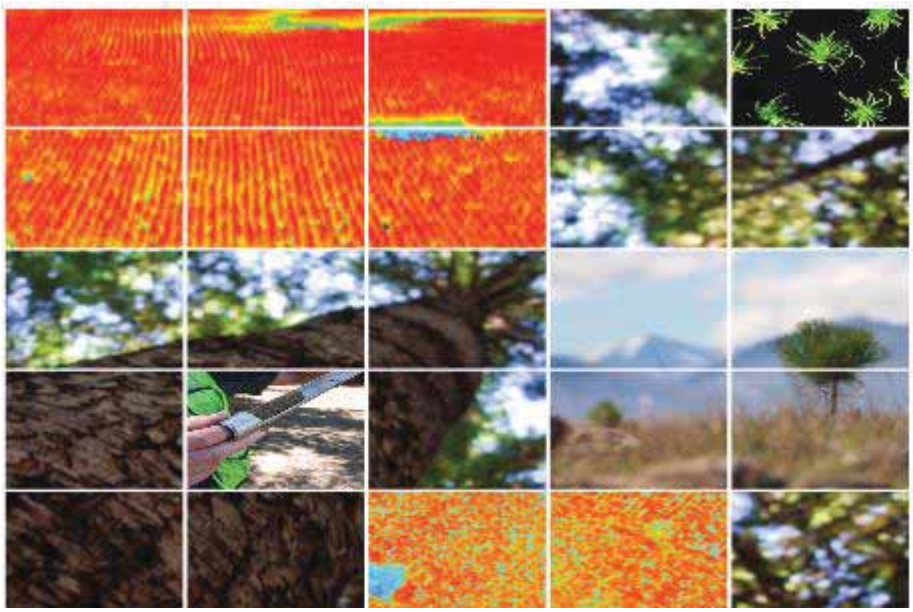
New Zealand Forest Growers' 2015 Science and Innovation Plan



Research and development to
increase the profitability and sustainability of
the New Zealand forest-growing sector

November 2015

NEW ZEALAND FARM FORESTRY ASSOCIATION

FOREST OWNERS ASSOCIATION

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1. FOREWORD

New Zealand's biological resources are its key global competitive advantage. Plantation forests, as one of these resources, sustainably produces wood, energy and stores carbon. These plantation forests, designed to grow wood that is suitable for customer needs in the market, will provide the feedstock for a capital intensive and high-tech manufacturing industry based in NZ and exporting finished goods abroad. To attract this investment, produce from plantation forests needs to meet the requirements of manufacturers which are fitness for purpose, consistent quality, competitively priced and produced from sustainable and well managed forests.

Raising the profitability of plantation forests is an imperative for the entire NZ forestry sector. Further investment in forest growing relies on current operations being profitable. To more than double the value of forest industry export earnings requires major investment in new and upgraded wood processing facilities. The assurance of a sustainable supply of wood will increase investors' confidence to make such investments.

To achieve the above, forestry investment must be competitive with other rural land uses. Land is the single biggest input cost for forestry investors and to secure land for new planting or to retain existing forest land, investors must compete with other land users. Other land users are striving through research and innovation to increase the value of products produced from each hectare of land. The forest industry must do likewise to remain competitive and continue to play an increasing role in New Zealand's economy. Key drivers for this are increasing forest productivity (mean annual increment –MAI), growing wood that is of uniform and consistent quality that enables the wood processors to improve recoveries and profitability and maintaining the industry's licence to operate.

Forest growing also provides other benefits. Forests also play an important role in protecting soils, enhancing water quality, reducing flooding and at the same time providing opportunities for recreation and biodiversity. To both maintain and enhance these benefits it is essential that the profitability of plantation forestry is increased whilst protecting these important environmental attributes that ensure our industry's licence to operate remains and access to international markets is protected. Research is a key means of achieving these objectives.

This 2015 New Zealand Forest Growers Science and Innovation Plan builds on the first forestry Science and Innovation Plan released in January 2012. It identifies and describes five key research objectives that will help transform plantation forestry from a log production business to the starting point of a market led and automated capital intensive manufacturing industry. They are:

- Protect forest assets and markets from adverse factors
- Improve productivity and uniformity within and between trees
- Sustain and enhance forestry's licence to operate
- Improve efficiency and safety in operations and supply chain logistics
- Ensure species options for diversity of sites and markets

The Plan also sets out a process for evaluating and considering research proposals to ensure that the investments will support the industry to achieve its goals.

The forest industry is dynamic. Changes in markets, world economics, regulations and the environment will inevitably result in the need for change to research priorities. This strategy is therefore a living document that will reflect these changes.

2. INTRODUCTION

This document was prepared to present strategic objectives for forest growing research and provide specific guidance on forest grower research priorities as determined by the joint FOA/FFA Forest Research Committee. Development of the strategic objectives and specific research priorities followed a consultation process involving representatives of forest growers, forest growing science providers, funding agencies, and forest sector industry organisations.

The document sets out the context of where forest growing research fits within the broader interests and strategic plans of the forest and forest products sector, the purpose and scope of this document, the linkage to markets and market drivers, forestry's potential, the role of science and innovation in achieving this potential, a statement of strategic objectives, identification of research priorities, description of current collaborative research programmes in the forest growing space, and the process of how research proposals are developed and considered.

The research priorities identified in this document are those seen as being the most important at the time of preparation of this document. It is expected that research priorities will change over time.

3. CONTEXT

The Wood Council of New Zealand (WoodCo) is the over-arching body for the forestry and wood-processing sector. Its members are the Forest Owners, Wood Processors and Manufacturers, Farm Forestry and Forest Industry Contractors Associations. Forest growers are an important subset of the broader New Zealand forest and forest products sector and are represented in WoodCo through participation by the Forest Owners Association and the Farm Forestry Association.

In May 2014 WoodCo, in their 2014 Manifesto - "Prosperity from Forestry and Wood Products", stated that its Strategic Action Plan was to increase export earnings from the sector from NZ$5 billion annually to NZ$12 billion by 2022. This would come from securing a sustainable supply of wood, shifting the emphasis away from commodities, and investing in jobs, skills, Research and Development and high value products that are made in New Zealand. The WoodCo Strategy, in comparison to the Forest Growing Science and Innovation Plan, has a focus on the wider value chain.

Another important document identifying challenges and opportunities in the forest and forest products sector is the Woodscape Report released in February 2013.

Both the Woodco Manifesto and the Woodscape Study include research as part of a broader statement of challenges and opportunities.

The 2012 New Zealand Forestry Science and Innovation Plan was a key document in describing a vision for plantation forestry in New Zealand and the key role of research and technology in delivering that vision. That document set out a vision to significantly improve the profitability of forest growing by doubling productivity on a per hectare basis while also improving the quality, consistency and uniformity of wood grown and increasing tree resistance to pests and diseases. Several key enablers of success that needed to be implemented were:

- Making industry needs and Crown Research Institute management more relevant to science direction
- Increasing the quality of science in the forestry sector
- Industry and research providers stepping up to the challenge.

Under the last bullet above it was stated that industry needed to play its part; most importantly by identifying research needs and the most effective delivery mechanisms.

Since publication of the 2012 New Zealand Forestry Science and Innovation Plan there have been a number of important changes relating to forest growing research:

i. How government allocates funding to research in primary industries has changed and the total allocation to forest growing research by government has declined with an expectation from government that industry will increase its commitment to research.
ii. A Forest Growing Levy was put in place, effective January 1 2014, with the purpose of funding collective forest grower investment in research, development and promotion that will advance New Zealand forestry domestically and overseas. More than half of the money raised by the Levy is being used to fund research priorities broadly outlined in the 2012 New Zealand Forestry Science and Innovation Plan. In 2015 the commitment from Levy funds to investment in research is over $3.5 million.
iii. Industry led research structures have changed with the establishment of an industry Forest Research Committee and the associated appointment of a full-time Research Manager and support function. The previous Future Forests Research Limited research themes of Radiata Management, Diverse Species and Environment have been wound up. Future Forests Research has been retained as an entity to manage the Steep Land Harvesting Research programme and a new Specialty Wood Products partnership.

Through the changes that have occurred during 2013/14 it became evident that the 2012 New Zealand Forestry Science and Innovation Plan had to be revised to provide more specific articulation of forest grower research priorities and to establish a process for how priorities will be reviewed and changed over time to guide industry co-funding for existing and new forest grower research programmes.

In preparing the 2015 version of the Forest Growers Science and Innovation Plan the broader industry view and vision set out in the 2012 document, which still stands and is reconfirmed in the 2014 WoodCo Manifesto, is included so that the 2015 Plan can stand alone as a replacement of the earlier Plan.

4. PURPOSE AND SCOPE

The 2015 NZ Forest Growers Science and Innovation Plan sets out strategic objectives for forest growing research which guide collective investment in research and development by forest growers. Under these objectives it sets out identified research priorities.

The purpose of the 2015 Forest Growers Science and Innovation Plan is to provide specific guidance on research priorities from the perspective of a forest grower to an audience of forest growers, science providers and funding agencies.

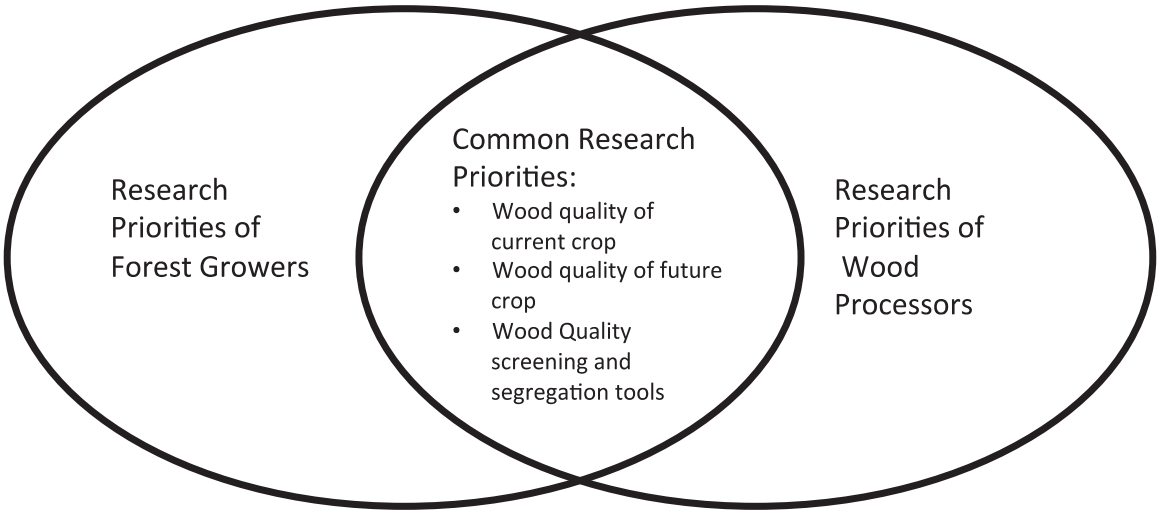
Funding for programmes addressing these research priorities may be from:

- the Forest Growers Levy
- industry participants contributing directly to collective research,
- core funding of science providers,
- direct funding by government,
- the various funds in place that can grant funding to forest growing related research, or
- a combination of the above.

The Plan is not intended to influence single client research programmes, where a forest grower or other organisation wishes to progress research that is proprietary and not managed on a collective basis.

The Plan is intended as a lead document. It is recognised that there are industry co-funded programmes that are contracted and in place. It is expected that many, if not most, of the identified research priorities will be contained in one or more existing research programmes. Funding for research from all sources is always going to be constrained. Existing programmes need tenure of funding, programmes are periodically reviewed, priorities will change over time, and new opportunities and challenges will be encountered that will result in a call for research funding. It is expected that some research priorities will be identified that may have to wait for some time before being allocated funding. This is a healthy situation as it engenders an environment where collective research programmes are developed in an orderly fashion and, over time, industry co-funding is directed to research topics that are well defined, supported and prioritised.

The scope of this Plan is restricted to activities directly associated with growing and managing forests and forest production. The connection between the interests of forest growers and wood processors is important. That connection, from a research perspective, centres on wood quality and is illustrated in the following diagram:



An up to date and well-considered Forest Growers' Science and Innovation Plan provides a sound basis for forest grower input into the review of existing co-funded research programmes, initiation of new research, allocation of industry co-funding and input into government research strategies.

It is expected that the Plan will be reviewed periodically, with research priorities being reconsidered on an annual basis and broader strategic objectives being reviewed as required but, indicatively, every three to five years.

5. LINKAGE TO MARKETS

Forest owners are acutely conscious and in frequent communication with their direct log-consuming customers, be those internal or external to the firm. The log processors are in turn dealing with remanufacturers, wholesalers or consumers of wood products. The primary linkage to markets and customers occurs via the price, quality and market pathway signals that travel along this chain from consumer to forest owner. Many New Zealand forest owners have, via their parent, associated or sister companies, direct linkages to consumers and market trends. Others make a point of travelling to meet end users of the wood they are growing, albeit that the supply has come though processors or remanufacturers.

At the industry leader and association levels there is frequent contact and sharing of views. The co-location of FOA, WPA, FFA, NZIF and NZ Wood at the Forest Wood Centre on The Terrace in Wellington is a deliberate and successful means of facilitating the sharing of ideas and positions on various topics and markets.

Despite this there remains a need for forest owners to pay attention to worldwide developments and trends that have the potential to impact on markets for forest products up to three or four decades in the future. The approach adopted in setting priorities in this Plan is that the science must focus on enhancing those wood properties that we know are desired in the highest value structural and appearance solid wood products. Such properties also work well for residue users for pulp and energy. But the industry will take care not to cut off options to change direction if market trends or niche markets start to favour some other log properties as new markets and products emerge in a world that will increasing rely on sustainable resources like forests for more and more of its basic needs.

The industry leaders that process logs and remanufacture into consumer products have been consulted in the preparation of this Plan and it articulates well with the plan produced by that portion of the forest industry sector – the Wood Processing and Manufacturing – Science and Innovation Plan.

6. THE VISION FOR PLANTATION FORESTRY IN NZ

"The NZ forest growing industry will continue to be recognised as a world leader in sustainable wood fibre production to meet the needs of domestic and international markets."

Forestry Sector Defined

The forest industry includes two major subsectors: 1. Forestry, and 2. Wood Processing. Forestry is about growing and protecting forests, harvesting, and transporting logs to log processors. It starts with genetics and generally ends at the mill yard - be that in NZ or overseas. The wood processing and forest products subsector generally starts with the log and includes a wide range of industries from sawmilling, panels, pulp and paper, chemical extractives, through to renewable energy.

The plantation forestry sector is generally regarded by local government as being the most sustainable productive land use for NZ hill country.[1] Provided it is prudently managed, plantation forestry is recommended in council plans for protecting water quality because of its general ability to reduce soil erosion and reduce nutrient inputs to groundwater and surface waters (e.g. Lake Taupo[2]), compared to other productive land uses such as pastoral agriculture. It is also superior to other productive land uses for providing biodiversity values (e.g. birds, frogs, bats, fish), recreation, and hunting.

[1] Horizons Regional Council One Plan
http://www.horizons.govt.nz/assets/one-plan- 1.
august-2010/HRC_OP_Vol4_Chapter5.pdf
[2] http://www.waikatoregion.govt.nz/Projects/Lake- 2.
Taupo/Nitrogen-management-in-the-Lake-Taupocatchment/#nonfarming

Current Situation – NZ Forest International Perspective

New Zealand's main competitive advantage in international forestry lies in the efficient production of solid wood from softwood plantations, primarily radiata pine and to a lesser extent Douglas-fir. Everything else, including all other product types, all other species, carbon markets, ecosystem services etc, is of secondary importance to the main purpose for NZ plantation forests – which is to make a profit. The carbon market is an emerging one, although its potential to influence investment has already been demonstrated.

The main areas for industrial softwood in the world are in the northern hemisphere; Russia, Europe, and North America. These forests are either natural forests being exploited or managed natural species. The productivity of most of these forests is lower than current NZ radiata pine forests by a factor of five. However, the wood quality from these older, natural forests is generally better than NZ radiata pine, particularly for structural uses, and the main products are solid wood. Other products, such as pulp, MDF, and bioenergy, are generally subsidised by the solid wood industry and are only practical if produced from residues. The economic return from natural, or semi natural northern hemisphere forests is less than radiata pine on average as the cost of forest replacement is rarely covered. In more populated areas the forests are under increasing quasi-environmental constraints that increase production costs, but in some cases are government-subsidised. These forests are owned by either the state, institutions, or private co-operatives. There has been a general move away from vertically integrated forest businesses, as processing companies have unlocked the large amounts of capital invested in their forests. The expectation is that future energy costs will ultimately rise and there will be increased regulation of and costs attached to environmental pollution. Wood is well placed to position itself as a building material of choice in this new operating environment.

7. FORESTRY SECTOR POTENTIAL

New Zealand plantation forestry is a world leader in sustainable wood production primarily as a consequence of the implementation of several decades of government and industry funded research. Over the last 30 years the country has moved away from a reliance on its rich natural forest resource to virtually 100% production from the exotic estate. However, the transition has not been straightforward as several challenges have had to be overcome to realise the large resource of valuable forest that exists today and to develop the large and varied markets for the wood and fibre.

While plantation forestry and the accompanying processing and utilisation industries are success stories that we can be proud of, there are many new research challenges and opportunities to protect the existing resource, maintain and develop new products and markets, and remain internationally competitive.

Why invest in forest growing and protection research?

The forest industry provides a significant opportunity to meet the government's targets to treble the value of the country's exports over 15 years. It can do this both by growing and harvesting more and better wood more efficiently, and also by adding value to the processed product.

Markets want our wood and demand is growing!

Within Asia, notably China, Japan and India, there are large opportunities for NZ wood – both as logs and lumber. New Zealand is already a significant supplier of wood to China (Figure 1) and this is expected to increase. China's wood fibre demand is predicted to increase to > 450 million m^3 by 2020 and despite increased domestic production will still face a deficit of about a third of that level. New Zealand's output by then could be around 35 million m^3/annum. Japan is facing a very large demand for wood to rebuild after its recent devastating earthquake. India's economy is also expanding rapidly and demand for wood is increasing. By value exports to India have risen 450% over the last five years and the country has moved from 12th most important export destination to 5th. In addition the US housing market has returned to life with significant flow on effects and our nearest market, Australia, has a sizeable latent housing demand which it is not able to meet solely from domestic timber production.

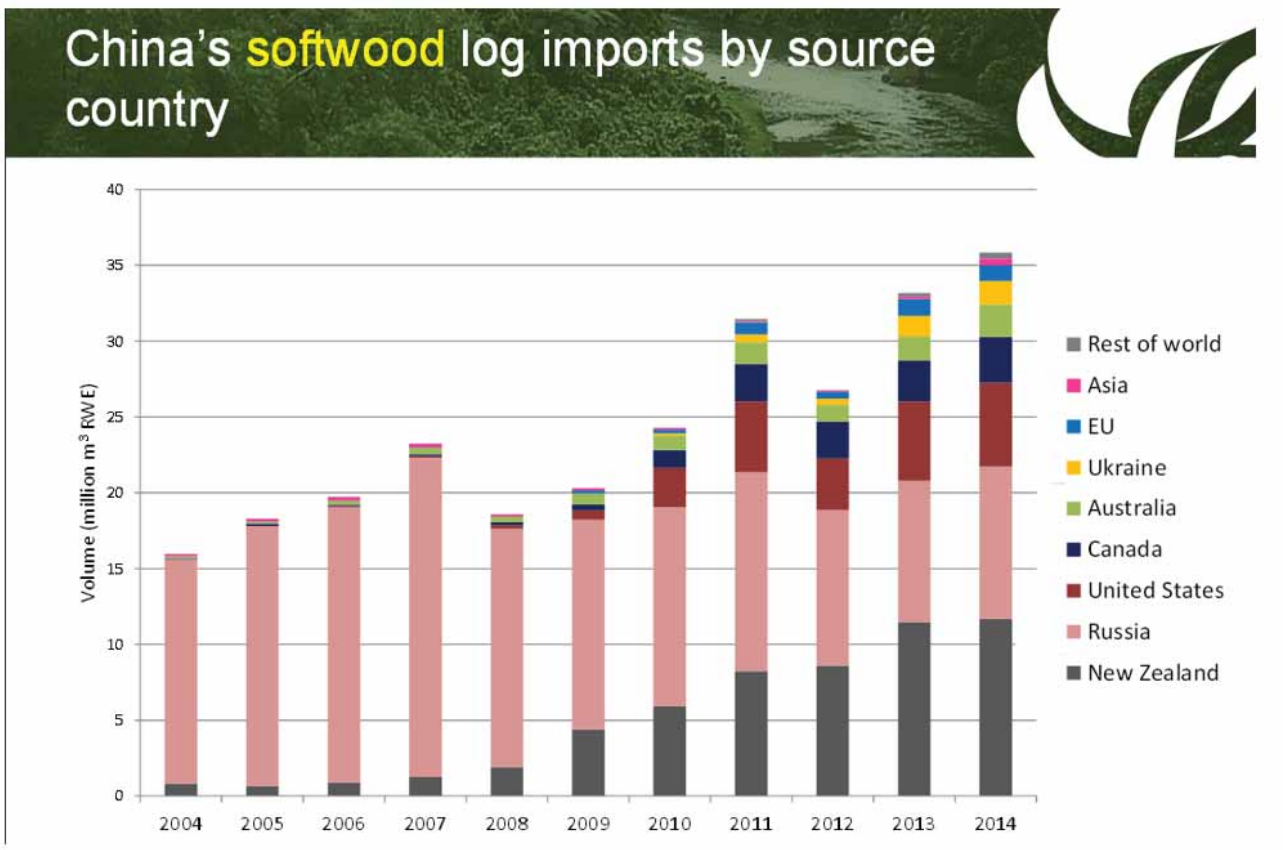


Figure 1. Reference Forest Trends, 14 April, 2015

Large and Early Returns on Science Investment

New Zealand has 1.74 million ha of plantation forests already in the ground, of which 90% is radiata pine and approximately 52,000 ha of this is harvested and replanted every year. Expanding new forest planting is critical to offset the national carbon emissions that will arise from about 2018 with the harvesting of mid-1990s plantings.

The opportunity for industry and NZ is to increase the profitability of forestry and to provide significant flow of economic benefits to NZ. This can be achieved by improving the net value of the harvested trees, enhancing the production (and quality where possible) of the trees in the ground, and establishing new forests that are faster growing, higher quality and more disease resistant. Many industry leaders consider a 5 m3/ha/ yr increase in productivity over the next 10 to 15 years as a very conservative estimate of what can be achieved by applying existing knowledge more effectively through greater technology and knowledge transfer. An additional 5 m3/ha/yr (total = 10) can be gained by applying advanced genetics and by reducing losses by pathogens, although much greater effort and close partnerships with researchers are required to achieve this goal (pers comm. David Balfour, CEO Timberlands).

Industry Profile

Plantation forestry occupies 7% of NZ's land area, contributes around 3% of New Zealand's GDP and together with wood processing, employs 21,000 workers directly and many more indirectly. At ~ $4.8 billion per annum forestry is NZ's third largest export earner and has a projected potential harvest increase of almost 30% by 2025 (Figure 2). This will make forestry a $6.5 billion industry if the increased production is exported as logs. If the Woodco Strategy targets for value added processing are achieved forestry has the potential to lift export earnings to 12 billion by 2025.

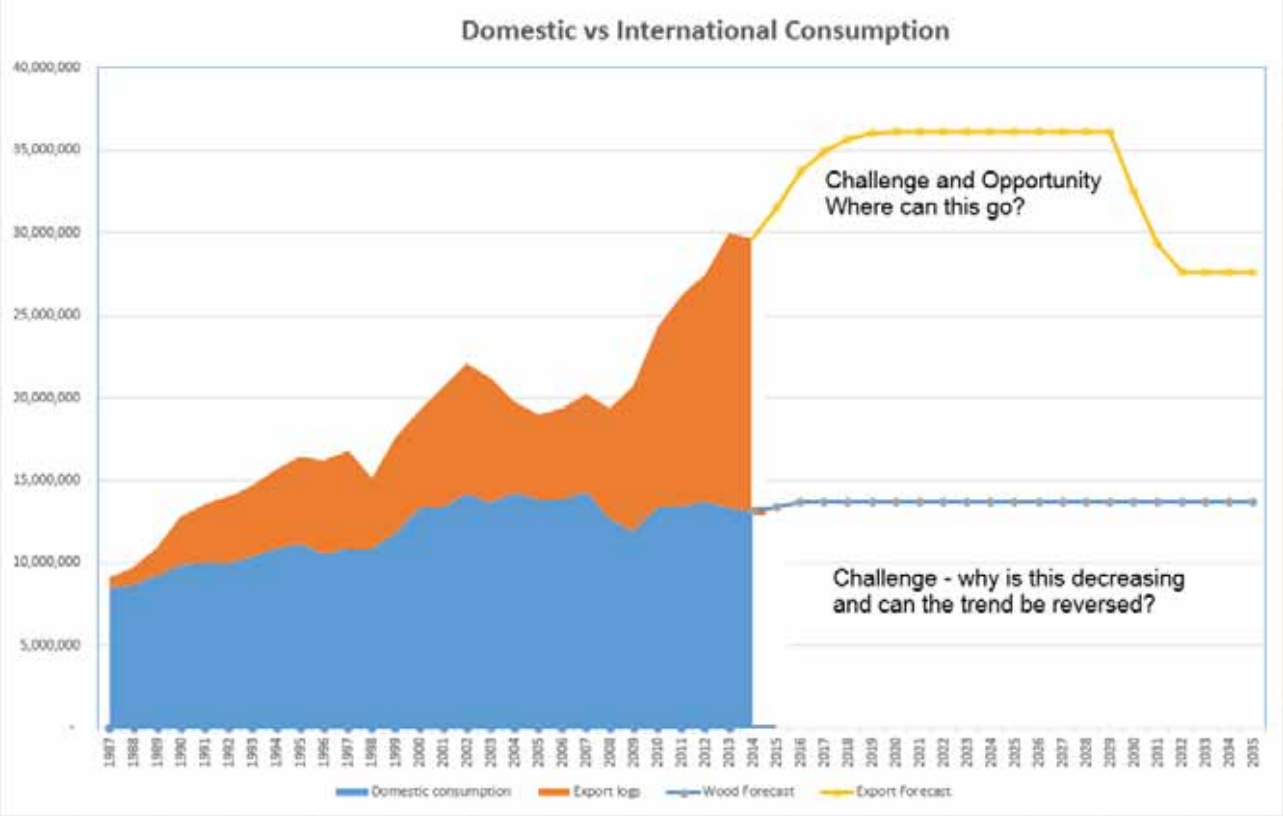


Figure 2. Domestic vs International Consumption

Market Drivers

Plantation forests are established to provide feedstock to wood using industries. In order for a high labour cost country like NZ to compete, industries need to be capital intensive, and the more consistent the feedstock the more competitive will be the processing. The ideal forest tree is, and will continue to be, one that is fast growing, cylindrical, disease resistant, with small branches (knots) and uniform wood properties characterised by being stiff, stable, strong, and blemish free. Higher value markets generally require these wood properties, whereas markets that pay less for raw material (e.g. fibre board, pulp and paper, biochemicals, bioenergy, etc.) are presently much less discerning. Therefore, the focus of NZ plantation forestry will be to grow trees of consistent dimensions and wood quality suited for the higher margin, solid wood or engineered wood markets with residues very much a by-product. Consistency, quality and productivity will continue to be key to a successful industry.

Over the last 40 years as the plantation resource has matured the volume of logs processed in NZ has increased from an annual supply of four million m^3 to 30 million m^3 / annum (Figure 3. below). At the same time the log export market has also greatly expanded, most recently as Asian countries have increased their demand for raw materials to feed their expanding manufacturing capacity. Traditional sources of high quality structural and appearance grade logs from tropical and boreal forests are declining for a variety of environmental protection, access/ quality and biological reasons.

The shortfall is being met by expanding plantations forests worldwide. New Zealand can play a significant role by exploiting our competitive advantage in fast growing softwood forests, including:

- good structural and appearance grade properties of radiata pine;
- responsiveness of radiata pine to genetic improvement;
- access to renewable energy for log processing;
- a capacity to extract high value components from radiata pine and other species for the sustainable supply of biomaterials and green chemicals;
- fertile soils with good regular rainfall but unsuitable for intensive agriculture due to hilly terrain;
- fast growth rates.

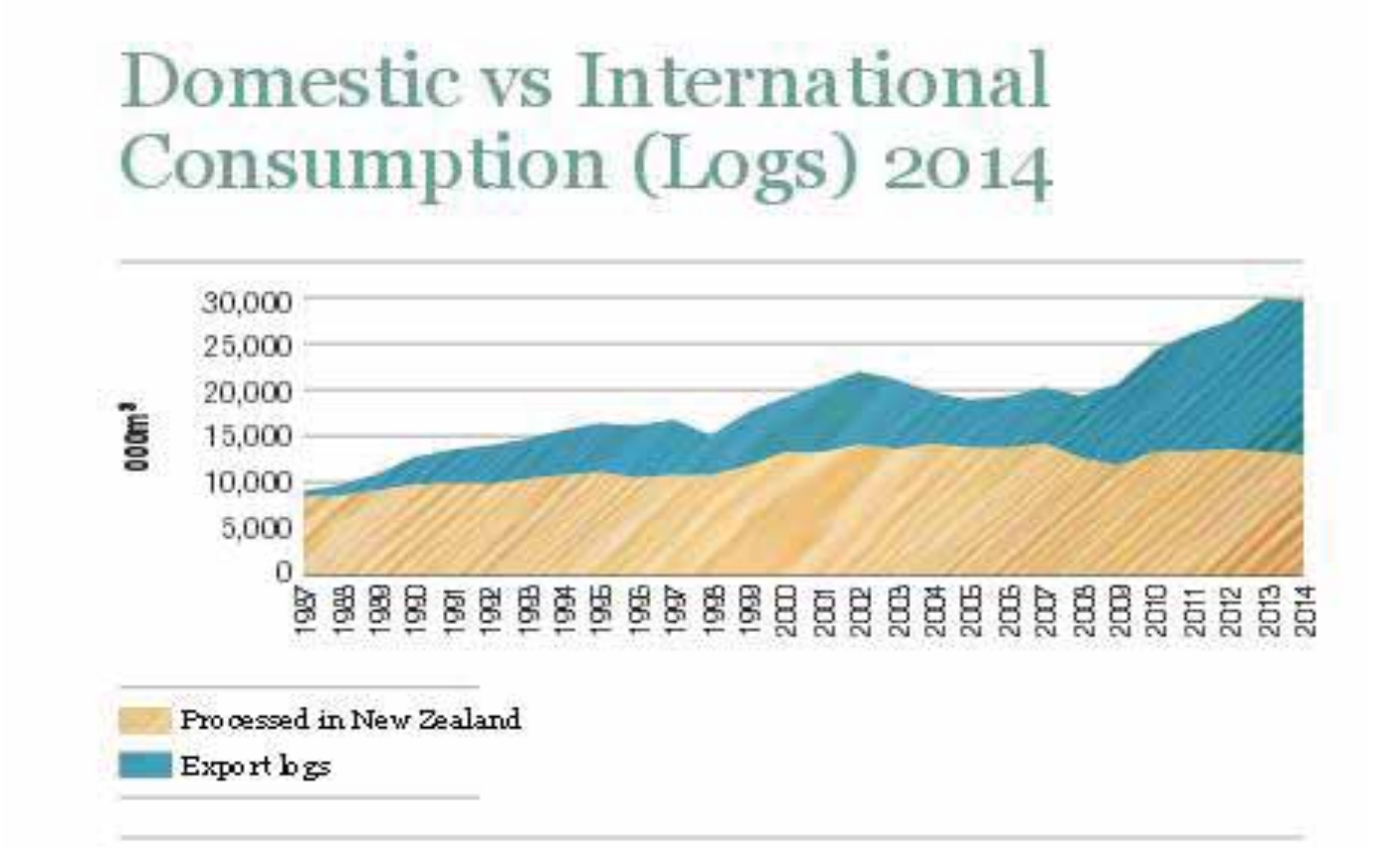


Figure 3. Domestic vs International Consumption (Logs) 2014

Forestry's Contribution to GDP

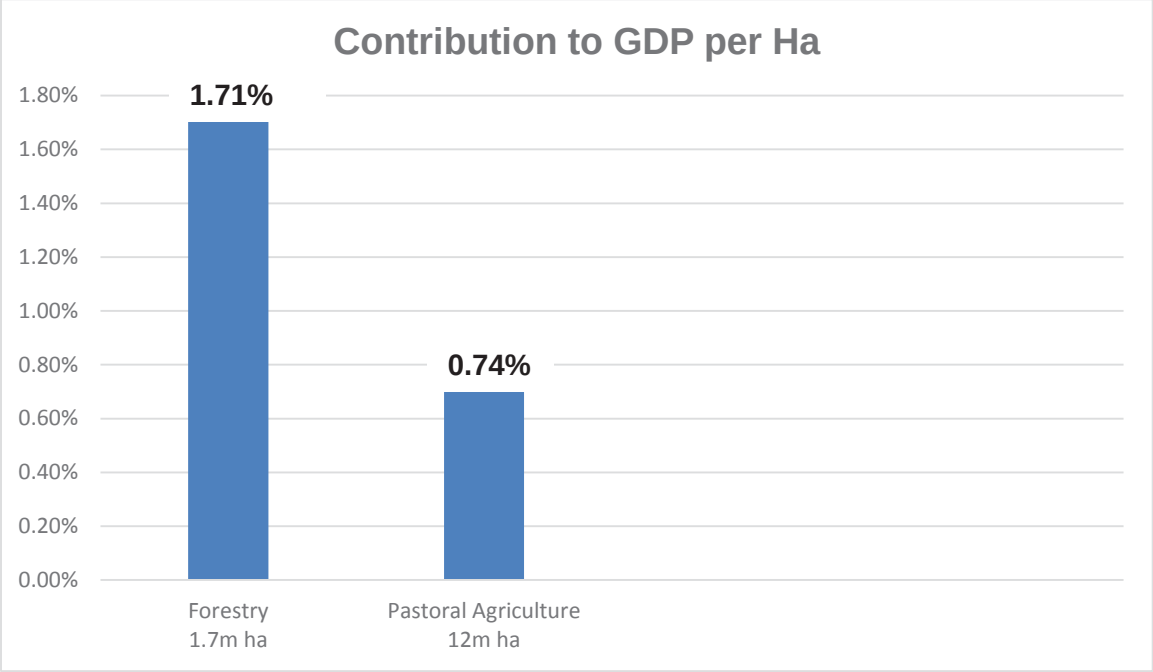


Figure 4. Source: Treasury Documents 2009 : Kit Richards, PF Olsent Ltd

Of the 1.74 million ha of plantation forests, 38% is privately owned in small estates (less than 10,000 ha) and there is a significant component of Maori owned land and an increasing area of forest ownership (http://www.nzfoa.org.nz/images/stories/pdfs/factsandfigures_2014_web.pdf). The industry is characterised by a complex and interdependent supply chain. As with pastoral farming, major assets are located either "inside the forest gate" (forestry) or "outside the forest gate" (processing). However, the 16 million m^3 of export logs (MPI provisional exports statistics to 30/6/2015) that leave the forest are still very much of the "forestry" component of the supply chain until they reach processing plants overseas.

Forestry profitability has recently improved, mainly because of increasing Chinese demand, but the fundamentals of the industry remain on a knife edge in terms of international competitiveness. Costs are high and labour productivity is relatively low compared to many competing countries. In recent years large tracts of NZ plantation forest have been converted to dairy pasture. Investment in new land planting has been absent or very low for the last ten years and NZ faces many challenges to reverse this trend and provide productive and environmentally sound uses for the multiple tracts of "marginal" land that exist within pastoral farms at present. The main opportunities facing NZ forestry in the next 10 years to which research can contribute include:

1. Increasing profitability from existing forests.
2. Fully exploiting the approaching increase in harvest volume expected.
3. Increasing productivity and wood quality, consistency and uniformity from new planting and replanting.
4. Protection from biosecurity threats and improved management of current forest health issues.
5. Reducing costs.
6. Demonstrating sustainability and renewability.
7. Managing carbon credits and liabilities.
8. Other ecosystem services: nitrogen reduction, soil conservation, improved water quality, and peak flood reduction and recognition of their value.
9. Promoting the increased use of wood and wood fibre.
10. Integrating forestry for sustainable land use on intensively farmed lowlands.

8. THE CONTRIBUTION OF RESEARCH TO ACHIEVING THE POTENTIAL

The Contribution of Research to Achieving the Potential

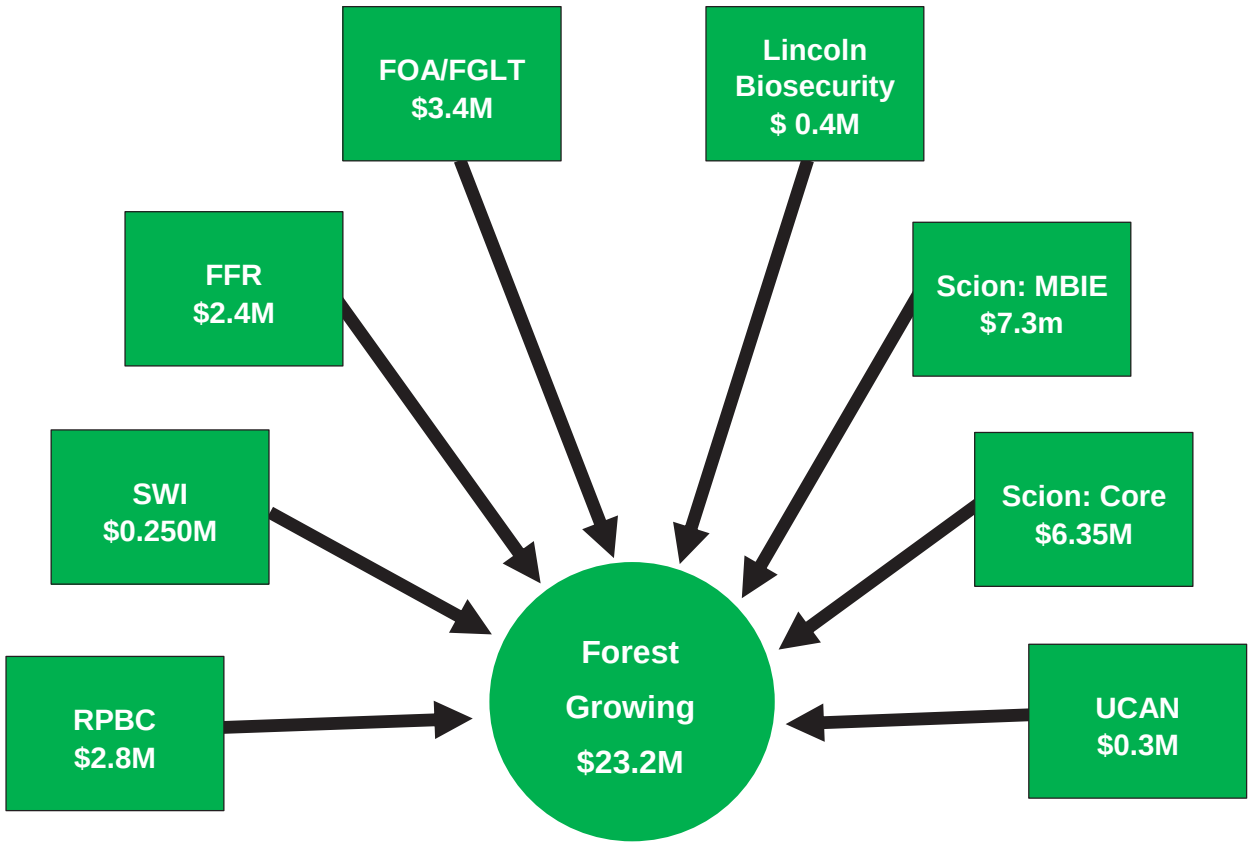


Figure 5. Breakdown of current forest growing research (The SWI figure is for research related directly to forest growing only).

Industry Investment in RS&T in Forestry

Government and industry together contribute approximately $23m/year to forest growing science (Figure 5). Of this approximately 24% is industry funded. This doesn't include the considerable Arborgen funding that leverages the Scion molecular biology programme. The Forest Growers Levy Trust contributed $3.5M in 2015 to support forest growing research and industry companies continue to fund collective research projects in addition to the levy including Radiata Pine Breeding, Steep Land Harvesting and Specialty Wood Products. Industry also funds in-house research, although the level of funding is confidential and the results are generally not made available to the wider industry. This is mainly operational research, but it does add considerable knowledge and benefit to the investor. Industry in particular funds those research programmes where it expects to get the greatest return on its investment. The Solid Wood Innovation (SWI) (which was previously the Wood Quality Initiative), the Radiata Pine Breeding Company (RPBC), the FFR Innovative Harvesting PGP and the Specialty Wood Products (SWP) partnership are all 50/50 funded between industry and government (MBIE or MPI).

Components of the SWI programme have direct relevance to forestry (e.g. log segregation technology) and benefit the forest growers by potentially raising the value of the end products. Similarly, the RPBC benefits the wood processors and product manufacturers in the longer-term by producing logs with preferred traits such as stiffer, stronger and more stable wood. Most of the programmes funded by MBIE have a higher ratio of government to industry funding due to the higher component of longer term more riskier research and the benefit these programmes also provide to small forest growers and the recognised wider public good benefits.

Forest biosecurity and forest health research receives considerable direct ($1.0M/yr) and indirect ($1m/yr for Forest Health Surveillance, diagnostics, and database) financial support from the forestry sector. Additional to this, and not shown in Figure 5, is the research programme to find a replacement for methyl bromide for export log treatment (and other applications). This programme is managed by STIMBR (Stakeholders in Methyl Bromide Reduction) and is funded to $2.5m over 5 years on a 50/50 split between industry and government.

Also not specifically shown is the Fire Research programme, which includes stakeholders outside of the forestry sector and to which FOA contributes $60,000 per year.

9. STRATEGIC OBJECTIVES

The strategic objectives for the 2015 Forest Growers Science and Innovation Plan are:

Improve the profitability of growing forests on a sustainable basis:

1. Protect forest assets and markets from adverse factors.
2. Improve productivity and uniformity within and between trees.
3. Sustain and enhance forestry's license to operate.
4. Improve efficiency and safety in operations and supply chain logistics.
5. Ensure species options for diversity of sites and markets.

1. Protect forest assets and markets from adverse factors.

With a commercial value of approximately $20B protecting NZ's plantation forests from injurious agents such as periodic fire and wind events and biosecurity threats is of very high priority. Loss of forest resource to these agents reduces forest asset values and threatens future wood flows which impact on the wood processing sector's ability to add value within New Zealand. Forest pests and diseases also have the potential to shut NZ's logs and wood products out of international markets. Protecting access to these important markets is critical.

2. Improve productivity and uniformity within and between trees.

New Zealand pine plantations have historically been producing at sub optimum levels of productivity and wood quality for a variety of reasons including sub-optimal silvicultural regimes, sub-optimal management of soils, weeds and nutrition, not realising the full benefit of improved genetics and substantial losses due to pathogens. To support profitable wood processing producing wood that is more consistent and of uniform quality is a high priority.

3. Sustain and enhance forestry's license to operate.

Being able to demonstrate sustainability is key to investors and also to markets and regulators. Increasingly markets require products that are produced sustainably and are supported by independent verification. Forests provide many environmental benefits to society that are being increasingly recognised and valued, but there is potential for negative environmental impacts, particularly at harvesting time, that can raise community concerns. If these potential impacts are not well managed there is a risk of the industry's licence to operate being threatened.

4. Improve efficiency and safety in operations and supply chain logistics.

New Zealand forest growers must remain internationally competitive to compete successfully in world markets. Safe and cost effective forest operations with efficient distribution to domestic markets and ports is a critical component of a profitable industry. As an increasing proportion of the harvest will be on steep land, often in smaller forest blocks more distant from markets, it is even more important for the industry to focus on efficiencies in harvesting and transportation.

5. Ensure species options for diversity of sites and markets.

A resilient forest industry requires alternative species to radiata pine for those sites not well suited to radiata and as a backup in the event of biosecurity incursions threatening our major species. There is demand for wood products that are naturally durable, stiffer and with higher appearance properties that cannot be readily met from radiata pine. As pressure continues to go on supplies of these timbers from natural forests the demand can be expected to increase. Our knowledge of these species, their site preferences, genetic to site matching, sawing and timber processing and markets are less developed than for radiata with the result that growers and processors have less confidence in these species.

10. RESEARCH PRIORITIES

Research priorities were defined following a process comprising:

- Input from a consultative process
- Consideration by the Forest Growers' Research Committee of a long list of suggested research priorities
- Refinement, consolidation, and paring down of the long list to a list of research priorities endorsed by the Forest Growers' Research Committee
- Stack ranking the endorsed list of research priorities using an evaluation matrix comprising the following weighted criteria:

    - How well is it aligned with the Strategic Objectives?
    - How quickly will benefits be realised?
    - What is the likelihood of adoption?
    - What is the potential commercial payback?
    - What is the potential for leverage of industry funding?
    - How important is building or protecting research capability in the area of proposed research?
    - Are others undertaking this research?
    - Is this research enhanced by collaboration?

The table on the next page sets out the list of research priorities arising from this process and identifies whether each priority is part of an existing programme, in full or in part, or not part of an existing programme.

Identified Research Priorities:

Key: Included in a current collective research programme
Included, in part, in a current collective research programme
Not part of a current collective research programme

		Relates to:
• Improve screening tools for Radiata wood quality in standing crop		2
• Use of remote sensing technology and other tools/approaches to characterise tree crop and link to soils, site, climate and genetics		2
• Detection technologies for forest health monitoring and surveillance		6
• Mitigation of the risk of phytophthora disease risk through disease resistance, disease management and fundamental knowledge of tree defence mechanisms to phytophthora species		4 6 7
• Non-chemical alternatives for phytosanitary treatment of export logs including debarking		9
• Mechanisation of felling and extraction on steep land		8
• Enhancing productivity in older stands		2
• Improved understanding of the performance of riparian reserves in reducing sedimentation		
• Reducing herbicide use and alternatives to herbicides		10
• Improve wildfire behaviour analysis and spatial modelling		3
• Improve wildfire threat analysis taking account of asset values at risk.		3
• Leverage of GCFF programme for other species, particularly D fir		
• Utilising soil biota and endophyte technology for disease resistance and increased productivity		5
• Improved understanding of the impacts of mechanised harvesting systems across a range of soil types		
• Maintain the integrity of other species breeding programmes with emphasis on health, form, vigour, stiffness and durability		1
• Extend water quality monitoring network within production forest catchments		
• Genomics technology to increase the speed of the breeding cycle		7
• Propagation technologies for other species to speed the deployment of improved genetics		
• Improved growth models for other species supported by PSP data		
• Improved efficiency from log making to customer point of sale - optimal bucking, volumetric scanning, debarking to a phytosanitary standard, log ID and tracking		
• Understanding the genotypic variation in water and resource utilisation efficiency		
• Matching other species to site with confidence using process based models		

Key:
1. Diverse Species
2. Sustainable Intensification
3. Fire
4. Phytophthora
5. Bioprotection
6. Foliar Diseases
7. Radiata Pine Breeding Company
8. Steep Land Forest Harvesting
9. STIMBER
10. Weeds

Those priorities that have been coded with a red key in the above table are priorities that are not currently being addressed by collaborative research programmes. These priorities are:

- Improved understanding of the performance of riparian reserves in reducing sedimentation.
- Leverage of GCFF programme for other species, particularly D fir.
- Improved understanding of the impacts of mechanised harvesting systems across a range of soil types.
- Completing the gaps in the water quality monitoring network from production forest catchments.
- Propagation technologies for other species to speed the deployment of improved genetics.
- Improved growth models for other species supported by Permanent Sample Plot data.
- Improved efficiency from log making to customer point of sale - optimal bucking, volumetric scanning, debarking to a phytosanitary standard, log ID and tracking.
- Understanding the genotypic variation in water and resource utilisation efficiency.
- Matching other species to site with confidence using process based models.

All other identified priorities are addressed in full or in part in current collaborative research programmes further described in Section 7.

11. RESEARCH PROGRAMMES

Six research programmes have been co-funded by the Forest Levy in 2015/16.

	Annual Funding				
Programme	**MBIE**	**Forest Levy**	**Scion**	**Other**	**Total**
Specialty Wood Products	.71	0.345	0.55	0..365	1.970
Sustainable Intensification (Growing Confidence in the Future of Forestry)	3.380	1.600	-	0.200	5.180
Fire	0.700	0.06	0.05	0.300	1.110
Phytophthora	2.200	0.400	0.500	0.270	3.370
Bioprotection	-	0.300	0.080	0.030	.410
Needle Diseases	-	0.340	1.890	0.160	2.390
Steep Land Harvesting		.250	.150	1.100	1.500
Total	**6.280**	**3.045**	**2.770**	**1.185**	**15.930**

In addition to the above programmes a number of smaller R&D projects have been approved for funding over the 2015-16 calendar years:

	Annual Funding				
Programme	**MBIE**	**Forest Levy**	**Scion**	**Other**	**Total**
Herbicide Fate		.050			.05
Waterway Recovery from Storm Damage		.022			.022
Site Productivity Estimation		.085			.085
In Forest Debarking		.135			.135
Nutrient Management		.080			.080
Weeds Research		.120		.120	240
Pest Control in Urban Areas [(1)]	1.25	.075	.170	.148	1.643
Water Quality Monitoring		.080			.080
Impact of Harvesting on Riparian Margins		.020			.020
Total	**1.25**	**0.667**	**.170**	**.268**	**2.355**

[(1)] Subject to Successful MBIE Bid

The term of industry funding commitments for levy and non-levy funded research programmes are shown in Figure 1 (refer 13. Appendices).

The sources of funding for forest growing research programmes are shown in Figure 2 (refer 13. Appendices).

Diverse Species

The current Diverse Species programme is a small programme supporting research into commercial species other than radiata pine. Forest Growers' interest in other species is primarily to make best use of available forest sites, for risk management and to access higher value niche market opportunities that cannot be met with radiata pine. The objective of the programme is to continue previous work to progressively raise the confidence of forest growers to invest in these species. The focus of the programme is genetic improvement so as to raise forest health and productivity and to produce wood of a suitable quality for further processing. The species in the programme are Douglas fir, coast redwoods, cypress species (*C. macrocarpa, C. lusitanica* and hybrids) and a range of eucalypt species. These include industrial species such as *Eucalyptus nitens, E. fastigata and E. regnans* and the range of naturally durable species being investigated by the NZ Dryland Initiative species.

Characteristics of these other species include natural durability, strength, appearance, impact hardness and an ability to perform better than radiata on some sites such as cold, dry and very fertile sites.

New matching government funding support through the MBIE partnership programme was secured for this Specialty Wood Products (SWP) programme from 1 July 2015 for a seven year period.

Sustainable Intensification (Growing confidence in forestry's future) Research Programme

The "GCFF" research programme targets different intervention points in the forest growing cycle for both current and future forests. Its goal is to increase the returns from existing forests through mid-rotation interventions aimed at increasing productivity, while also focusing on how to increase the productivity and consistency of future forests.

The research programme is organized into three main Research Aims (RA). A fourth research aim focuses on technology translation.

RA1: A systems approach to maximizing the benefit from existing forests:

- Segregation of the current resource
- Enhancing the productivity of older stands

RA2: Building more productive, higher quality forests for the future.

- Phenotyping the forest
- Doubling radiata pine productivity
- Enhanced activity of the soil microbial community

RA3: Sustainability under intensified regimes.

- Sustainability of soil, water and biodiversity
- Sustainability over multiple rotations
- Spatial economic modelling for sustainable forestry

RA4: Closing the gap. Translating science into sustainable business growth.

- The development of the forest phenotyping platform is one of the core elements of the programme and provides the information that forest managers, researchers and tree breeders can use to understand how the interaction of genetics, environment and management affect productivity and wood quality. Recent remote sensing research has enabled individual trees to be delineated from LIDAR images. Including attributes about these individual trees, such as genetic origin, site characteristics and management history, will extend this. With advances in sensor technology and computing power, very large numbers of trees can be assessed in order to better understand the drivers of productivity and wood quality.

The GCFF programme addresses the following research priorities identified in Section 10:

- Improved screening tools for Radiata wood in standing crop
- Use of remote sensing technology and other tools/approaches to characterise wood quality and link to soils, site, climate and genetics
- Enhancing productivity in older stands

Fire

The fire research programme is managed through the National Rural Fire Authority. The programme applies research themes and outcomes from high fire prone countries in a New Zealand context. The contribution from forest owners is used in conjunction with separate contributions from NRFA, local government, Defence and Department of Conservation targeting vegetation fire. Benefits include enhanced firefighter safety, improved understanding of fire behaviour, safe and effective use of fire as a land management tool and the ability to deploy effective suppression resources.

The Fire Research Programme addresses the following priorities identified in Section 10:

- Improve wildfire behaviour analysis and spatial modelling
- Improve wildfire threat analysis taking account of asset values at risk.

Phytophthora (Healthy Trees, Healthy Future)

Phytophthoras are considered a growing threat to the plantation forest industry as well as to New Zealand's native forests and urban trees. The industry has learned through experience, both international, and nationally, that there is a need to be much more pro-active preparing for new incursions, or from problems caused by species of phytophthora already present in New Zealand. *P. multivora and P. cactorum*, affecting mainly apples, fit into the latter category and there is particular concern about the problems other species such as *P.cinnamomi* might cause to forestry, amenity and horticultural species. Radiata pine, kauri and apple are being used as model hosts.

The objectives of the research are to take a systems biology approach to understanding tree responses to pathogen attack. Host-pathogen interactions are assessed concurrently at the biochemical, genetic and disease expression level and to improve plant breeding, development of diagnostic tools, evaluation of chemically induced responses and establish a core understanding of host defence/ pathogenicity mechanisms associated with Phytophthora infection.

The benefits are to develop improved genetic tolerance to phytophthora disease, a fundamental understanding of the mechanisms of phytophthora infection, selection for broad resistance to phytophthora infection and an improved resilience of NZ forest estates to new phytophthora biosecurity threats.

The Phytophthora Research Programme addresses the following priorities identified in Section 10:

- Mitigation of the risk of phytophthora disease risk through disease resistance, disease management and fundamental understanding tree defence mechanisms to phytophthora species.

Bioprotection.

Bioprotection work is managed alongside the foliar diseases research programme. The Bioprotection research programme is conducted to establish a long-term symbiotic relationship between radiata pine and beneficial microbes. The main focus is to induce systemic resistance against foliar diseases by using endophytes and elicitors. Induced resistance can effectively 'immunise' trees from a variety of diseases/disorders, because it causes a broad-spectrum activity response by the plant (analogous to vaccination).

The Bioprotection Research Programme addresses the following priority identified in Section 10:

- Utilising soil biota and endophyte technology for disease resistance and increased productivity.

Needle Diseases

Needle Diseases a science programme to understand and mitigate the effects of needle diseases on radiata pine and to underpin the Forest Biosecurity Programme. Objectives include maintenance and improvement of forest health, provision of the science underpinning forest biosecurity work and an improved understanding of Red Needle Cast and other foliar diseases (such as Dothistroma and Cyclaneusma) including mitigation options.

The Forest Biosecurity Research Programme addresses the following priorities identified in Section 10:

- Mitigation of the risk of phytophthora disease risk through disease resistance, disease management and fundamental understanding tree defence mechanisms to phytophthora species.
- Detection technologies for forest health monitoring and surveillance.

Radiata Pine Breeding Company (RPBC) Research Programmes (not co-funded from the Forest Levy)

The RPBC has two research programmes, one focused on traditional tree breeding and related techniques, and the other on the development of genomic selection and genomic breeding values.

Combined the two programmes address the following priorities in Section 10:

- Mitigation of the risk of phytophthora disease risk through disease resistance, disease management and fundamental knowledge of tree defence mechanisms to phytophthora species.
- Genomics technology to increase the speed of the breeding cycle.

Steep Land Forest Harvesting (not co-funded from the Forest Levy)

The objectives of the Steep Land Harvesting programme are to improve harvesting productivity and worker safety by developing and commercialising a range of new harvesting technologies in the tree felling and extraction phase of steep country harvesting operations.

The outcomes expected from the programme include:

- A 25% reduction in steep terrain harvesting costs
- Zero lost time injuries during felling and breaking out on steep country
- A 10% reduction in fuel costs
- Development of new harvesting machinery for domestic and export sale.

To achieve these outcomes, the programme is investing in the following research and development activities:

- Mechanisation on steep terrain
- Increased productivity of cable extraction
- Development of operational efficiencies

The Steep Land Forest Harvesting Research Programme addresses the following priority identified in Section 10:

- Mechanisation of felling and extraction on steep land

Stakeholders in Methyl Bromide Reduction (not co-funded from the Forest Levy)

STIMBR (Stakeholders in Methyl Bromide Reduction Incorporated) brings together New Zealand industry, government and research organisations and individuals with the aim of: Providing a united voice in support of initiatives aimed at enhancing market access and biosecurity clearances for goods and products while reducing the release of methyl bromide into the atmosphere.

STIMBR's research programme covers:

- Methyl bromide destruction technology
- Potential alternate chemical fumigants
- Reduction in methyl bromide fumigation rates
- Proof of concept for joule heating technology
- Methyl bromide recapture
- Debarking options

The STIMBR programme addresses the following priority identified in Section 10:

- Non-chemical alternative for the phytosanitary treatment of export logs

Weeds Research (not co-funded from the Forest Levy)

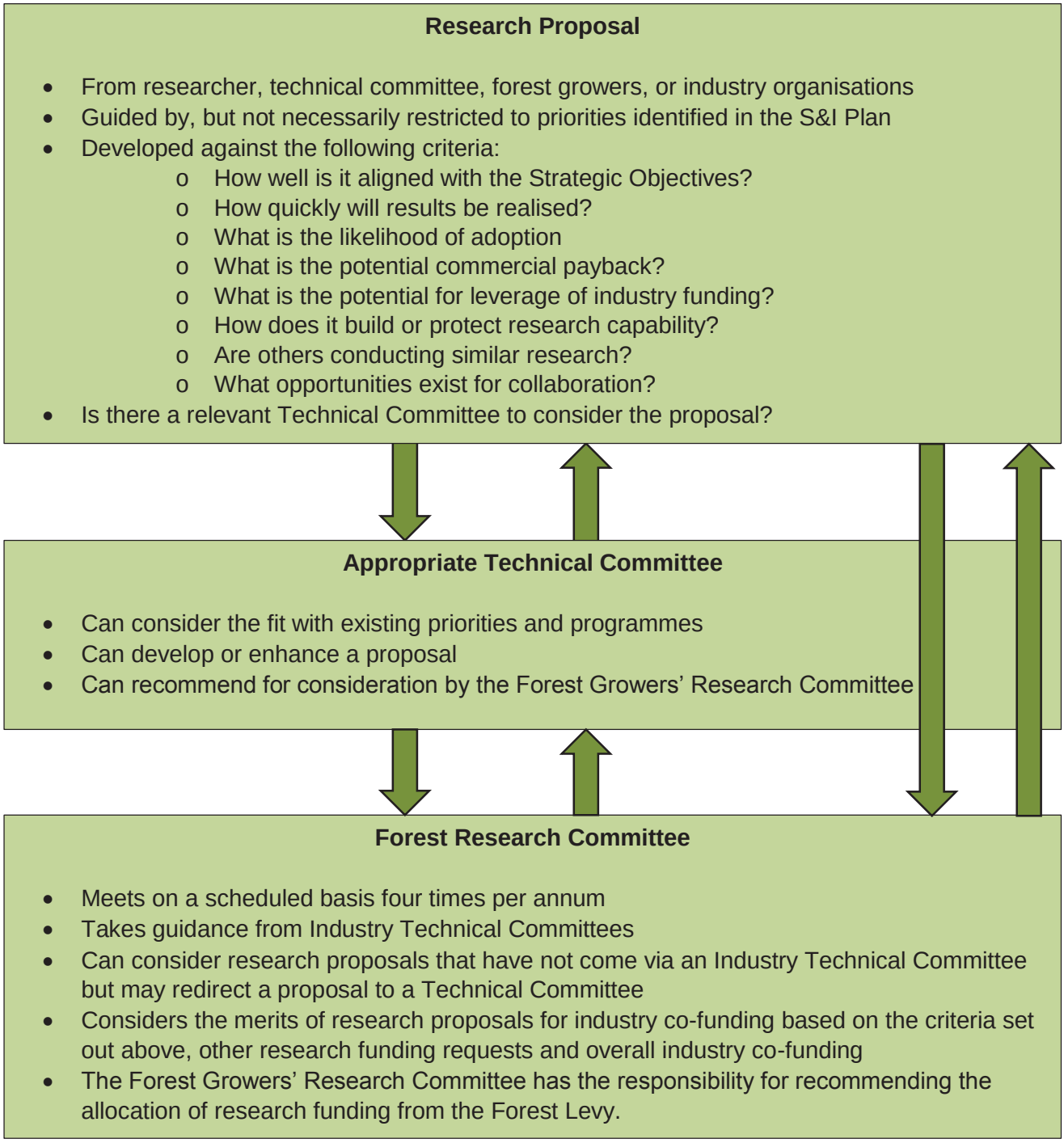
Weeds research is currently funded through two Sustainable Farming Fund Projects and a joint industry/Scion/AgResearch programme. Both SFF projects terminated on 30 June 2015 and targeted non-chemical control of pampas grass, a major weed problem in forestry establishment and finding alternative herbicides for forestry establishment that are acceptable to Forestry Stewardship Council (FSC). The joint programme runs until 30 June 2016.

This programme addresses the following priority in Section 10:

- Reducing herbicide use and alternatives to herbicides

12. PROCESS FOR PROMOTION AND EVALUATION OF RESEARCH PROGRAMMES

The following diagram sets out how research proposals should be developed and advanced to the Forest Research Committee through the appropriate Industry Technical Committee, or where the proposal is outside of the scope of the existing Industry Technical Committees, then direct to the Forest Research Committee.



13. APPENDICES

Industry Led Research Structure

Responsibility for the management of forest growing research programmes supported by the Forest Levy was transferred from FFR to FOA on 1 April 2014

Responsibility for all Forest Levy co-funded forest growing research sits with the new Research and Development management structure overseen by a joint FOA/FFA Forest Growers' Research Committee. The following diagram depicts the new structure.

The role of the Forest Growers' Research Committee is to identify research programmes and projects of importance to the forest growing and harvesting sector, work with other groups to arrange research funding and dissemination of information, and provide forest growers' views on pan industry research.

Each of the Forest Levy co-funded programmes has a Technical Committee made up of industry subject matter experts who have been appointed for their technical knowledge and expertise and not as company or organisation representatives. This is important as the programmes are for the benefit of all forest grower levy payers. At least one member of each Technical Committee is also a member for the Forest Growers' Research Committee. This provides for good connection between the Forest Growers' Research Committee and the Research Programme Technical Committees.

A single Technical Committee is providing oversight of the three forest biosecurity/forest health research programmes.

Following the agreement of the Harvesting Theme Members, FFR has been refocused on the Steep Land Harvesting Programme, which is not co-funded by the Forest Growing Levy. Associated with the refocusing of FFR on the harvesting programme has been a reduction in the size of the FFR Board, a change in the trustee shareholder of the company from Scion to an independent trustee company and a management agreement being put in place with FOA to cover the management of the company. The FFR legal entity is available for other collaborative research ventures where a contracting entity is required by funders and has been used for the new Specialty Wood Products Partnership.

Preparation of the 2015 Forest Growers Science and Innovation Plan

The 2015 Forest Growers Science and Innovation Plan was prepared following a managed consultative process involving the following:

- NZFOA Executive Council
- NZ Farm Forestry Research Committee
- NZ Forest Growers Research Committee
- NZFOA Environment Committee
- NZFOA Forest Health Committee
- Chair of Stakeholders in Methyl Bromide Reduction
- Scion
- Radiata Pine Breeding Company
- Solid Wood Innovation
- School of Forestry – University of Canterbury
- Landcare Research
- Lincoln Bio-Protection Centre
- Ministry of Business Employment and Innovation
- Ministry of Primary Industries
- NZ Wood Processors and Manufacturers Association
- Bioenergy Association of New Zealand
- New Zealand Drylands Forests Initiative

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Reference and Related Documents

The following documents have been cited in this plan or are relevant to this plan:

- 2012 New Zealand Forestry Science and Innovation Plan – New Zealand Forest Owners Association
- NZFOA Forest Biosecurity Research Strategy – 2011 – New Zealand Forest Owners Association
- New Zealand Forest and Wood Products Industry Strategic Action Plan – Feb 2012 – Wood Council of New Zealand Inc.
- Woodscape Study Report – February 2013 – Wood Council of New Zealand Inc.
- Manifesto – Prosperity from Forestry and Wood Products – May 2014 – Wood Council of New Zealand Inc.
- Scion – Prosperity from Trees – Statement of Corporate Intent 2014-2016
- Scion – Growing Confidence in Forestry's Future – Research Programme 2013-2019

Forest Growing Research Industry Funding Commitments

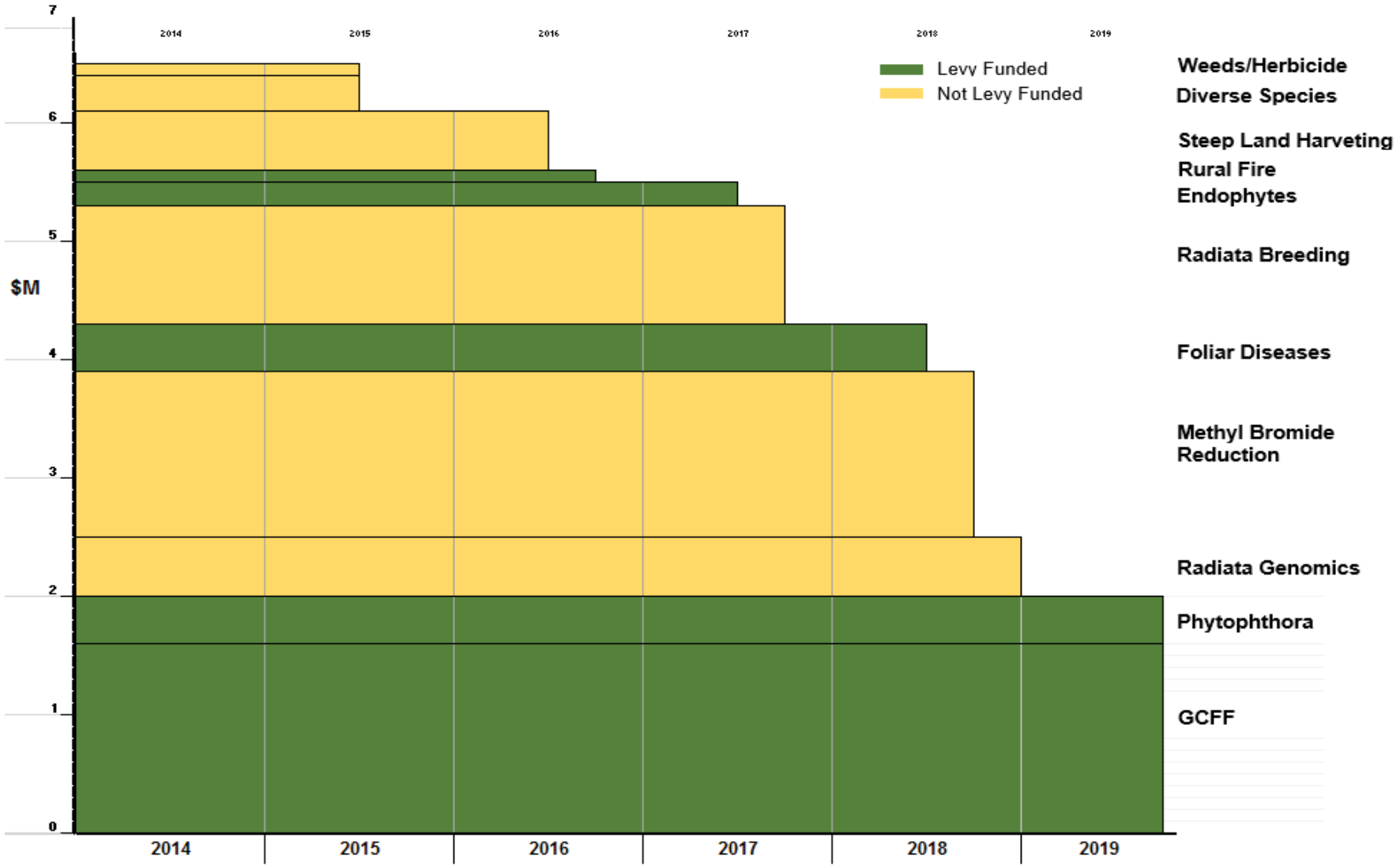

Figure 1

Forest Growing Research Funding

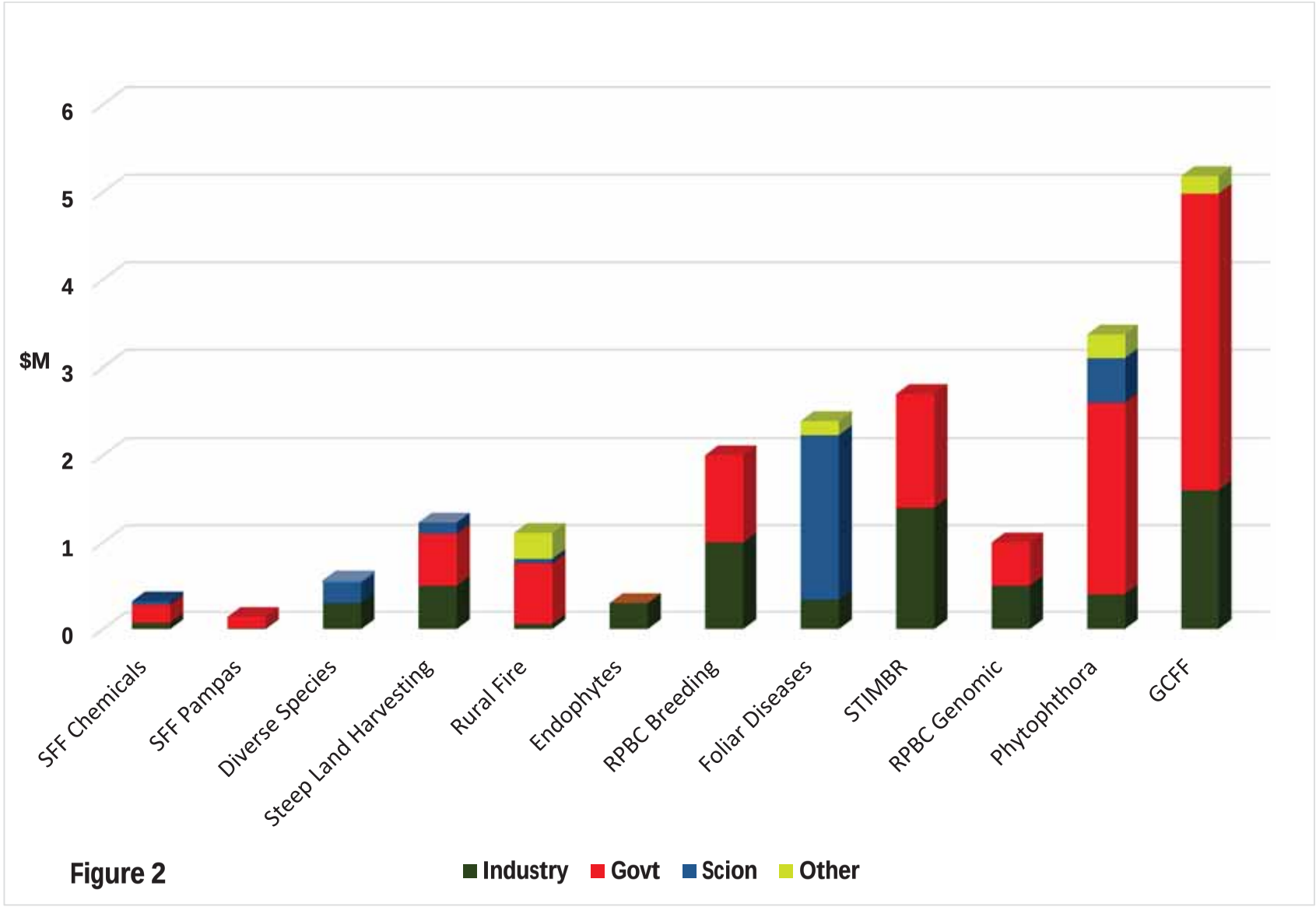

Figure 2