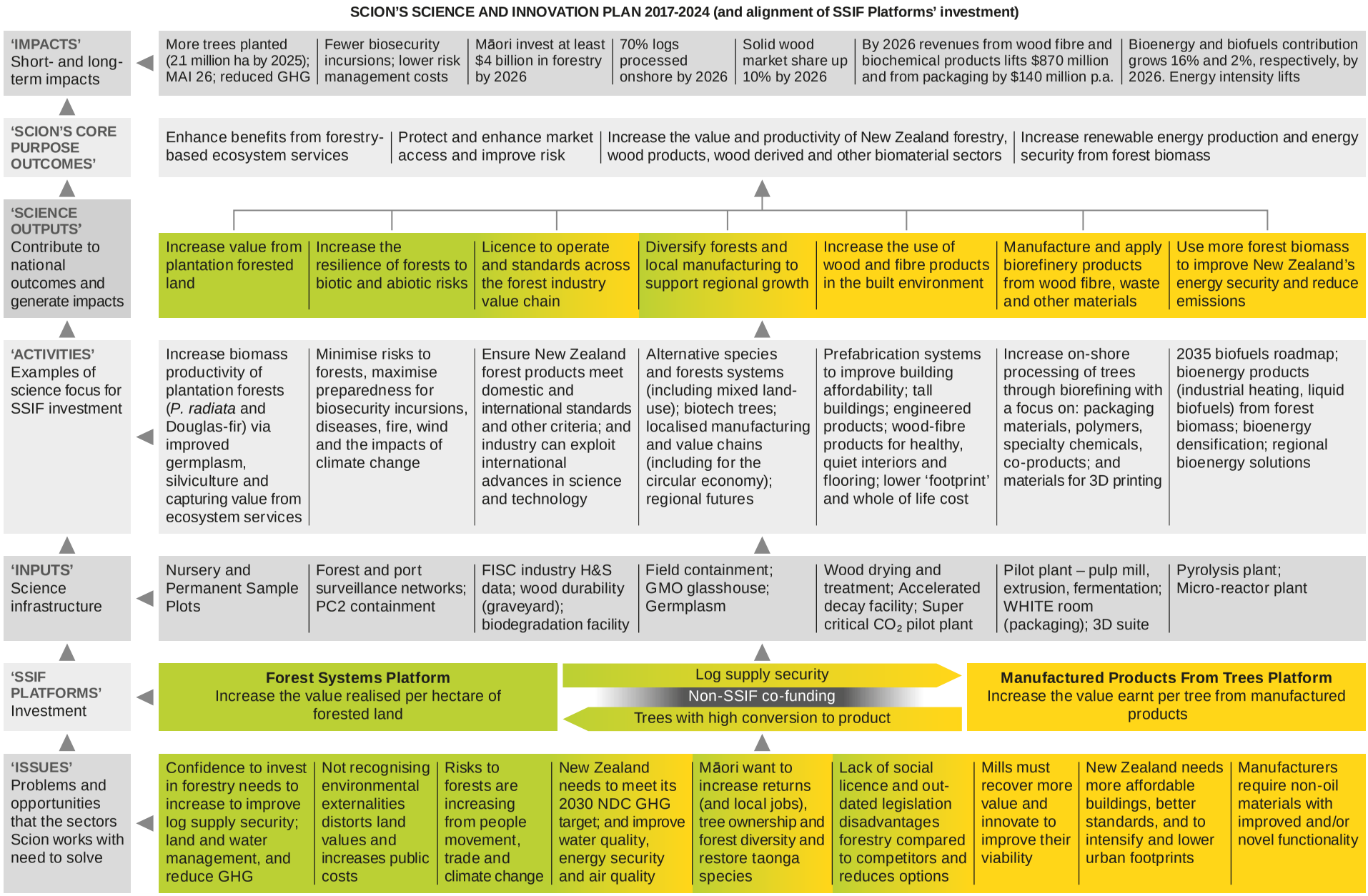


Figure 16: *Scion's Science and Innovation Plan.*

5. Science output targets for impact areas

The nature of the forest growing sector and long-term investments into assets and other infrastructure associated with manufacturing from trees and making biobased products, means that a 30-60 year view is important to science planning for the sectors Scion works with. However, while aspects of the portfolio do require long-term underpinning investment – such as tree breeding and growing a 'low carbon' renewable energy sector through the use of forest biomass – other parts of the portfolio must be managed more dynamically to reflect new industry challenges (e.g. a new disease threatens plantation forests or a wood products standard for *Pinus radiata*).

With this investment horizon in mind, the customers (end-users) of Scion science outputs are:
"those who do and will grow trees and those who do and will manufacture products from trees".

Providing potential future investors in forest growing and manufacturing from trees with objective, authoritative science outputs to build their confidence to invest in the New Zealand forest industry and bioeconomy is an important role for Scion. This includes helping investors understand the opportunities associated with partnering with Māori.

The key stakeholders for these platforms include:

- forest growers (owners and investors), wood and wood fibre (e.g. pulp and paper) processors, advanced manufacturers, forest operations and logistics firms, and energy companies;
- Māori entities;
- Ministry for Primary Industries, Ministry for the Environment, Te Puni Kokiri, Environmental Protection Authority, Ministry of Business, Innovation and Employment, Ministry of Foreign Affairs and Trade and Department of Conservation;
- local government (territorial authorities); and
- research collaborators domestically and internationally.

Selection and shaping of impact areas

Each of the seven impact areas in Scion's science and innovation plan was defined through substantial input from organisations who will deliver the impact (i.e. end users), Māori and other collaborators, national and international science entities, and government agencies and local territorial authorities. Regular on-going interaction with stakeholders gives us confidence that the seven impact areas will address their critical challenges and priorities through to 2024 as well as beyond this timeframe.

Documents consulted in preparing the plans for impact areas were:

1. New Zealand Government's Business Growth Agenda: http://www.mbie.govt.nz
2. National Statement of Science Investment 2015-2025: http://www.mbie.govt.nz
3. The New Zealand Forest and Wood Products Industry Strategic Action Plan. The Wood Council of New Zealand: http://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: http://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: http://www.tpk.govt.nz
7. Wood Processing Science and Innovation Plan; New Zealand Wood Processors and Manufacturers Association 2012: http://www.wpma.org.nz
8. MBIE and MPI Regional Growth Studies: http://www.mpi.govt.nz
9. National Policy Statements for Fresh Water Management: http://www.mfe.govt.nz/fresh-water/national-policy-statement and under consultation for Forestry.
10. NZ Energy Strategy: http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-strategies

SSIF investment allocations to platforms and impact areas

Scion's core funding portfolio (based on previous capability funding and long-term successful competitive government grants) was established in 2011. This has now been replaced by Strategic Science Investment Funding which funds platforms and infrastructure. The two platforms funded within Scion are Forest Systems and Manufactured Products from Trees. These SSIF Platforms are mutually interdependent as illustrated in Figure 17 (and by the colour shading where the impact area contributes to both platforms). The cross-cutting impact areas include:

- ensuring licence to operate and developing standards ahead of new technology reaching markets;
- diversifying forest and forest product value chains; and
- supporting local manufacturing in the regions.

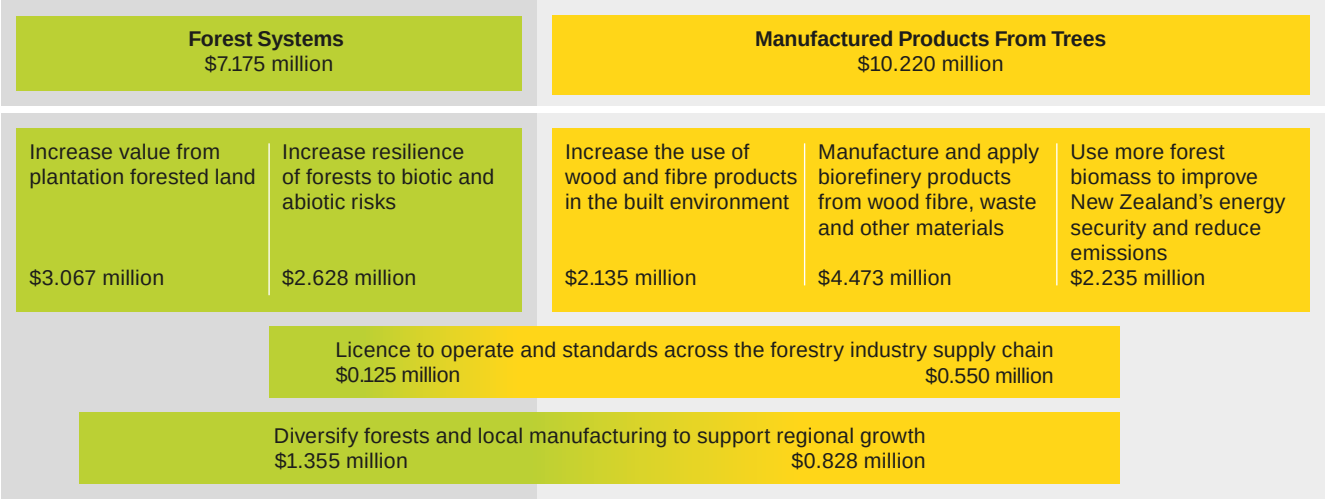


Figure 17: *Alignment of impact areas to the two platforms and their respective platform SSIF allocation, with two impact areas overlapping the two platforms.*

SSIF programme funding, like core funding, will be applied to:

- Supporting activities, such as discovery science, where direct industry investment is unlikely until proof of concept is demonstrated and the risks are quantified.
- NSCs where 'additionality' can be generated through collaboration with challenge parties and cascade new knowledge and technologies from the NSCs to Scion's customers and stakeholders.
- Facilitating joint research with international partners.
- Growing industry co-investment through joint business cases.
- 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).
- Improving the excellence and impact of Scion's science, and until additional SSIF Infrastructure funding is secured:
  - Sustaining national databases and collections such as the National Forest Herbarium and Permanent Sample Plots (PSP) in forests for genetic improvement research and the 'graveyard' (long term trials for wood durability).

Generally SSIF is of a strategic nature and contracted to impact areas for 3-5 years to enable 'stretchy' science and capabilities to be built. Consistent with the 2010 CRI Taskforce Review, flexibility is retained to reallocate SSIF to address high priority industry challenges (such to identify the cause and find solutions to red needle cast disease in radiata pine from mid 2012).

Key questions and steps in managing SSIF investment:

1. *Is the SSIF Platform investment proposal strategy-driven and well informed and supported by science foresight, market intelligence, the stakeholder sources described earlier and the guidance of the Board and external expert advisory panels? The investment must always help Scion fulfil and be consistent with its Statement of Core Purpose.*
2. *Is sufficient investment being made into Horizon 2 and 3 mid- to long-term science discovery? The target is at least 60%.*
3. *Is there 'capacity' at Scion and with collaborators to deliver the outputs (i.e. science expertise, equipment, pilot plant, industry's ability to provide field trial space or in their manufacturing plant)? If not, will additional capex be required. Given this capability status and its track record, what is the likelihood of achieving a successful outcome (i.e. is the investment proposal plausible and are the risks manageable?).*
4. *Are the shifts in allocations both within and between impact areas supported by an assessment – both qualitative and quantitative – of the value proposition and potential impact of particular areas of science relative to the other options? As well as internal expertise in techno-economic*

modelling, Scion has good working relationships in place with leading external consultancies such as Locus Research, Market Economics, NZIER and Indufor.

5. *Are there other ways of resourcing this? Such as via other external contested funds; third party investors or internal reinvestment. This also includes consideration of the likelihood and timeline for the programme becoming independent of SSIF funding.*
6. *Ultimately, judgement based on answers to the above and experience is required to finalise the allocations of SSIF to impact areas.*

Alignment of SSIF with National Science Challenges

Scion is engaged in six of the National Science Challenges. Scion's SSIF aligned to each NSC in 2017/18 is tabulated below.

NATIONAL SCIENCE CHALLENGE	2017/18	PRIMARY FOCUS AREAS
New Zealand's biological heritage	$2,407k	Forest Herbarium; citizen science (pest identification)
Our land and water	$150k	Supply chains, land-use integration
Resilience to nature's challenges	$100k	Rural fire, weather hazards
Science for technological innovation	$500k	Remote sensing; additive manufacturing, biopolymers and biofibres
Building better homes, towns and cities	$200k	Multi-rise wood buildings; smart cities

Table 2: *Alignment of SSIF to National Science Challenges.*

As the NSCs' research plans are finalised, and investment is allocated to research projects, it is becoming clearer where Scion can best align SSIF investment.

Scion will ensure that its stakeholders and customers are well-briefed on the new knowledge and technology the NSCs generate in order that these science outputs can be adopted quickly (e.g. forestry's role in catchment management within environmental limits).

Investing in delivering Scion's strategic outcomes (impact areas)

In addition to SSIF, Scion receives investment from the Ministry of Business, Innovation and Employment science investment funds 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, industry and commercial firms. All these investments are aligned to achieving Scion's strategic outcomes (represented by the impact areas). The mapping of investment to these impact areas is shown in Figure 18. Overlaps between investments and outcomes occur, for example, an investment into tree genetic improvement (linked to Impact Area 1) may also improve tree health and thus resistance to a biosecurity incursion (linked to Impact Area 5).

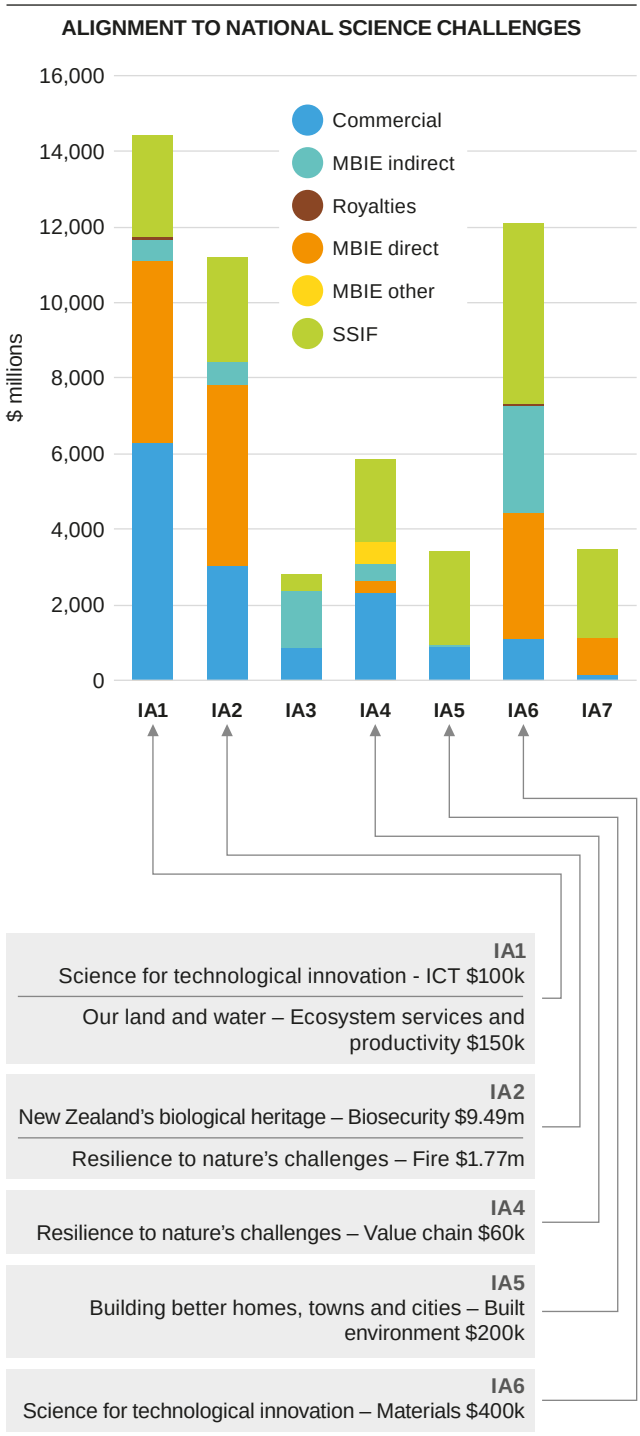


Figure 18: *Investment ($) directed to achieve each Impact Area (IA) and the investment Scion is making into the National Science Challenges.*

IA1 Impact Area 1: Increase value from plantation forested land

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.

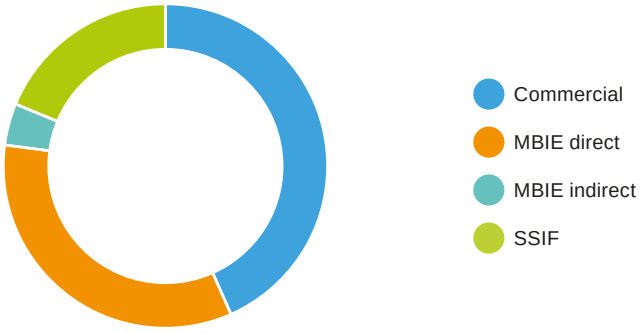
We will support forest growers, farm foresters, Māori, wood manufacturers and government in their ambitions to enhance the value created and derived from forestry.

Specific aims are to:

- Increase the volume and value 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 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.
- Support monetisation of the contribution that forests make to environmental and community well-being (ecosystem services).
- Enable higher and sustainable growth rate (MAI) to improve profitability of forestry along the value chain – from land use to market.
- Reduce the proportionately large cost of harvesting in the forest-to-mill forest-to-port supply chain.

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.
- *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* – 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 2022, 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 m^3 ha^{-1} yr^{-1} [50] and in a way that enhances the sustainability of forest growing in New Zealand.

Leading indicators are:

- By 2018, improved growth models made available to industry to support better silvicultural management.
- 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, 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, four biotech tree lines with modified productivity traits are being developed by field trials and reported to stakeholders.
- By 2020, first phase of ecosystem services assessment and evaluation completed and presented to industry.
- By 2022, new forest management regimes are adopted by industry to ensure capture of value from forest ecosystem services such as carbon capture and sequestration.
- 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.
- On-going: The forest sector continues to adopt best practice remote sensing and analytical methodology developed by Scion.

[50] 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.

IA2 Impact Area 2: Increase the resilience of forests to biotic and abiotic risks

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.

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-2: Ensure New Zealand forests are resilient to current and future natural threats

By 2022, 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 2018, policy makers and forest growers are accessing Scion's knowledge of climate change impacts and resultant implications to provide guidance in managing risk and adapting to impacts of climate change.
- 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, 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, options to reduce the impact of *Phytophthora* on radiata pine, kauri and one horticultural species have been identified.
- 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.
- By 2020, Scion will have identified radiata pine germplasm with improved drought resistance
- 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.

IA3 Impact Area 3: Licence to operate and standards across the forest industry value chain

By 2026, 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-3: 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) and account for different market needs. To ensure that effective progress is made against this impact area, 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.

Leading indicators are:

- By 2018, with industry progress a programme of work focussed on the design and commercialisation of modern harvesting tools, value chain approaches and labour productivity.
- By 2019, in partnership with key collaborators, Scion is developing and testing two robot prototypes to be deployed autonomously in the forest to undertake silviculture operations such as pruning and thinning.
- By 2020, Scion will have implemented a learning review process with key agencies (FISC) 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).
- By 2018, 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 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 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 domestic 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 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.

IA4 Impact Area 4: Diversify forests and local manufacturing to support regional growth

By 2026, Scion and its partners will have provided tools, new plant material and new product options that will have supported the aspirations of growers to expand plantings of non radiata exotic species and indigenous species and manufacturers to explore alternative processing options. This investment will reflect increased confidence in being able to secure high value for their products along the seed-to-market value chain.

Impact KPI-4a: Diversification of forest systems

- By 2018, a conceptual framework has been developed for the economic assessment of alternative forestry options, focused on indigenous forestry and Māori land holdings.
- 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 partners (note: this objective also contributes to Impact KPI 8 – bioenergy).

Impact KPI-4b: Facilitate new seed-to-market value chains for specialty wood products

By 2026, Scion and its partners will have provided new plant material, management regimes, wood processing options and supply chain optimisation strategies to support the diversification of the forest sector and contribute to regional growth and development.

Leading indicators of this are:

- By 2018, Scion and iwi tangata whenua and other partners will have secured external investment supporting the commercial opportunity associated with Northland totara.
- By 2018, a conceptual framework has been developed for the economic assessment of alternative forestry options, focused on indigenous forestry and Māori land holdings.
- 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.
- By 2018, a viable short rotation product specific forestry model that significantly improves the economics of growing forests has been developed in partnership with industry.
- 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 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 at least 5% over 2014 plantings.
- 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.
- 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 2020, 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.

IA5 Impact Area 5: Increase the use of wood and fibre products in the built environment

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 to:

- Increase the application of wood and wood-based products in building solutions to deliver greater economic, social and environmental outcomes.
- Develop new and enhanced engineered wood products to support export growth into high-value niche markets.
- Increase exports of wood products, based on Douglas-fir, eucalypts, cypresses and indigenous timbers into high-value niche applications.
- Improved productivity of the construction sector through application of prefabricated wooden structures.

Alignment to the National Science Challenge *Building better homes, towns and cities* is in building systems, including sustainable wood and fibre-based systems and integrated energy and waste management, medium density housing, urban planning.

Impact KPI-5: Expand opportunities for wood products and building systems

By 2019, 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 2018, Scion will have demonstrated and secured external investment 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, 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 2019, Scion, with *Building better homes, towns and cities* 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.

IA6 Impact Area 6: Manufacture and apply biorefinery products from wood fibre, waste and other materials

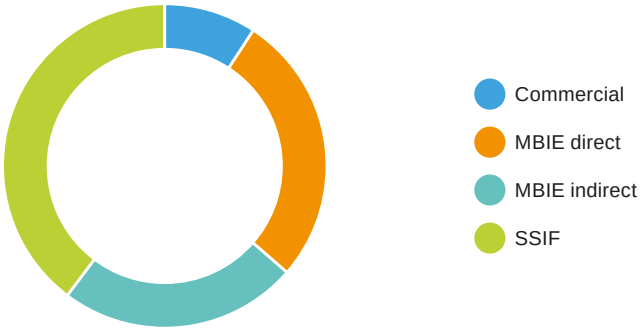
By 2026, Scion has supported existing and new industries to establish new biobased manufacturing capacity for export and domestic markets worth at least $1 billion per annum more than 2011 values.

We will support the New Zealand wood and biomass processing and manufacturing industries and those with aspirations to build new enterprises 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.
- 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).
- 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* is in design, materials and manufacturing themes, e.g. 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 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 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, 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.

IA7 Impact Area 7: Use more forest biomass to improve New Zealand's energy security and reduce emissions

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 (http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-strategies), the EECA 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 (http://www.bioenergy.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.

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 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.

6. Scion's supporting strategy

In this section, other elements of Scion's strategy 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"[51] 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, 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 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.
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 bioprotection laboratories (estimated CAPEX is $16 million).
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, 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.

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

2. Enhance technology and knowledge transfer through effective information management, web delivery technologies and science data management planning. This supports Scion's strategy to grow productivity through smart processes and systems.
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.

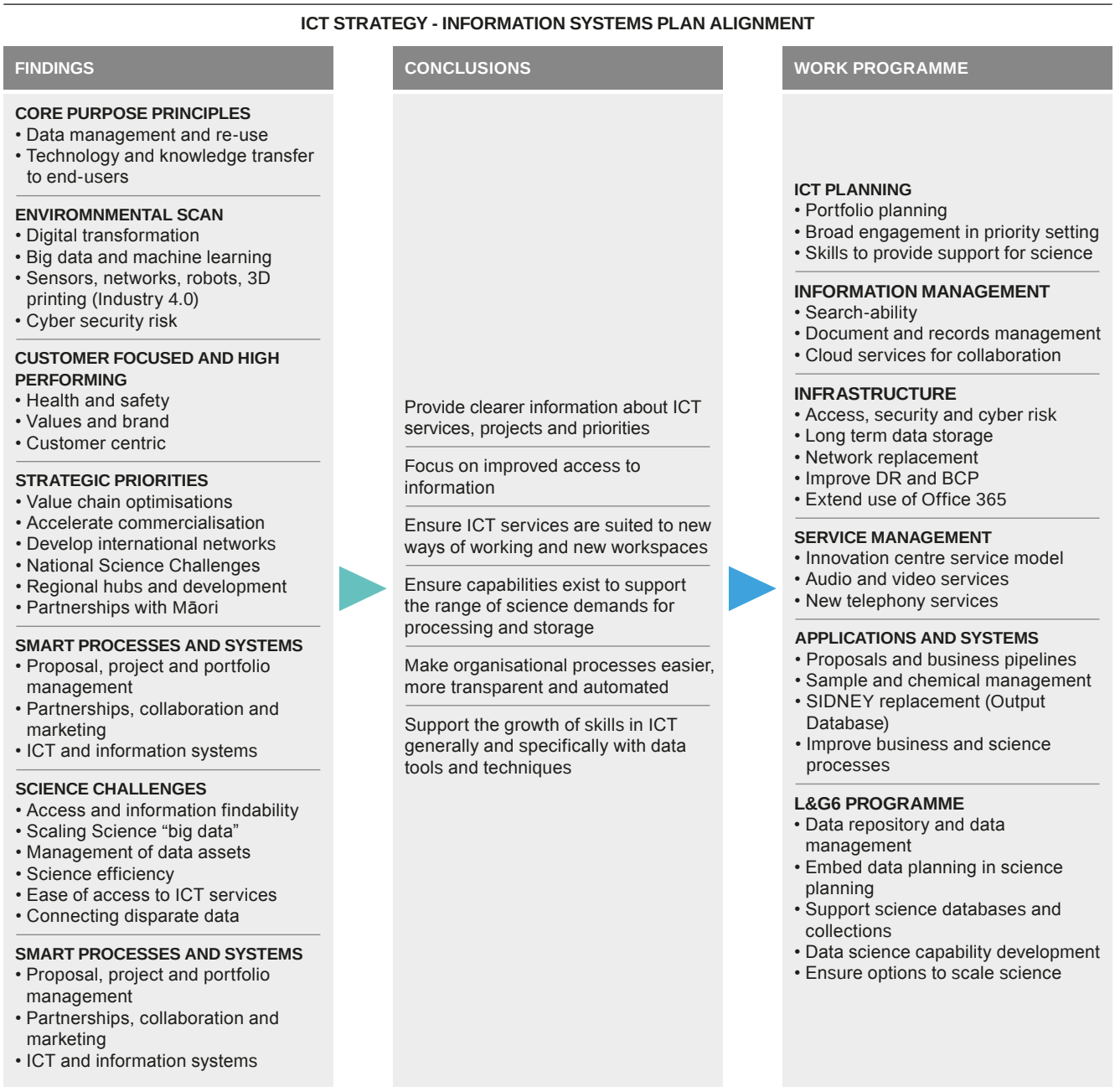


Figure 19*: Scion's IT plan is aligned to achieve Core Purpose Outcomes and SCI targets.*

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 (page 39), which is unique to New Zealand and integral to the expansion of the packaging research programme. Scion will be seeking industry investment via contracts for product development and services.

Scion's WHITE room commercial-scale box room facility.

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 laboratories 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[52]

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, student engagement with school programmes and visits to companies; Scion's website, multi-media tools, media releases, trade articles, 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.
2. Apply techno-economic models to ensure all technologies optimally align with user needs and enable 'best packaging' of technology for end-users.
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 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 3. Of particular significance over the planning period will be the formation of a host of new relationships through the National Science Challenges.

[52] 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.

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 3: *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 3, 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[53] (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). Agencies with world leading capability and technologies that are synergistic and complementary to Scion, such as VTT (Finland), VITO (Belgium), Fraunhofer (Germany), Chinese academies, the Japanese Forest Research and Products Institute (JFFPRI), and Australian research organisations and 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 4.

[53] 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 ('Graveyard')	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 (PSP) 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 4: *Scion's databases and collections of national significance.*

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 $400,000 of this provided through infrastructure funding. Where appropriate and robust cyber security can be applied, 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 (such as the Permanent Sample Plat (PSP) and germplasm datasets – 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 2022 are summarised in Table 5. Financial performance indicators are included in Table 6. Associated consolidated cash flow and balance sheet details are presented in Tables 8 and 9.

Scion is budgeting to grow revenues by 5.3% in 2017/18 to $54.279 million and achieve an Operating Profit (EBIT) of $2.025 million (Table 5). This represents a 7.1% return on equity (RoE) before reinvestment. Reinvestment of $1.550 million will generate a tailored RoE of 4.3% (Table 6). Future revenues are projected to increase at between 3.0% and 7.1% 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 impact of significant new facility developments at Scion's Rotorua campus. In particular, Scion has $10 million of Endeavour Funding coming off contract over 2018/19 and 2019/20 that will need to be replaced. Scion has a strong pipeline of government programmes submitted and in development to support this.

PROJECTED STATEMENT OF FINANCIAL PERFORMANCE FOR THE FIVE YEARS ENDING 30 JUNE 2022

	30/06/2017 $000	30/06/2018 $000	30/06/2019 $000	30/06/2020 $000	30/06/2021 $000	30/06/2022 $000
Revenue						
Core funding	17,734	17,733	17,733	18,620	18,620	18,620
Other MBIE revenue	13,548	14,813	15,331	15,331	15,561	15,795
Commercial and other	20,131	21,543	22,267	22,843	23,765	24,730
Royalties	119	190	570	998	2,494	5,611
Total revenue	51,532	54,279	55,902	57,791	60,439	64,755
Operating Expenditure						
Personnel	25,727	28,240	28,805	29,669	30,886	33,048
Other operating costs	21,686	22,364	23,071	23,781	24,912	26,928
Total operating expenditure	47,413	50,604	51,876	53,451	55,797	59,976
Scion margin	**4,119**	**3,675**	**4,026**	**4,340**	**4,642**	**4,780**
Loss on disposal of fixed assets	3	0	0	0	0	0
Restructuring costs	(31)	(100)	(100)	(100)	(100)	(100)
EBIT-R*	**4,091**	**3,575**	**3,926**	**4,240**	**4,542**	**4,680**
Reinvestment	(1,465)	(1,550)	(1,750)	(1,950)	(1,950)	(2,000)
EBIT	**2,626**	**2,025**	**2,176**	**2,290**	**2,592**	**2,680**
Net Interest income/(expense)	327	366	146	5	(12)	21
Profit before tax	**2,953**	**2,391**	**2,322**	**2,295**	**2,580**	**2,701**
Tax	(875)	(693)	(673)	(666)	(748)	(783)
Group profit after tax	**2,078**	**1,698**	**1,648**	**1,629**	**1,832**	1,918
Profit attributable to shareholders	**2,078**	**1,698**	**1,648**	**1,629**	**1,832**	1,918

*EBIT-R is EBIT before reinvestment

Table 5: *Projected Statement of Financial Performance for the five years ending 30 June 2022.*

PROJECTED FINANCIAL PERFORMANCE INDICATORS FOR THE FIVE YEARS ENDED 30 JUNE 2022

	Forecast 2017	Target 2018	Target 2019	Target 2020	Target 2021	Target 2022
Efficiency:						
Operating margin	12.2%	11.3%	12.2%	12.4%	12.6%	12.1%
Operating margin per FTE	$21,237	$19,702	$21,851	$22,715	$23,641	$23,093
Risk:	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Quick ratio	2.59:1	1.65:1	0.89:1	0.90:1	0.90:1	1.04:1
Interest coverage	N/A	N/A	N/A	N/A	N/A	N/A
Operating margin volatility	20.9%	12.6%	8.5%	8.1%	8.5%	9.0%
Forecasting risk	1.7%	1.7%	1.5%	0.7%	0.3%	0.2%
Growth/Investment:	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Adjusted before reinvestment	8.9%	7.1%	7.0%	7.0%	7.2%	7.2%
Adjusted return on equity	5.9%	4.3%	4.0%	3.8%	4.1%	4.2%
Revenue growth	9.5%	5.3%	3.0%	3.4%	4.6%	7.1%
Capital renewal	1.4x	2.3x	2.7x	1.5x	1.2x	1.2x

Table 6: *Projected Financial Performance Indicators for the five years ended 30 June 2022.*

2. Reinvestment of surpluses

Scion's reinvestment portfolio underpins its strategy through Learning and Growth (L&G) initiatives. In addition it is important to note the significant investment into accelerating commercialisation. This strategic intent is fully consistent with the recommendations 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 Section 2). 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.

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. Over time the focus on external facing initiatives has increased and in 2017/18 reinvestments are all external facing initiatives (see Table 7) that support Scion's strategy and forest industry stakeholders' goals:

1. Part fund the Scion Chair of Sustainable Forest Management at the Toi Ohomai Institute of Technology and industry secondments (L&G1);
2. Grow the Māori economy through improved communication and regional hui to meet directly with iwi (L&G3);
3. International S&T collaborations to speed-up innovation in forestry, solid wood and wood fibre processing and manufacturing firms producing industrial bioproducts (L&G4);
4. Accelerate commercialisation (L&G5);
5. 'Big data' informatics capability (L&G6).

A brief rationale for some of these was provided earlier (Section 3) under strategic initiatives. Levels of investment in each L&G and the aggregate impact on RoE are shown in Table 7.

SUMMARY OF STRATEGIC LEARNING AND GROWTH (L&G) INITIATIVES 2017/18 TO 2021/22

	2018		2019		2020		2021		2022	
Reinvestment project ('000)	EBIT	RoE	EBIT	RoE	EBIT	RoE	EBIT	RoE	EBIT	RoE
L&G1 Customer focused culture and agile workforce	110	(0.3%)	100	(0.2%)	50	(0.1%)	50	(0.1%)	50	(0.1%)
L&G3 Engage Māori, build Māori economy	100	(0.3%)	100	(0.2%)	100	(0.2%)	100	(0.2%)	100	(0.2%)
L&G4 International linkages and strategic relationships	150	(0.4%)	150	(0.4%)	150	(0.3%)	150	(0.3%)	150	(0.3%)
L&G5 Commercialisation capability	200	(0.5%)	100	(0.2%)	0	0.0%	0	0.0%	0	0.0%
L&G6 Big data (data intensive science)	350	(0.9%)	300	(0.7%)	100	(0.2%)	0	0.0%	0	0.0%
Accelerating commercialisation	640	(1.6%)	1,000	(2.4%)	1,550	(3.6%)	1,650	(3.7%)	1,700	(3.6%)
Total reinvestment	1,550	(3.9%)	1,750	(4.2%)	1,950	(4.5%)	1,950	(4.3%)	2,000	(4.3%)
Tax	(434)	1.1%	(490)	1.2%	(546)	1.3%	(546)	1.2%	(560)	1.2%
Profit impact on reinvestment	**1,116**	**(2.8%)**	**1,260**	**(3.0%)**	**1,404**	**(3.2%)**	**1,404**	**(3.1%)**	**1,440**	**(3.1%)**
Initial target RoE		7.1%		7.0%		7.0%		7.2%		7.2%
Revised RoE target after impact reinvestment		4.3%		4.0%		3.8%		4.1%		4.2%

Table 7: *Summary of strategic learning and growth (L&G) initiatives 2017/18 to 2021/22, underlying (target) RoE and tailored rate of return. Allocations from 2018/19 are indicative.*

3. Cash position, balance sheet structure and dividends

Scion is forecasting end-of-year cash balances in the range of $11.2 million (June 2017) to $0.5 million (June 2020) over the five-year planning period (Table 8). This is judged to be prudent given the ongoing revenue uncertainty with contestable funding; and proposed innovation centre including modernisation of the aging (circa 1950s) wood engineering laboratories and test facilities (scheduled to commence in 2017/18 and estimated to cost $15–$17 million). The combination of reinvestment of surpluses of $1.5–$2.8 million per annum and capital renewal ($6.0–$11.9 million per annum) means Scion net assets are forecast to grow by $7.6 million to $46.1 million over the planning period (Table 9).

PROJECTED STATEMENT OF CONSOLIDATED CASH FLOWS FOR THE FIVE YEARS ENDED 30 JUNE 2022

	30/06/2017 $000	30/06/2018 $000	30/06/2019 $000	30/06/2020 $000	30/06/2021 $000	30/06/2022 $000
Cashflow from operating activities						
Cash received from operations						
Crown	31,174	32,402	33,064	33,951	34,181	34,414
Other clients	20,149	21,853	22,710	23,710	26,126	30,206
Interest	348	348	146	5	(12)	21
Total cash received from operations	**51,671**	**54,603**	**55,920**	**57,666**	**60,295**	**64,641**
Cash disbursed on operations						
Personnel	25,708	27,957	28,850	29,713	30,928	33,089
Suppliers	19,298	20,227	20,060	21,926	21,752	23,715
Taxation	1,345	720	733	668	721	772
Total cash disbursed on operations	**46,351**	**48,904**	**49,643**	**52,306**	**53,400**	**57,576**
Projected net cashflows from operations	**5,320**	**5,699**	**6,278**	**5,359**	**6,895**	**7,066**
Cashflow from investment activities						
Purchase of investments	(470)	0	0	0	0	0
Purchase of fixed assets	(4,832)	(9,464)	(12,466)	(6,950)	(5,950)	(5,850)
Purchase of intangibles	(226)	(120)	(150)	(150)	(150)	(150)
Net cash received/(disbursed) from investing activities	**(5,528)**	**(9,584)**	**(12,616)**	**(7,100)**	**(6,100)**	**(6,000)**
Cashflow from financing activities						
Increase in term debt	0	0	0	800	0	0
Repayment of term debt	0	0	0	0	(800)	0
Total cash disbursed on financing activities	**0**	**0**	**0**	**800**	**(800)**	**0**
Net increase (decrease) in cash	**(208)**	**(3,885)**	**(6,338)**	**(941)**	**(5)**	**1,066**
Exchange rate effect	0	0	0	0	0	0
Opening cash balance	11,433	11,225	7,341	1,003	62	57
Closing cash balance	**11,225**	**7,341**	**1,003**	**62**	**57**	**1,123**

Table 8: *Projected Statement of Consolidated Cash flows for the five years ended 30 June 2022.*

PROJECTED STATEMENT OF CONSOLIDATED BALANCE SHEET FOR THE FIVE YEARS ENDED 30 JUNE 2022						
	30/06/2017 $000	30/06/2018 $000	30/06/2019 $000	30/06/2020 $000	30/06/2021 $000	30/06/2022 $000
Current assets						
Short term investments and cash	11,225	7,341	1,003	62	57	1,123
Debtors	6,562	6,372	6,499	6,629	6,762	6,897
Prepayments	953	980	980	980	980	980
Inventory	380	380	380	380	380	380
Total current assets	**19,120**	**15,073**	**8,862**	**8,052**	**8,179**	**9,380**
Less current liabilities						
Creditors	4,105	5,266	5,371	4,297	4,383	4,471
Personnel liabilities	2,455	2,779	2,834	2,891	2,949	3,008
Income in advance	1,872	1,664	1,664	1,664	1,664	1,664
Provision for tax	310	284	224	222	249	261
Total current liabilities	**8,742**	**9,993**	**10,094**	**9,074**	**9,245**	**9,404**
Net working capital	**10,378**	**5,080**	**(1,232)**	**(1,022)**	**(1,066)**	**(24)**
Investments						
Investments in subsidiaries and associates/intangible assets	532	532	532	532	532	532
Intangible assets	847	831	831	831	831	831
Total Investments	**1,379**	**1,363**	**1,363**	**1,363**	**1,363**	**1,363**
Fixed assets						
Fixed assets	28,616	35,687	43,647	45,867	46,943	47,818
Biological assets	550	550	550	550	550	550
Total fixed assets	**29,166**	**36,237**	**44,197**	**46,417**	**47,493**	**48,368**
Term liabilities						
Provision for staff liabilities	1,328	1,388	1,388	1,388	1,388	1,388
Deferred tax liability	1,132	1,132	1,132	1,132	1,132	1,132
Term debt	0	0	0	800	0	0
Total term liabilities	**2,460**	**2,520**	**2,520**	**3,320**	**2,520**	**2,520**
Projected total net assets	**38,463**	**40,160**	**41,809**	**43,438**	**45,270**	**47,188**
Represented by						
Share capital	17,516	17,516	17,516	17,516	17,516	17,516
Retained earnings brought forward	18,808	20,886	22,583	24,232	25,861	27,693
Revaluation reserve	61	61	61	61	61	61
Current profit (loss)	2,078	1,698	1,648	1,629	1,832	1,918
Projected closing shareholders funds	**38,463**	**40,160**	**41,809**	**43,438**	**45,270**	**47,188**

Table 9: *Projected Statement of Consolidated Balance Sheet for the five years ended 30 June 2022.*

8. Performance monitoring and reporting

Scion's strategic indicators, measures and targets are presented in Table 10 and 11, respectively. These comprise CRI generic and Scion specific indicators (Table 10) 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 the Appendix. Financial indicators reported quarterly are presented in Table 6 (Section 7).

Investment

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 11.

INDICATOR NAME	MEASURE	FREQUENCY	2017 FORECAST	2018 TARGET
End user collaboration	Revenue per FTE ($) from commercial sources	Quarterly	$68,644	$69,523
Research collaboration	Publications with collaborators	Quarterly	>80	>80
Technology and knowledge transfer excellence	Commercial reports per Scientist FTE	Annually	1.0	1.0
Science quality	Mean citation score	Annually	2.3	2.4
Financial Indicator	Revenue per FTE ($)	Quarterly	$174,685	$173,637
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%
Māori economic development	Partnerships (number and value) established with Māori entities to support economic development through the forest industry	Quarterly	n>5; >$1m	n>5; >$1m
Accelerated commercialisation	Technologies in Scion's pipeline (number and co-investment ($)); 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 Zero harm	Qualitative <50 days EEO rating Zero harm

Table 10: *Scion's performance monitoring scorecard indicators and measures*

SCION'S 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% 10%
	Technologies adapted or co-invented for New Zealand industry through international networks	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 11: *Scion's strategic initiatives outcomes scorecard (ratings shown are estimated percentage completion of the actions described in Section 3).*

9. Concluding comments

The world is moving to a renewable bio-based economy. This is driven by climate change concerns, growing population and demand, and by social and personal preferences. The COP21 Paris Climate Agreement is boosting market demand 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[54]. Forestry and products and energy from wood have a very large opportunity to be a key component in the future renewable world. Some of the opportunities include:

- renewable based bio-degradable plastics (3D printing);
- advanced materials such as carbon nanofibers;
- renewable bio-energy production, particularly for transport and industrial use;
- chemicals from trees through bio-refineries;
- sustainable land-use and carbon reduction;
- new breeding techniques to optimise trees for end products;
- tall timber buildings that perform better in earthquakes and deliver great environments;
- sterile trees to prevent uncontrolled spread into other forests (e.g. native areas);
- improved environmental outcomes through water quality protection; and
- improved socio-economic outcomes through employment and skills development.

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; achieving sustainable land use and improving water quality.

Export earnings from forest and wood products have steadily increased in recent years, albeit slower than envisaged in the industry's (Woodco) Strategic Action Plan. Wood processors are benefiting from a strong domestic building market, modernisation of their plants; and increased product diversity such as via engineered wood products for prefabricated building systems.

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, particularly in Northland and Canterbury. This requires a multi-pronged approach to lifting the profitability of forestry as land-use, lowering forest operation and other supply chain costs and increasing the capacity of mills to pay higher log prices by moving them up the value chain, examples being generating more value from residues and currently little used components of the tree such as barks and the post-harvest stumps. There is also considerable scope to repurpose radiata pine via biotechnology into short rotation systems for specialist industrial purposes. Improved competitiveness of wood processing in New Zealand, as is currently occurring in the central North Island, will help to reduce forest growers' high exposure (circa 70% in 2015/16) to the Chinese log market and will enhance economic opportunity in regions such as Northland[55], the Bay of Plenty, East Coast and Otago-Southland. As described in Section 5, these are all focus areas for Scion research.

There are strong synergies in boosting planting rates to improve log supply security and reducing greenhouse gas emissions. 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 .

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. Alternative species also mitigate the vulnerability of New Zealand plantation forests to biosecurity and climate change risk.

All that Scion does is relevant to Māori and the Māori economy. 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

[54] 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

[55] 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

incorporations with significant forest assets and large areas of under-utilised land with good potential for forestry'.

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 will help to exploit changes in the external operating environment and maximise opportunities for the forest industry and industrial bioproducts.

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. 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 consist 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.

1.1. 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, 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 (IFRS), and other applicable Financial Reporting Standards, as appropriate for profit-oriented entities. The financial statements comply with 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 (NZUs) 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 NZUs arises when the Group is entitled to claim the NZUs from the government.

NZUs are initially measured at fair value on entitlement as an intangible asset unless the Board of Directors has 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 considers there is an active market for the sale of NZUs. NZUs 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	20–60 years
Plant and Equipment	3–20 years
Furniture and Fittings	10–20 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 Strategic Science Investment Fund, 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.

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 uses 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. Management uses the experience of a registered actuary to reduce the risk of misstatement resulting from these judgements and estimates.

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