National primary industries research, development and extension (RD&E) framework

RD&E strategy for the forest and wood products sector

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This document has been compiled on the basis of extensive stakeholder consultation with representatives of the forest and wood products sector, government, and the providers and funders of forest and wood product RD&E.

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ACRONYMS

ABARE	Australian Bureau of Agricultural and Resource Economics
AFCS	Australian Forest Certification Scheme
ANU	Australian National University
BRS	Bureau of Rural Sciences
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
DCC	Department of Climate Change
DEC	Department of Environment and Conservation (Western Australia)
DECCW	Department of Environment, Climate Change and Water (New South Wales)
DEEDI	Department of Employment, Economic Development and Innovation (Agri-Sciences Queensland)
DERM	Department of Environment and Resource Management (Queensland)
DEWHA	Department of the Environment, Water, Heritage and the Arts
DoR	Department of Resources (Northern Territory)
DPI	Department of Primary Industries (Victoria)
DPIPWE	Department of Primary Industries, Parks, Water and Environment (Tasmania)
DSE	Department of Sustainability and Environment (Victoria)
FPC	Forest Products Commission (Western Australia)
FPQ	Forestry Plantations Queensland
FFPC	Forestry and Forest Products Committee
FSC	Forest Stewardship Council
FT	Forestry Tasmania
FTE	full-time equivalent
FWPA	Forest and Wood Products Australia
I&I NSW	Industry and Investment NSW
I&I NSW-S&I	Industry and Investment NSW, Science and Innovation
MIG	Montreal Process Implementation Group for Australia
Mt	Million tonnes
NRETAS	Department of Natural Resources, Environment, The Arts and Sport (Northern Territory)
PEFC	Programme for the Endorsement of Forest Certification schemes
PIMC	Primary Industries Ministerial Council
PIRSA	Department of Primary Industries and Resources South Australia
PISC	Primary Industries Standing Committee
R&D	Research and development
RD&E	Research, development and extension
RPCC	Research Priorities and Coordination Committee
RRDC	Rural Research and Development Corporations
RWG	Research Working Group
SCU	Southern Cross University
UM	University of Melbourne
UTAS	University of Tasmania
UTS	University of Technology, Sydney

EXECUTIVE SUMMARY

Australia's forest and wood products sector directly employs 76,000 people and generates an annual turnover of more than $21 billion. The sector's resource base — plantation forests, and part of the native forest estate — is managed in accordance with internationally accepted norms of sustainability to ensure the continued supply of a wide range of wood products and environmental services.

The longer-term outlook for the forest and wood products sector is very positive. In the next decade and beyond, it can increase its already substantial contribution to national social, economic and environmental goals, including through new opportunities created by demand for carbon sequestration services and biomass for renewable energy, and by market expansion for wood products driven by population growth and social trends. At the same time, however, the sector must cope with an increasingly complex and competitive production and market environment, evolving climate-change policy, and the need to realise and demonstrate sustainability. To meet these opportunities and challenges, effective and efficient research, development and extension (RD&E) is essential.

This document forms part of the National Primary Industries RD&E Framework developed under the Primary Industries Ministerial Council. It initiates a process of strategy development designed to ensure that RD&E meets the future needs of the forest and wood products sector and the Australian public.

The forest and wood products sector RD&E effort currently comprises about 500 researchers and support staff across 50 organisations at an estimated annual cost of $104 million. While, historically, RD&E has served the sector well, there is clear evidence that capacity has become increasingly dispersed and is declining significantly due to an aging demographic among researchers in some disciplines, restructuring and redirection by RD&E providers, and a diminution of resources. Since 1982 there has been a real decline both in total research funding and in research intensity (i.e. research expenditure as a percentage of industry turnover). Combined with other sector drivers, these trends suggest an increasing need for an RD&E effort that is more nationally coordinated and aligned.

The process to develop a National Primary Industries RD&E Framework provides an opportunity to gain greater recognition for the challenges facing RD&E capability in the forest and wood products sector and to develop coordinated approaches for addressing investment levels, sustaining or developing research capability, improving information sharing and ensuring cost-effective and efficient RD&E.

This document presents an initial view of future RD&E capability requirements in the forest and wood products sector and sets out key actions that need to be taken. It also proposes the establishment of a national-level Forest and Wood Products RD&E Forum to promote cooperation and coordination in the provision of RD&E to the sector and to assist in the alignment of investment in key research priorities. By bringing together key funders, providers and users of RD&E, the Forum will provide a mechanism for reviewing priorities, monitoring capability, and developing common performance measures for effective and efficient RD&E.

INTRODUCTION

Australia's native forests are globally unique and the nation also has a significant forest plantation resource. The management of Australia's wood-production forests, both native and planted, takes place within strong regulatory frameworks and, overall, these forests are among the world's best managed.

Forests provide society with a diversity of products and environmental services. The sustainable management of both native forests and plantations is central to realising broader natural resource management goals and the delivery of critical environmental services, and ensuring the economic future of the forest industry.

Wood is an easily worked, versatile, environmentally friendly and aesthetically pleasing material with a very diverse range of end uses. It has been described as a 'natural plastic', the 'concrete of the 21st century', and the new biofuel.

In the next decade and beyond, the forest and wood products sector, which grows, harvests, processes and markets wood and wood-fibre products, has the potential to increase its already substantial contribution to Australia's economy and environmental sustainability. The sector also has opportunities to develop new tree crops for carbon sequestration, energy, and other products.

To embrace these opportunities, the sector must remain competitive with alternative materials, imported products, and other land-uses. One key to this competitiveness is effective and efficient research, development and extension (RD&E).

Integrated RD&E will ensure that the sector can compete effectively in the face of rapid technological, social, economic and environmental change. It will assist the sector to manage the risks associated with such rapid change and to maintain and expand its traditional markets and to embrace new ones. It will also provide a scientific basis for the sector's economic and environmental sustainability, which underpins its social licence to operate.

This document forms part of the National Primary Industries RD&E Framework (see box). It sets out a process of strategy development designed to ensure that RD&E in the sector is well-targeted, effective and efficient and can adapt to the changing needs of the sector and the community.

Background to the National Primary Industries RD&E Framework

Australia has a wide range of co-existing primary industries. While approaches to RD&E vary by industry, all involve rural R&D corporations or industry-owned R&D companies, state and territory governments, CSIRO, universities, and private providers. To optimise productivity and sustainability across the primary industry, the deployment of RD&E investment, which exceeds $1 billion annually, should be focused, efficient and effective.

In April 2005 the Primary Industries Ministerial Council (PIMC) endorsed the concept of 'National R with Regional D&E'. The concept recognises that basic and strategic research can be provided from a distance, with regional adaptive development and local extension required to improve the uptake of innovation by industry. In 2009 PIMC agreed to a

statement of intent on a national primary industries RD&E framework[1] to facilitate further cooperation between agencies and industry for improving the efficiency and effectiveness of the national RD&E capability. The framework will be a broad national plan to provide a more comprehensive, structured approach, spanning:

- **fourteen primary industry sectors**: beef, cotton, dairy, fisheries and aquaculture, forests, grains, horticulture, pork, poultry, sheepmeat, sugar, wine, wool, and new and emerging industries

- **seven cross-industry sectors**: animal biosecurity, animal welfare, biofuels and bioenergy, climate change and variability, food and nutrition, plant biosecurity, and water use in agriculture.

Each of these sectors is developing RD&E strategies, of which this strategy for the forest and wood products sector is one.

The implementation of the framework is expected to lead to a primary-industry RD&E effort that is more collaborative, more specialised and less fragmented. Overall, despite the additional costs that might be incurred by strengthening national linkages and support for regional and local delivery, efficiency and effectiveness will be improved. Agencies will retain and build capability in fields strategically important to their jurisdictions and industries while also collaborating effectively with others.

[1] National Primary Industries Research, Development and Extension Framework Statement of Intent June 2009.

SECTOR SCOPE

Forests are managed both for environmental outcomes and for the production of wood and non-wood products. The growing and harvesting of trees for wood and wood fibre is analogous to other primary industries such as cropping, horticulture and fisheries.

Taken as a whole, the forest sector is broader than many other primary industries, encompassing forest-growing, forest-related natural resource management, the production, marketing and use of non-wood forest products, forest-contact industries (such as tourism and national park management), and wood harvesting, processing, manufacturing, market use and product performance. The sector's resource — plantation forests, and part of the native forest estate — and the industries associated with it are diverse. Forests provide important environmental services such as the regulation of water yield and flow, carbon sequestration, the maintenance of soil and water quality, and the conservation of biodiversity. In several regions of Australia the forest sector is a vital part of rural economies, providing employment in forest-growing and management, harvesting, wood-processing, manufacturing, and related service industries.

This strategy focuses on the sector's forest-growing, wood-harvesting and wood-processing components, and the marketing and use of wood products in construction and other applications, called here the forest and wood products sector. The strategy also integrates the management of the sector with sustainable natural resource management and the multiple environmental and social benefits of forests. Major products in the sector include primary-processed wood products used in building and construction and the manufacture of furniture and other higher-value products; pulp and paper products; bioenergy and biomaterials; and engineered wood products.

INDUSTRY PROFILE

The resource base of the forest and wood products sector comprises public and privately owned natural forests and plantations used in wood production (Table 1), as well as areas of more-specialised tree crops such as sandalwood and oil mallees.

Table 1: Forest area used for wood production, and volume produced

Resource	Area (million hectares)	Annual wood production, 2007–08 (million m^3)
Multiple-use public native forests	9.40	6.9
Native forests on private land*	38.0	2.0
Softwood plantations	1.01	14.9
Hardwood plantations	0.95	4.6
TOTAL	**49.36**	**28.4**

*An estimated 3–5 million hectares of these native forests on private land are actively managed and a further 5 million, predominantly in Queensland, New South Wales and Tasmania, have the potentially to be available for management for timber products (Australian Forest Growers pers. comm., 2009).
Source: Montreal Process Implementation Group for Australia (MIG) (2008); Gavran and Parsons (2009); P. Sledge (Australian Bureau of Agricultural and Resource Economics — ABARE) pers. comm., 2010.

The sector makes an important contribution to the national economy: in the 2007–08 financial year, turnover was $21.4 billion, which was approximately 0.6% of Australia's gross domestic product.[2]

Australia has an overall trade deficit in wood-fibre products. In 2007–08:

- Imports of wood-fibre and wood products were worth $4.41 billion.
- The value of Australia's wood-fibre and product exports was $2.47 billion.
- The trade deficit in wood-fibre products, therefore, was more than $1.9 billion.

Total RD&E investment relative to industry value is low compared, for example, to the dairy, pork and wine sectors (Table 2).

Table 2: Size of selected primary industry sectors

Sector	Annual value*($ million, 2006–07)	Direct employment (FTEs)	Annual RD&E investment	RD&E investment as % of annual value
Forest and wood products	21 400	76,800	$104 million (2007–08)	0.47
Dairy	11 500	40,500 (farm and post-farm)	$95 million (pre-farmgate)	0.83
Pork	3420	7900	$23.5 million	0.69
Wine	6300	31,000	$59 million (annual recurrent, 2007–08)	0.94

*Total annual value of sales and service income; for pork this was taken to be 10% of meat-processing and 85% of cured meat and small goods.
Source: Australian Bureau of Statistics Manufacturing survey 8221 (2006–07); P. Sledge (ABARE) pers. comm., 2010; L. Kooymans (Australian Pork Limited) pers. comm., 2010; various national RD&E strategies, 2009.

[2] Figure excludes the value of finished products such as doors, windows and furniture; www.daff.gov.au/forestry/national/industries, viewed September 2009.

Total direct employment in the forest and wood product sector in 2007–08 was estimated to be 76,800 full-time equivalents (FTEs), comprising 13,200 people in the forestry and harvesting sectors and 63,600 people in the wood and paper manufacturing sectors.[3] The sector also supports a range of remanufacturing industries; the inclusion of these increases the total employment estimate to about 120,000 FTEs.[4]

The forest and wood products sector makes a substantial contribution to some key regional economies. In Western Australia's Great Southern region, for example, the forest plantation industry directly employed about 500 people in 2004; indirect employment creation there is estimated to be about 0.7 jobs for every direct job. In the Green Triangle of south-eastern South Australia and western Victoria, the forest and wood products sector:

- employs (directly and indirectly) an estimated 8,760 people[5]
- contributes an estimated 30% of the gross regional product of all primary industries combined and 23% of regional employment on a land base of about 10% of the region[6]
- supports a vocational education and training program for secondary school students and a four-year forestry degree in the region.[7]

Australia's commercial firewood sector, which draws on wood-production forests, is worth about $240 million per year and Australian households consume an estimated 4.5–5.5 million tonnes of firewood annually.[8] The non-wood forest product industries — such as the forest-based apiary industry (with annual revenues of about $65 million), and the sandalwood oil industry (with annual revenues of at least $40 million) — are also economically important.[9]

The inclusion of forest carbon credits in current and potential emissions trading schemes could increase the competitiveness and diversity of the sector. The New South Wales Greenhouse Gas Reduction Scheme, for example, which commenced in 2003, enables the sale of carbon credits from forests. Under this scheme the price of carbon has fluctuated widely, from as high as $23 per tonne (carbon dioxide equivalent) in 2007 to below $5 per tonne in mid 2009.[10] The introduction of a national emissions trading scheme or other mechanisms that place a price on carbon emissions in Australia may provide incentives to increase the area and type of plantations, alter rotation lengths, and increase the volume of wood in long-term use.

[3] MIG (2008).
[4] ibid.
[5] ibid.
[6] FITNET et al. (2008).
[7] MIG (2008).
[8] ibid.
[9] ibid.
[10] Buchanan et al. (2008); www.environmentalmanagementnews.net/storyview.asp?storyid=1003054, viewed December 2009.

The benefits of RD&E

Investments in RD&E are made for a wide range of reasons that can be broadly categorised as:

- the discovery of new knowledge
- the creation of development opportunities, new products and markets, and more efficient processes
- the maintenance and growth of a pool of knowledge and expertise to enable effective responses to future challenges
- risk mitigation.

In the last three decades, private and (mainly) public investment in RD&E in the forest and wood products sector has had substantial positive private and public benefits. For example:

- Advances in genetic improvement, site selection, silviculture and site resource management have:
  - greatly improved the productivity of softwood plantations in diverse environments, thereby ensuring continued supply to the multi-billion-dollar softwood-processing industry
  - underpinned a significant expansion of the hardwood plantation estate.
- Australia's softwood industry has been a leader in the introduction of new technologies such as kiln drying, machine grading and the development of engineered products such as laminated veneer lumber, I-beams and open-web floor joists, all of which have expanded markets and added to the profitability of the industry.
- Significant advances in the understanding of water catchment management and wildlife management in native forests have led to improvements in aspects of forest management — such as road construction and stream buffer protection, the retention of habitat trees, and reductions in the size of logging coupes — that have protected water quality and yield and maintained biodiversity in managed forests.
- RD&E investment in biosecurity has helped ensure that potentially devastating pathogens such as guava rust and pine pitch canker have not entered Australia, and enabled the effective management of native and exotic pests such as *Dothistroma*, *Sirex* and *Creiis* species, limiting their impacts in Australian plantations.
- An understanding of the physiological processes and functioning of Australian forest ecosystems has enabled the development of world-class process-based eco-physiological models, which, among other uses, will underpin forest-based responses to climate change.
- Innovative multidisciplinary approaches that modelled species distribution, identified and classified old-growth forests, and designed reserve systems helped in the development of regional forest agreements — a major forest policy initiative to resolve long-standing conflicts over the use of native forests — in New South Wales, Tasmania, Victoria and Western Australia.

- RD&E within the sector supported the introduction of multi-residential timber framing to Australia with such success that this framing technique has become a major approach to residential building construction in the country. In 2003–04, for example, ongoing building systems RD&E was estimated to have contributed to an extra $35 million in annual timber framing sales.[11]

The economic and social benefits, including spill-over effects, of RD&E investments are difficult to quantify. To provide a consistent approach, the Council of Rural Research and Development Corporations developed an assessment methodology in consultation with a wide range of stakeholders. Using this methodology, a study of 25 R&D projects funded by the Forests and Wood Products Research and Development Corporation[12] estimated the economic, social and environmental benefits from each project and compared these to the total financial investment. It calculated the overall benefit/cost ratio for the total investment to be 11 to 1.[13]

Despite these and other successes, however, there is, in some quarters, an apparent lack of acknowledgement of the role of RD&E in industry profitability and sustainability. Nevertheless, the following analysis of sector drivers makes it clear that effective and efficient RD&E will be essential if the Australian forest and wood products sector is to compete in the global marketplace in the future. To be successful the sector will need to embrace a culture of innovation, including knowledge generation and adoption, education, skill development, continuous improvement, and international best practice in a consistent, continuous and sustained manner.[14]

[11] Forest and Wood Products Research and Development Corporation (2004).
[12] Agtrans Research (2007).
[13] At a discount rate of 5% and based on assumptions developed in association with industry.
[14] Cutler (2008).

SECTOR DRIVERS

Competitiveness

The wood-based manufacturing sector includes:

- higher-value building, furniture and decorative products, such as engineered wood products and veneers
- products of intermediate value-adding, such as structural timber and paper packaging
- lower-value-added products such as logs and woodchips.

Currently, the supply of forest and wood products in Australia is driven largely by the demand for construction materials, especially in the domestic housing sector, but it is also influenced by domestic and international demand for consumer and industrial papers.

As the relative importance of manufacturing to Australia's economy has declined, the contribution of services has expanded considerably.[15] While the wood-based manufacturing sector remains strong — with gross employment, for example, relatively stable — the sector is likely to be increasingly affected by competition from imported products in some product categories. Australian paper manufacturers, for example, face increasing competitive pressure from producers in countries with lower labour costs, sometimes lower environmental standards, and capital subsidies from national governments.[16]

Nevertheless, Australia offers a number of competitive advantages for wood and wood-fibre manufacturers, including:

- a stable political and investment climate
- the reasonable size and relative stability of the domestic economy
- competitive energy prices
- the availability of wood fibre, especially for reconstituted products.

But the sector is vulnerable to:

- competitive pressures such as those created by an appreciation of the Australian dollar
- the economies of scale that can be achieved by some large international operations
- substitute materials, especially in housing construction
- low investment in RD&E and weak adoption of innovation.

Australia has always been a net importer, by value, of wood products: a large part of its exports are in the form of relatively low-value products such as woodchips and recovered paper, while imports are primarily of higher-value manufactured products, particularly printing

[15] ibid.
[16] Pulp and Paper Industry Strategy Group (2009).

and writing paper. Combined, imports of paper, paperboard, paper manufacture and pulp were worth just over $3 billion in 2007–08 (69% of total imports). Sawnwood imports were worth $784 million (18%) and wood-based panel imports were worth $482 million (11%).[17]

The ownership of plantations has been shifting from government to the private sector. In mid 2009, governments owned about 37% of the country's timber plantation estate (some of which was in joint ventures with the private sector), managed investment schemes owned 34% of the estate, superannuation funds 11%, timber industry companies 9%, and other private owners 9%.[18] The trend towards the private ownership of plantations is expected to continue, with implications for the funding of RD&E.

Competition from substitutes: Wood has also come under increasing competition from substitute products such as steel, aluminium, concrete and plastics in a range of end-uses. Many factors will determine the extent to which wood can retain or increase market share in the future. Potential opportunities for expanding wood use in the housing sector, for example, include:

- an increase in demand for materials that are less energy-intensive in their manufacture
- adoption of new wood composites and engineered wood products
- changes in demographics, which are likely to lead to new residential construction demands in cities and coastal areas.

Potential threats to wood use in the housing sector include:

- a decline in home alterations and additions
- the introduction of adverse environmental specifications and building regulations
- advances in steel and concrete technology.[19]

The mix of factors that determine market preferences for materials and their application can change rapidly. The industry will remain strong as long as it is able to respond effectively to issues such as life-cycle performance, affordability, recyclability, reliability and quality.

When building codes and regulations are conducive, the development of new wood-use technologies can greatly increase the range of uses to which wood is put in the construction sector. This will require the timely assessment, analysis and dissemination of market and product information matched by effective engagement with regulators, standards bodies, specifiers, designers and product innovators.

The development and deployment of new technological innovations in wood-fibre processing is most likely to take place internationally and the challenge will be to obtain and implement such new technologies in a profitable way. In other subsectors, domestic innovation will be required because of the nature of the resource and the environments in which the products will be processed and deployed.

[17] ABARE (2009).
[18] Gavran and Parsons (2009).
[19] Jaakko Pöyry and Four Scenes (2006).

Competition for land and water: Land is in demand for a wide range of uses, including the production of food, fibre and biofuels, carbon sequestration, biodiversity conservation, rural amenity, urbanisation and mining.

There is much uncertainty around the nature of such competition and its effects on the forest and wood products sector. It could, for example, increase the price of land and therefore the cost of wood production. Challenges for the sector include how it can complement and integrate more effectively with agricultural production at the landscape level, and how it can maintain its competitiveness as a land use. The development and application of broader landscape planning and management approaches may help to address forest-use conflicts and resource expansion constraints in the future. RD&E is vital in assisting the industry to compete for land by ensuring that the industry selects the most appropriate land and uses it as efficiently as possible to produce the greatest amount of wood sustainably.

The importance of water security in Australia is heightened by recurring drought and uncertainty about future water demand and availability due to population growth, land-use change, competition, and the potential impacts of climate change. Forest-related issues include:

- the impact of plantation establishment on catchment water flows and in comparison with other land uses
- the impact of fire and wood-harvesting in forested catchments on water quality and quantity
- the sustainability of plantations in lower-rainfall areas and in a potentially warmer and drier climate
- the role of forests in mitigating land and water degradation, including problems such as salinity.

The Intergovernmental Agreement on a National Water Initiative was signed in 2004 by the Australian Government and most state and territory governments[20] (the governments of Tasmania and Western Australia signed in 2005 and 2006 respectively). Its overall objective is to achieve a nationally compatible market-, regulatory- and planning-based system for managing surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes. Among other things, the agreement specifies that, in areas where water is already fully allocated or over-allocated, proposals for additional water interception activities, such as forest plantations, above an agreed threshold will require a water access entitlement. Such a requirement could have significant impact on further development of the plantation sector.

In some regions, particularly where agricultural crops are irrigated from groundwater, plantation forests are viewed as competitors for water resources, and conflict over water may constrain the expansion of wood-growing.

[20] Intergovernmental Agreement on a National Water Initiative between the Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and the Northern Territory, seen at http://www.nwc.gov.au/resources/documents/Intergovernmental-Agreement-on-a-national-water-initiative.pdf, July 2009.

RD&E can also play a role in minimising conflicts over water use by, for example, providing a knowledge base for water-allocation mechanisms, evaluating the impact of forests and other land uses on the quantity and quality of water resources, and optimising forest water-use efficiency through genetic resource development, site selection, and adaptive management regimes.

Changing nature of the resource

A significant difference between the forest and wood products sector and other primary industries is the changing nature of its resource base. Historically, most of Australia's hardwood supply has been obtained from publicly owned native forests, but access to this resource has been restricted by government land-use decisions. The area of publicly owned native forest available for timber production was 9.4 million hectares in 2005–06 compared to 11.4 million hectares in 2000–01, a reduction of 18%. Over the same period, the area of public nature conservation reserves (in which timber harvesting is not permitted) increased from 21.5 million hectares to 23 million hectares.

In 1999 the Government of Queensland initiated a 25-year transition in which public native forests in the state's southeast — its major timber-producing area — will be withdrawn from timber harvesting and recategorised as nature conservation reserves. New South Wales, Victoria and Western Australia have reported recent declines in their allowable wood harvest in multiple-use public native forests.[21] Overall, the prescribed sustainable yield in public native forests has halved since 1995.[22]

The decline in allowable harvest from public native forest has been accompanied, in some regions, by an increase in the harvest from the private native forest estate. The ongoing risk of access to this resource and sustainable management regimes being applied needs continued attention.[23]

Australia's plantation estate is now nearly 2 million hectares in size (Table 1).[24] This estate produces about two-thirds of Australia's log supply and the proportion is expected to increase in the future. The softwood plantation estate is mature and, without a change in the economics of the long-term rotations required for the supply of solid wood products, the estate is not expected to expand significantly.

The total area of the hardwood plantation estate, and wood production from it, are both increasing. Nevertheless, results from the first rotation, and substantial ownership changes, are likely to lead to some rationalisation of the short-rotation hardwood plantation resource.

The decline in the volume, log size and quality of the harvest from native forests will continue to pose a challenge for solid-wood processors and their key customers. Most of the hardwood plantation estate is devoted to a small range of species (mainly Tasmanian blue gum — *Eucalyptus globulus*) grown predominantly for wood fibre for pulp and paper. RD&E providers in several states, especially Queensland and Tasmania, have pursued research to develop alternative uses for plantation hardwoods. The vast majority of the current hardwood

[21] MIG (2008).
[22] I. Ferguson pers. comm., 2010.
[23] Australian Forest Growers pers. comm., 2010.
[24] Gavran and Parsons (2009).

plantation estate, however, will not produce logs suitable for a profitable solid-wood-products industry.[25]

An issue for the future, particularly in the plantation sector, is how to improve linkages in the marketplace between growers and processors in relation to log/product quality. Such linkages are currently most direct in relation to pulpwood, which generally sells on pulp yield. In the solid-wood subsector, silviculture and genetics are directed to growing trees with desirable wood properties but sales are generally made on the basis of volume/mass rather than wood quality. Overall, a number of structural and transactional issues in the sector ultimately result in a lack of alignment of interests in added-value production; overcoming those issues and increasing the integration of RD&E from forest to market are significant challenges for the sector.

Climate change

Predicted climate change will pose challenges but will also create opportunities for Australia's forest and wood products sector. The industry can, for example, play an expanded role in reducing Australia's greenhouse gas emissions. According to *Australia's State of the Forests Report 2008*[26], forestry is one of the most greenhouse-friendly sectors of the Australian economy — it was, for example, the only industry sector to be carbon-positive in 2005. Rapidly growing forests capture carbon, and mature forests, as well as wood products, store carbon until biological decay or fire returns the carbon to the atmosphere.

- According to one estimate[27], existing post-1990 plantations combined with new forest plantations dedicated to carbon sequestration could reduce carbon emissions by about 200 megatonnes (Mt) carbon-dioxide equivalent per year.[28]
- In 2005, about 90 Mt of carbon were stored in wood products in long-term service. An additional 136 Mt of carbon was stored in end-of-service-life wood products disposed of in landfill.[29]
- In 2005, Australian plantations and commercial native forests removed a net 43.5 Mt carbon-dioxide equivalent from the atmosphere.
- Plantations offset about 3.5% and managed native forests about 5.5% of total Australian greenhouse gas emissions in 2005. Additional storage in wood products offset a further 1% of emissions.[30]

Wood can be used as a carbon-neutral bioenergy substitute for fossil fuels, in the manufacture of a range of plastics and other chemicals, and as a low-carbon-emissions alternative to materials such as steel, aluminium and concrete. Thus, forests and wood products can sequester carbon, provide energy substitution, and result in avoided emissions.

[25] Nolan et al. (2005).
[26] MIG (2008).
[27] Buchanan et al. (2008).
[28] This level of carbon sequestration in forest plantations would have significant investment and land-use implications; in reality, therefore, forest plantations are likely to make a significant but smaller contribution to carbon sequestration.
[29] FWPA and CRC for Greenhouse Accounting (2006).
[30] MIG (2008).

Maximising the carbon benefits of the sector will require RD&E for, among other things, the development and adoption of more efficient technologies and work practices, the increased use of wood in long-term applications, and the integration of processes in the production of solid wood, wood fibre, energy and chemicals. It will also require policy settings, both nationally and globally, that recognise and encourage the important contribution of the forest and wood products sector to climate-change mitigation.

Climate change will also have implications for forest productivity and adaptation. Under some climate-change scenarios, for example, Australia's temperate forests could experience a greater incidence of drought, which would exacerbate problems caused by pests and fire. An analysis of regional climate-change scenarios, for example, has suggested that plantation productivity could decrease in:

- *P. radiata* plantations in southern New South Wales and possibly at the western edge of the estate
- the eastern and northern extents of the *E. globulus* and *P. radiata* estates in Western Australia.[31]

On the other hand, growth rates could increase in some forests due to the fertiliser effect of an increased atmospheric concentration of carbon dioxide and to favourable changes in climate. For example, increases in production have been predicted for:

- *E. globulus*, *E. nitens* and *P. radiata* in Tasmania
- the mid-to-lower northern regions of the hybrid pine estate
- *P. radiata* and *E. globulus* plantations in East Gippsland and higher-altitude parts of central and north-eastern Victoria.[32]

Realising and demonstrating sustainability

Society increasingly demands that its goods and services are provided from demonstrably environmentally sustainable sources. The forest and wood products sector, therefore, needs to continually demonstrate its sustainable management of ecological assets, including land, water and biological resources, the effective management of fire and other potential threats, and the maintenance of ecological processes in forested landscapes (Figure 1).[33]

In contrast to many other primary industries, the Australian forest and wood products sector has a sustainability reporting framework at the state, territory and national levels, with linkages to well-established global intergovernmental forest assessment systems.

As part of this, Australia participates in an international approach to forest sustainability known as the Montreal Process[34], which has developed criteria and indicators to characterise and measure the essential components of sustainable forest management. Australia has adapted the Montreal Process's criteria and indicators to report on the state of

[31] Battaglia et al. (2009).
[32] ibid.
[33] URS Australia (2007).
[34] The Montreal Process Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests comprises countries with temperate and boreal forests.

its forests every five years.[35] The continued development of the criteria and indicators, and their periodic measurement, is an important task of RD&E.

Demand for information on the sustainability of forest management is also being met by forest certification. Certification is a process whereby the sustainable management credentials of a forest are independently investigated and certified. Certification schemes typically require forest management practices that are more stringent than provided by law alone, and they encourage forest managers to display their sustainability credentials when marketing their products. Two major forest certification schemes operate in Australia — the Australian Forest Certification Scheme (AFCS), which is accredited by the international Programme for the Endorsement of Forest Certification schemes (PEFC), and the Forest Stewardship Council (FSC)'s scheme.

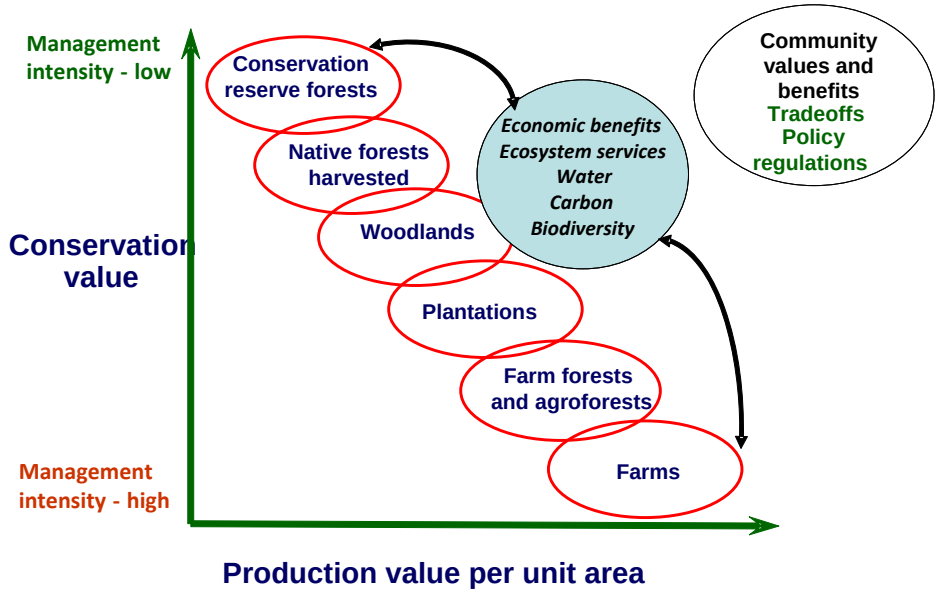
In addition to certification, most multiple-use public forests and some private forests are now managed in accordance with codes of forest practice and externally accredited environmental management systems, which provide a structured approach to the planning and implementation of measures to protect the environment.

Balancing competing demands for forests, and understanding community attitudes towards the Australian forest and wood products sector, including the use of wood products, requires strong community engagement. RD&E is needed, therefore, to assure society of the sector's responsible use of forest resources, the long-term sustainability of forest management, and the environmental credentials of wood products.

For many decades, wood production was the central focus of forest management and elements such as water catchment management, cultural and heritage issues, biodiversity and, more latterly, climate change, were addressed as part of a multiple-use management regime. In recent years, however, such issues have been the focus of considerable attention and their management has, in many cases, assumed priority over wood production, especially in native forests. This shift in emphasis is illustrated in Figure 1. The forest and wood products sector has been proactive in adapting to this new reality but will no doubt need to continue to adapt as new opportunities and challenges arise.

[35] The most recent report was MIG (2008).

Figure 1: The forests and natural resources continuum



Source: Modified from Nambiar (1996), Nambiar pers. comm., 2009.

Opportunities for wood and wood fibre

Beyond the maintenance and expansion of existing markets for wood products there is increased global interest in the greater use of woody biomass to replace fossil-fuel-derived products and energy in a carbon-emissions-constrained world. Opportunities for wood and fibre products exist across the value spectrum, from bioenergy to biomaterials. Many of these opportunities are enabled by climate-change mitigation imperatives; others reflect technological advances and changing social preferences.

The Australian Bioenergy Road Map, published by the Clean Energy Council in 2008, sets a target contribution of bioenergy towards electricity generation in Australia of about 3.7% by 2020, which is more than four times the current contribution of 0.9%. Australia's current electricity generation from biomass is significantly lower than that of leading European countries, where bioenergy is already contributing 4–14% of total electricity generation, more than half of it from wood. While wood is arguably better used as a source of industrial and domestic heat/steam than as a source of electricity alone, under the Australian Bioenergy Road Map wood-related wastes (e.g. sawmill and pulp mill residues) would supply about 28% of the target electricity production, and urban biomass (including demolition timber) would supply about 7%.

Pyrolysis technology offers energy and product streams such as biogas, biochar, bio-oil and chemical feedstock. Advances in pyrolysis technology indicate the potential for it to be deployed at less-capital-intensive scales using feedstock of wider technical specification than in the past. The efficiency and cost-competitiveness of the direct production of liquid fuel (ethanol or methanol) from woody biomass is also being progressively improved. Such

technologies may gain increased market acceptance in response to government policy instruments such as renewable energy certificates and emissions trading schemes.

Using a combination of biotechnology applications and new industrial processes, residues from traditional forest operations and new forest plantation resources can be used in the production of new products such as bioplastics, chemicals and pharmaceuticals.

In North America, the development of integrated forest biorefineries has been proposed as a way in which the pulp and paper industry can fully integrate forest biomass for the simultaneous production of several marketplace products, including fibre for pulp and paper products as well as chemicals and energy, thereby creating additional revenue streams.[36]

The introduction and strengthening of renewable energy regulations in Australia indicates a need for RD&E on wood-based biofuels to identify the best commercial and energy outcomes.

[36] e.g. see www.bio.org/worldcongress/applications/breakout/PrintSingle.aspx?pID=22&appID=3494.

RD&E RESOURCE ANALYSIS

Expenditure

Forest and wood products R&D[37] is conducted in about 50 public and private organisations across Australia. Investment in such work can be divided into two broad categories:

1) forest R&D, which includes research mainly related to species selection and breeding, and the management and protection of wood-production forests, including plantations

2) wood products R&D, which includes research on primary wood conversion, product and market development (including paper products), and timber engineering.[38]

In the 2007–08 financial year about $59.6 million was spent on forest R&D and about $26.8 million was spent on wood products R&D. If administrative costs are included, total expenditure was about $104 million. In unadjusted dollars this represents an increase of about 4.7% per year since 1981–82. When expenditure is adjusted to 1982 dollars, however, there was a real decline in total expenditure of just under 0.6% per year over the period, despite a slight increase since 2002 (Figure 2).

Since 1982 there has been an overall real decline in expenditure per unit area and per unit harvested wood volume. There has also been a decline in expenditure as a percent of industry turnover — from about 0.56% in 1994/95 to 0.47% in 2007–08.

Major funding sources in 2007–08 were:

- Australian Government (44% of total funding)
- state agencies (28.5%)
- private sector (20%)
- universities (7.5%).

Figure 3 shows the source and expenditure of funds by the major contributors. In broad terms, the Australian Government contribution to research funding has increased over time while that of the states has declined.[39] Private industry investment, as reflected in the Forest and Wood Products Australia (FWPA) levy of approximately 0.20% of gross value of production, is lower than many other primary industry sectors.

Research undertaken on native forests and softwood plantations has declined in recent years, whereas that on hardwood plantations — which have been increasing significantly in area — has grown. Funding for wood products research increased in real terms between 2001–02 and 2007–08, due partly to investment in CRC Wood Innovations.[40]

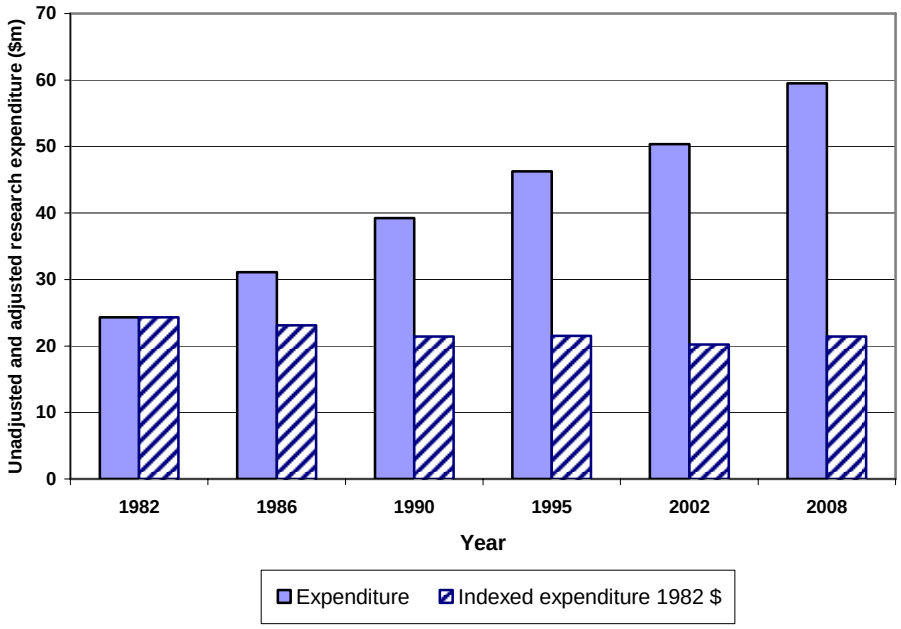
Capacity and structure

In 2007–08 an estimated 500 FTE researchers, technicians and other support staff were involved in R&D in the forest and wood products sector in state and federal agencies, universities and private organisations. Most private RD&E providers are at a relatively small

[37] Historically, 'extension' has not been measured in surveys of R&D expenditure. The data presented in this section, therefore, exclude the extension component of RD&E.
[38] This section draws on Turner and Lambert (2009) for estimates of R&D expenditure and capacity.
[39] See the longitudinal studies conducted by John Turner, Marcia Lambert and others, reported most recently in Turner and Lambert (2009) and also in Turner and Lambert (2005).
[40] Turner and Lambert (2009).

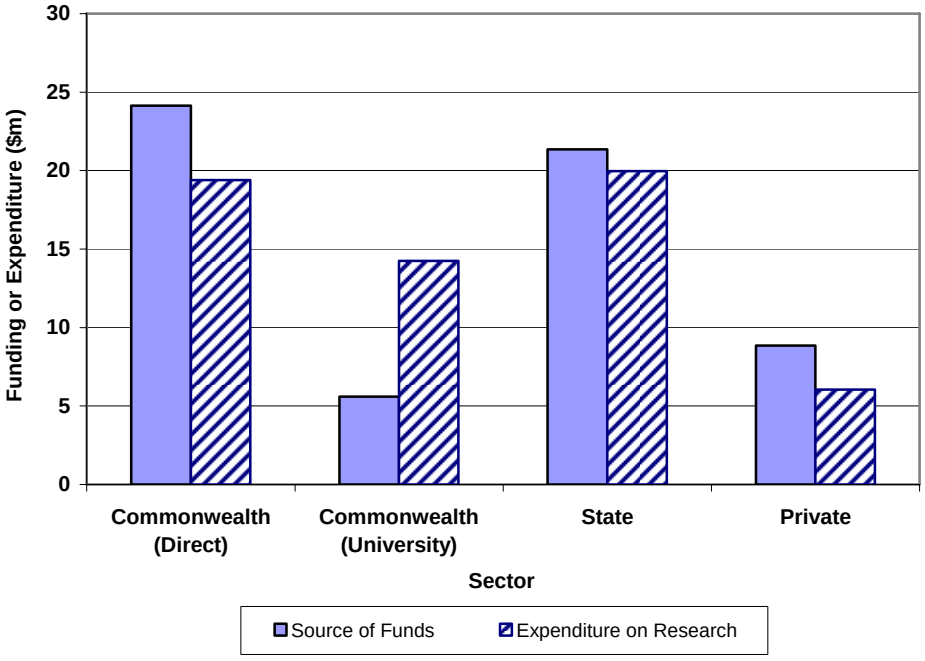
scale and work as individuals or in very small groups, or are associated with other organisations.

Figure 2: Actual and real expenditure on forest and wood products R&D, 1981–82 to 2007–08



Source: Turner and Lambert (2009).

Figure 3: Sources of funding and expenditure on forest and wood products R&D, 2007–08



Source: Turner and Lambert (2009).

Table 3 shows the breakdown of capacity by state and federal agencies and universities and by major area of activity.

Table 3: Estimated R&D capacity by major public agency, and key areas of activity, 2009

State or territory	Institution*	Capacity (FTE researchers, technicians and other support staff)**	Major resource focus and key R&D areas
ACT	CSIRO (various divisions; note that CSIRO is a national agency with capacity to operate in different forest regions)	143	Native forests and plantations — hydrology, forest growth and physiology, tree improvement, predictive modelling, climate change, wood products
	Australian National University	14	Native forest ecology and management — socioeconomics/policy, carbon sequestration
NSW	Forests NSW	21	Softwood and hardwood plantations — tree improvement, silviculture, wood properties
	I&I NSW-S&I	32	Native forests and plantations — forest health, biodiversity and ecology, forest growth, carbon accounting, recycled organics, climate change
	Southern Cross University	10	Native forests and plantations — socioeconomics, genetics, wood properties, ecology, extension
	University of Technology Sydney	5	Wood engineering
NT	n.a.	n.a.	n.a.
Qld	Department of Employment, Economic Development and Innovation (Agri-Sciences Queensland)	28	Hardwood plantations — tree improvement, physiology, productivity, modelling, forest health
		20	Plantation-grown wood properties, processing, timber products, performance enhancement
SA	Forestry SA	24	Softwood plantations — productivity management growth and model development, forest health, wood properties
Tas.	Forestry Tasmania	28	Native forest management, hardwood plantations — forest protection, hydrology, silviculture
	University of Tasmania	21	Native forest management — ecology, wood products
Vic.	Department of Forest and Ecosystem Science/University of Melbourne	59	Native forest ecology and management, plantations — forest protection and management, forest operations, tree improvement, hydrology, climate change, wildfire, wood products
WA	Forest Products Commission	20	Hardwood and softwood plantations — tree breeding, hydrology, forest growth, carbon sequestration
	Department of Environment and Conservation	24	Native forest management — conservation biology
Total		**449**	

* Note that the CRC for Forestry and FWPA contribute to the funding of a significant number of R&D personnel through partner organisations, including some of those listed in this table.

** Table excludes private organisations, graduate students, institutions with small capacities, and some small localities in larger organisations. The capacity shown, therefore, is less than the total national estimated capacity. These are the best-available estimates, but the sector is undergoing major change and more detailed analysis will be required in the future.

Source: Adapted from an unpublished supplementary survey by J. Turner, D. Flinn & M. Lambert, 2009; K. Crews (University of Technology Sydney) pers. comm., 2009; P. Kanowski (Australian National University), pers. comm., 2009; J. Vanclay (Southern Cross University), pers. comm., 2009.

The RD&E architecture has changed considerably over the last decade. This is particularly so at the state level as a consequence of land-use decisions, including through regional forest agreements, which have led to the division of native forest management responsibilities between a range of agencies and the corporatisation or privatisation of plantation forests.

Historically, state governments have had a significant role in commercial forest-growing and resource ownership and, in some instances, in the downstream processing of wood. This is in contrast to agriculture, where governments have traditionally provided policy and sector services such as RD&E without themselves being in the business of agriculture. As noted above, however, the role of government in the forest and wood products sector is changing, with evident long-term impacts on RD&E capacity.

Except in Tasmania, the traditional model of state forest agency with its own in-house research group to address business needs has virtually ceased to exist. It has been replaced by a range of models, including stand-alone research groups partly supported by government appropriation, the integration of RD&E capability and capacity into larger primary industry research groups, and the splitting of such capability and capacity between conservation and forest business agencies.[41]

The net effect of structural changes at the state level has generally been a reduction in forest and wood product RD&E capability and capacity and an increase in organisational complexity. As noted above, in many jurisdictions, responsibilities for different aspects of RD&E are now often distributed between several agencies (Table 4).

In recent years CSIRO has changed its direction towards investing more on strategic research areas that are addressing broader national priorities while moving away from research areas that are directly assisting industries, particular in some near-to-market areas or where industry is not well placed to capture research outcomes. As a result, CSIRO's capacity and capability in the forest and wood products sector has been significantly downgraded and some of its staff either absorbed by the Sustainable Ecosystems, Plant Industry, or Material Science and Engineering divisions or retrenched. If there are functional engagement mechanisms with industry, it could increase the breadth of expertise available to the forest and wood products sector.

The number of universities with RD&E activities has increased, although they lack coordination and are potentially in direct competition with each other. The University of Melbourne has become a major R&D provider — significantly funded by contracts with Victorian state agencies — by combining existing university research capability with former state-agency capability.

The number of private companies (such as managed investment scheme companies) investing in plantation forests has increased. Combined, their research efforts have also grown, particularly through the use of cooperative research mechanisms. Also within the private sector (although some government agencies may also be involved), are a number of national representative, technical associations and state-based industry or promotion

[41] Compared to traditional agriculture, the forest and wood products sector deals with fewer commercial species that are grown in defined geographical ranges. Typically, forest R&D occurs within commercial forests rather than at dedicated research stations. Therefore, opportunities to rationalise infrastructure by combining programs or reducing research stations are less readily available within the sector than in some other primary industry sectors.

organisations; some of these may be both research providers and/or funders, depending on circumstances.

Table 4: Roles and responsibilities of state and national government investors in forest and wood products sector RD&E

Role and responsibility	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust government/ national
Forest industry and production, forest policy	I&I NSW, Forests NSW	DoR	DEEDI	PIRSA	DIER	DPI	DEC, FPC	DAFF
Land and forest management policy	I&I NSW, DECCW	NRETAS	DERM	PIRSA	DIER, DPIPWE	DSE	DEC	DAFF (DCC), DEWHA
Production forest management and marketing	Forests NSW	-	FPQ/ DERM	ForestrySA	FT	Vic Forests	FPC	-
Forest research — primary investor	I&I NSW-S&I, Forests NSW, SCU, UTS	DoR	DEEDI	PIRSA, Forestry SA	FT, UTAS	DSE, UM	DEC, FPC	ABARE, ANU, BRS, CSIRO

Note: neither the CRC for Forestry nor FWPA is listed in this table because they work predominantly through partner organisations. Nevertheless, they establish direction and provide resources in a number of research fields.
ABARE = Australian Bureau of Agricultural and Resource Economics; ANU = Australian National University; BRS = Bureau of Rural Sciences; CSIRO = Commonwealth Scientific and Industrial Research Organisation; DAFF = Department of Agriculture, Fisheries and Forestry; DCC = Department of Climate Change; DEC = Department of Environment and Conservation; DECCW = Department of Environment, Climate Change and Water; DEEDI = Department of Employment, Economic Development and Innovation (Agri-Sciences Queensland); DERM = Department of Environment and Resource Management; DEWHA = Department of the Environment, Water, Heritage and the Arts; DIER = Department of Infrastructure, Energy and Resources; DoR = Department of Resources; DPI = Department of Primary Industries; DSE = Department of Sustainability and Environment; DPIPWE = Department of Primary Industries, Parks, Water and Environment; FPC = Forest Products Commission; FPQ = Forestry Plantations Queensland; FT = Forestry Tasmania; I&I NSW = Industry and Investment NSW; I&I NSW-S&I = Industry and Investment NSW, Science and Innovation; NRETAS = Department of Natural Resources, Environment, The Arts and Sport; PIRSA = Department of Primary Industries and Resources South Australia; SCU = Southern Cross University; UM = University of Melbourne; UTS = University of Technology, Sydney; UTAS = University of Tasmania.
Source: Adapted from Research Priorities and Coordination Committee minutes, May 2009.

The major cooperative RD&E mechanism in the forest and wood products sector since 1991 has been the cooperative research centres program. The CRC for Temperate Hardwood Forestry, created in 1991, was superseded by the CRC for Sustainable Production Forestry in 1997; this, in turn, was superseded by the CRC for Forestry in 2005, which is due to terminate in 2012. The CRC for Hardwood Fibre and Paper Science (1993–99) and the CRC for Wood Innovations (2001–08) were major initiatives in forest product R&D. Overall, the CRCs act or have acted as focal points for coordinated RD&E in specific areas.

The CRC for Forestry, if extended beyond 2012, will continue to coordinate RD&E on some key issues, including processing and adding value to the plantation resource, improving supply-chain performance and profitability, and addressing management challenges for forest estates that are arising across an increasing array of values, including carbon. Funding from the CRC Program to support these activities is leveraged from outside the sector, making it an important addition to recurrent RD&E funding in the sector.

Many RD&E providers identify dispersal of research effort, and a lack of recruitment to replace an ageing workforce, as significant issues in the sector. A lack of a critical mass of researchers could jeopardise the long-term viability of some providers or of some research

areas. CSIRO has provided capacity and some national leadership in RD&E in the sector in the past but, given the restructuring there, this seems less likely in the future.

Research can be categorised as incremental and strategic: incremental research is usually conducted in short-term projects to address immediate RD&E needs and strategic research addresses longer-term trends and concerns. The increasingly dispersed nature of RD&E in the forest and wood products sector potentially encourages incremental research at the expense of strategic research. In the long term, this would hinder the processes of knowledge production and application and, therefore, could pose a risk to the viability of the forest and wood products sector.

Data on expenditure and the number of people employed in extension activities — that is, the effort devoted to raising awareness of and promoting the adoption of research outputs, leading to impacts on productivity, the efficiency of processing, etc. — in the sector are lacking. The forestry subsector has never had an extension service along the lines of that supported by agricultural agencies and extension activities have been far less formalised.

On the other hand, a number of regional timber development associations provide detailed and regular extension services to timber-users in the broad construction marketplace and to the production industry through technical and research extension. This capacity has declined significantly in Queensland and Victoria, but the Timber Development Association of New South Wales and the Tasmanian Timber Promotion Board remain active. Wood Council Australia was formed recently by timber development associations, timber producers and merchants to help coordinate timber-related extension and R&D.[42] FWPA supports and manages a wood promotion campaign directed at consumers and specifiers that contains a extension element.

Until recently, the main users of state-based forest RD&E were within the state agencies that maintained the research capacity and there was less focus on external customers. CSIRO had wider linkages with both forest growers and the wood-processing industries in terms of undertaking R&D and promoting adoption. In recent years the CRC for Forestry has provided some new extension capacity. Private consultants may also be involved in extension activities. Traditionally, the sector has relied predominantly on the scientists themselves to promote and aid the adoption of research outputs.

Current capability

The categorisation of current research capacity and capability by research area has not previously been attempted for the sector. A preliminary analysis using 15 research categories has been undertaken to obtain an initial assessment (Table 5, Figure 4). This approach identified just over 280 full-time or part-time researchers (excluding technicians and other support staff) in the public and private sectors. Table 6 shows the adequacy of current RD&E capability, as rated by RD&E providers, using the same research categories.

Overall, the strongest capability in terms of numbers is in ecology, forest soils/productivity, forest health, genetic improvement, and wood science and technology and the most limited capability is in harvesting and transport, socioeconomics and policy, timber engineering and extension. While no data are available on the age profile of researchers, anecdotal evidence

[42] G. Nolan, pers. comm. 2010 ; http://woodcouncil.org.au

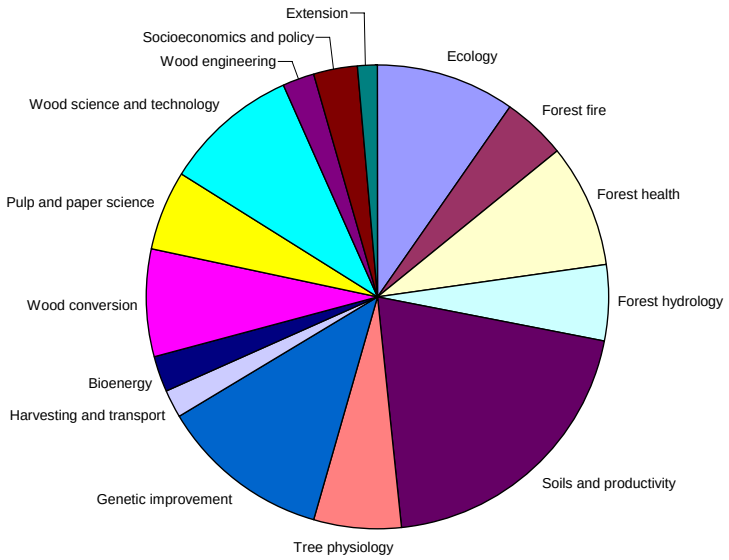
suggests that it is skewed towards the older age groups. Whilst these figures and views reflect historical development more detailed analysis of this type will be required in the future to endeavour to match work force needs with industry opportunities.

Table 5: Current public and private research capacity and capability, by research area and jurisdiction

Research category	ACT*	NSW	NT	Qld	SA	Tas.	Vic.	WA	Total
Ecology	2	7	0	1	0	4	12	4	30
Forest fire	3	1	0	0	0	2	6	2	14
Forest health	4	5	0	6	1	3	4	3	26
Forest hydrology	3	1	0	0	0	5	6	2	17
Soils and productivity	13	11	1	4	5	8	15	5	62
Tree physiology	6	4	0	2	0	4	2	1	19
Genetic improvement	7	4	1	4	6	9	4	2	37
Harvesting and transport	0	1	0	0	0	2	3	0	6
Bioenergy	1	5	0	0	0	0	2	0	8
Wood conversion	0	0	0	7	0	0	15	1	23
Pulp and paper science	0	11	0	0	0	0	6	0	17
Wood science and technology	0	3	0	6	0	0	18	2	29
Wood engineering	0	4	0	0	0	1.5	1.5	0	7
Socioeconomics and policy	4	2	0	0	0	1	3	0	10
Extension	1	0	0	0	0	2	1	0	4
Total	**44**	**59**	**2**	**30**	**12**	**41.5**	**98.5**	**22**	**309**

Where 'Bioenergy' = Bioenergy (conversion of wood to energy and other products — pyrolysis, pellets, liquid fuels); 'Education and extension' = persons involved in education research or extension; 'Forest fire' = Fire behaviour and management; 'Forest health' = Forest health and biosecurity; 'Soils and productivity' = Forest soils and productivity, including silviculture and management; 'Tree physiology' = Tree physiology/ecophysiology; 'Genetic improvement' = Tree selection and genetic improvement; 'Wood conversion' = Wood conversion (sawmilling, drying, veneering, fibre products); 'Wood science' = Wood science and technology, including measurement of wood properties, relationship of wood properties to management and genetics, resource assessment.
*Relates primarily to CSIRO and the Bureau of Rural Sciences, which both have a national role.
Jurisdictional totals in this table may not tally with those in Table 3 because they may include national-level personnel, such as those working for CSIRO. Moreover, technical and support staff are omitted from this table.
Source: Unpublished supplementary survey by J. Turner, D. Flinn & M. Lambert, 2009; personal communications.

Figure 4: Broad distribution of public-sector and private-sector researchers, by research category



Source: Unpublished supplementary survey by J. Turner, D. Flinn & M. Lambert, 2009; personal communications.

Table 6: Adequacy of current RD&E capability, based on a survey of key RD&E providers

Capability	1	2	3	4	5	6	7	8	9	10
Ecology	■	■	■	■	■	■	■	■		
Forest fire	■	■	■	■						
Forest health	■	■	■	■	■					
Forest hydrology	■	■	■	■	■	■				
Soils and productivity	■	■	■	■	■	■	■	■		
Tree physiology	■	■	■	■	■	■				
Genetic improvement	■	■	■	■	■	■	■	■	■	■
Harvesting and transport	■									
Bioenergy	■									
Wood conversion	■	■	■	■						
Pulp and paper science	■	■								
Wood science and technology	■									
Wood engineering	■									
Socioeconomics and policy	■	■								
Extension	■									

Source: Based on an unpublished supplementary survey by J. Turner, D. Flinn & M. Lambert, 2009 and a survey of key RD&E providers.

National coordination

A number of bodies have been created to improve communication, coordination and representation in the sector, or within specific elements of the sector. Very few of these bodies have a primary focus on RD&E, although they may deliberate on issues that impact on RD&E.

Intergovernmental policy coordination is conducted through the Forestry and Forest Products Committee (FFPC), which is an advisory committee to the Primary Industries Standing Committee (PISC) and the Primary Industries Ministerial Council (PIMC). In 2009 the Australian Government Minister for Agriculture, Fisheries and Forestry established the Rural Research and Development Council as the Australian Government's key strategic advisory body on rural R&D.

The Research Priorities and Coordination Committee (RPCC) reports to the FFPC and provides coordination of forest research conducted by state and federal governments and has strong links with other research providers. It advises the FFPC on research-related issues, research needs and technology transfer relevant to maximising forest productivity and managing a range of forest values within the context of sustainable forest management. In June 2008 the FFPC adopted a strategic directions document prepared by the RPCC, the aim of which is "to provide a clear statement of research needs to inform future research investment decisions in all areas of the sector"; it sets out a number of research priority areas presented within five themes (Appendix 1).[43] The RPCC manages a number of research working groups (RWGs) that consist of key researchers drawn from government agencies, universities, CSIRO and other research providers. It has traditionally played a research coordination role rather than a research planning or research policy role.

A key national body with a focus on RD&E funding is FWPA, a not-for-profit industry-services company established in 2008. One of its key services is to identify, prioritise and provide funding for key RD&E and capacity-building activities that have the widest benefit for the forest and wood products industry (domestic growers, processors and importers). FWPA's mandate is determined by its members — wood processors, private and government forest growers, and Australian importers of forest products. FWPA operates four skills-based advisory groups covering the growing, processing and marketing functions of the sector (excluding pulp and paper).

The Australian Government matches eligible R&D expenditure by FWPA subject to conditions specified in a statutory funding agreement. Total RD&E expenditure by FWPA is less than 10% of the sector total, indicating that it is a less dominant player in funding compared to some other rural research and development corporations (RRDCs) or industry-services companies operating in other primary industry sectors.[44]

FWPA recently adopted a strategic plan comprising four strategies and a number or priority themes (Appendix 2). It has also identified 13 investment priorities for its R&D activities and is progressively developing 3–5-year investment plans for each of these priorities to ensure

[43] RPCC (2008).

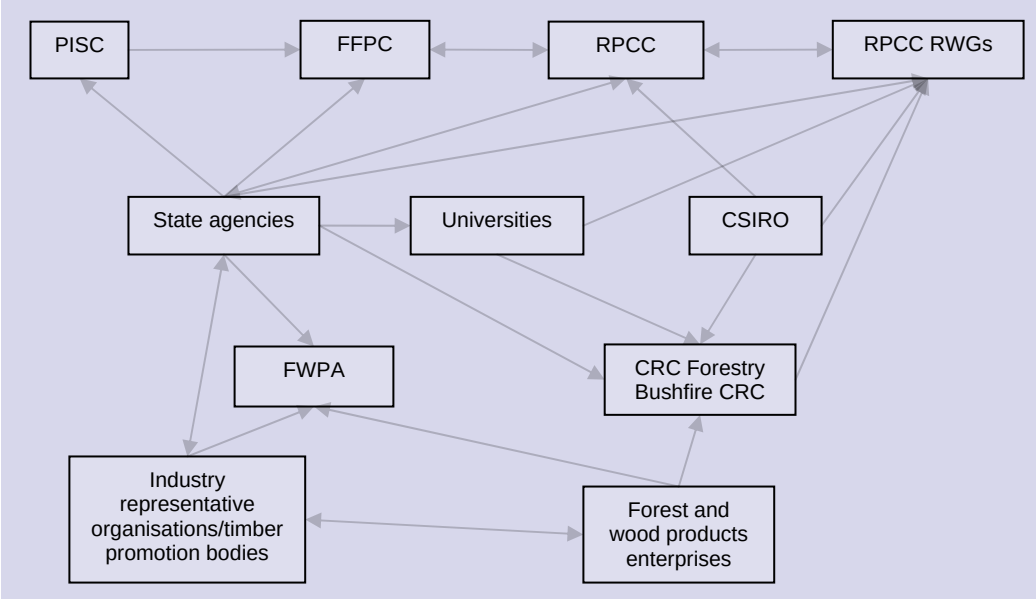
[44] e.g. Dairy Australia contributes about 20% of total RD&E funding in that sector (source: www.dairyaustralia.com.au/Research-and-Innovation/Research-Funding.aspx, viewed November 2010, and Table 2), and the Grape and Wine Research and Development Corporation contributes about 35% of total RD&E funding in that sector (source: Grape and Wine Research and Development Corporation 2008 Annual Report and Table 2).

that the investments can be clearly linked to specific industry outcomes. FWPA is the only RRDC that receives funding (and draws membership) from state government agencies and the importer sector.

Some of the RD&E providers in Australia's forest and wood products sector have, or have had in the past, advisory and working groups comprising forest-sector researchers and managers. There are also joint organisations consisting of individual companies, representative associations and government agencies to improve communication and provide advice to state and federal government ministers. At the national level, the most prominent body is the Forest and Wood Products Council, a forest-industry advisory body to the Australian Government Minister for Agriculture, Fisheries and Forestry. At times, these bodies may be involved in the establishment of specific research priorities.

Figure 5 illustrates the existing network that facilitates the exchange of information between organisations. The figure shows that, while there are many options for coordination and collaboration, there is no single overarching body or group that provides policy and guidance for RD&E at the national level. It also shows that there is no clear pathway for the flow of information that might be used in the development of coordinated RD&E strategies.

Figure 5: Interactions of RD&E providers through existing structures



Note: Directional arrows indicate the involvement of one entity type in another by participation in a board or advisory group.

Where key organisations see their contributions

As part of its deliberations in developing RD&E sector strategies, the PISC R&D Committee compiled, for all sectors and cross-sectors, a summary of how state agencies and CSIRO perceived their future roles in RD&E. The responses of PISC member agencies related to the forest and wood products sector are shown in Table 7. This table suggests a basis for interagency discussion on RD&E coordination.

Table 7: Future forest RD&E priority focus for PISC agencies

	NSW	NT	Qld	SA	Tas.	Vic.	WA	CSIRO
Tropical	Support	Link	Major	N/A	N/A	N/A	Support	Support
Temperate	Major (carbon) /support	N/A	Link	Link	Major	Link	Major	Support

Major: Agency will take a lead national role by providing significant R&D effort.
Support: Agency will undertake R&D but other agencies will provide the major R&D effort.
Link: Agency will undertake little or no R&D. Instead it will access information and resources from other agencies.
Source: Adapted from a PISC-generated table on future RD&E priority focus across primary industry sectors.

Challenges facing the sector

Despite the apparently considerable capacity and availability of funds, there is widespread concern within the sector that RD&E capacity is in a perilous state. Ongoing resource cutbacks and greater dispersal of the capacity between agencies will potentially reduce both the impact of RD&E and communication between key stakeholders.

As noted above, the RD&E effort in the forest and wood products sector is distributed between a large number of agencies (sometimes within the same state), CRCs, universities, CSIRO (where it is spread over a number of divisions) and the private sector. Coordination at the project level, and at the level of individual researchers, is often good, and the basis for current arrangements is often robust. During the preparation of this plan, however, there was widespread recognition that, in a time of rapid policy, regulatory and technological change, there is a need for improved coordination and planning at the national and strategic levels.

There is concern that research priorities are not being determined by a sufficiently iterative process between industry, RD&E providers and other stakeholders and therefore do not adequately reflect the changing needs of the sector. To some extent this may be a natural outcome of the heterogeneous nature of the sector, but it reduces the capacity to drive research prioritisation at the national level.

Table 8 presents a strengths, weaknesses, opportunities and threats analysis for RD&E in the forest and wood products sector. From this, several key needs have been identified, including:

- strengthen the coordination and planning of RD&E capacity and capability at the national level to address national sector priorities
- enhance the critical mass of investment and resource utilisation to better deliver RD&E outcomes to the forest and wood products sector
- explore new models for the cost-effective delivery of RD&E
- identify capability needs and build capability in RD&E through a nationally coordinated approach that provides researchers with attractive career paths, a creative research environment, and adequate resources
- ensure that RD&E findings and opportunities are used effectively by developing extension programs to communicate R&D findings to research users, policy makers and the broader community
- encourage international networking to ensure that the forest and wood products sector is well placed to take advantage of innovations created internationally.

Table 8: Strengths, weaknesses, opportunities and threats analysis of RD&E in the forest and wood products sector

Strengths	Opportunities	Weaknesses	Threats	Implied needs
The forest and wood products sector has shown itself capable of innovation, with the capacity to adapt to a changing resource and competitive environment. Good existing regional coverage, with RD&E resources in many of the major wood production areas. A long history of forestry research, including investment in long-term forest sites. A history of collaboration in wood products research. High-quality research capability in some areas in the sector. Existing national coordination of government-funded forestry R&D. A diversity of R&D providers.	Increased coordination between RD&E providers, and regional consolidation. Availability of compatible skills in other sectors. Development of new career pathways and incentives to attract young researchers. The adoption of a more effective model of RD&E provision and coordination in the sector. The role of forests and wood products in mitigating climate change. A large increase in the supply of wood fibre from plantations suitable for reconstituted products. The wider societal values associated with native forests and plantations compared to alternative land uses. Consolidation of the wood-production sector into larger and potentially more research-responsive companies.	Overall decline in investments in sector RD&E. The ageing, declining number, and fragmentation of the R&D workforce, resulting in a decline in capability and capacity and a lack of succession planning. Limited and declining capacity in the extension of R&D across the supply chain. Apparent lack of acknowledgement in industry of the role of RD&E in industry profitability and sustainability. Lack of industry engagement with the community on the environmental costs and benefits of production forests. Lack of industry engagement with the community on the environmental benefits of the full range of forest products. A tendency to focus on short-term applied research rather than longer-term, more strategic research, and a loss of long-term research sites as a result of restructuring. Limited national-level coordination of RD&E involving private and public providers, users and funders. A lack of key performance indicators of RD&E effectiveness. The commodity focus of the wood-fibre-growing and processing sectors. A lack of RD&E coverage in some regions, especially the tropics. Reduced policy focus and fragmentation of responsibility for forests, leading to declining support for production RD&E.	Poor public perception of the sector could reduce the use of wood and RD&E investment. Funding for RD&E could be cut further. Competition from overseas RD&E providers could reduce funding for local researchers. The contribution of some RD&E providers could be reduced because of poor industry engagement. Loss of coordination role of CRCs, if discontinued. Some RD&E providers might shrink to a point where they no longer have a critical mass for effective RD&E. Failure to strengthen extension efforts could further reduce the benefits of innovative research. RD&E capacity could be further fragmented. Low higher-degree enrolments, with consequences for RD&E and the sector's succession planning.	Strengthen the coordination of RD&E at the national level. Reverse the real decline in investment in RD&E. Create a mechanism for effective communication between providers, users and funders of RD&E in the forest and wood products sector, and to ensure a balance in RD&E between the policy needs of governments and the innovation needs of industry, and to strengthen the commitment of industry to RD&E. Develop performance indicators for RD&E in the forest and wood products sector. Develop new models for the cost-effective delivery of RD&E. Encourage the sharing and storage of information and data between RD&E providers. Develop a nationally coordinated approach to increase extension capacity in three main areas: – extension to forest growers, including in regions of low-to-medium-rainfall suitable for commercial forestry, to ensure they support the development of and adopt innovative forest-growing and forest management practices – extension to producers, to assist them to improve their production capability – extension to wood users, particularly in the construction sector, to ensure that design and engineering needs are met. Encourage international networking to ensure that the forest and wood products sector is well placed to take advantage of innovations created internationally. Build capacity in RD&E through a nationally coordinated approach that provides researchers with attractive career paths, a creative research environment, and adequate resources.

FRAMEWORK FOR A NATIONAL RD&E STRATEGY

Innovation in the forest and wood products sector involves a complex web of private and public organisations that provide funding and supply RD&E services. Two of the key benefits of developing a national RD&E strategy for the sector[45] are to identify opportunities for improving the leadership and delivery of RD&E to meet the changing needs of the industry and other stakeholders, and to ensure strong public support for a productive and sustainable forest and wood products sector.

Underlying this RD&E strategy is a vision of profitable, innovative, competitive and sustainable forest industries. Key areas where the strategy will contribute to industry outcomes, which, in turn, will help achieve this vision, are:

- enhanced competitiveness of forest products vis-à-vis other materials based on performance and environmental footprint
- sustainability measures that are scientifically robust, operationally feasible, easily understood and relevant to the community and broader user groups
- capacity and capability for resource expansion and the utilisation of new wood resources
- adoption of improved forest management practices through a culture of continuous improvement and learning
- a biosecure forest industry
- increased accessibility of information through a variety of mechanisms.

Sector-wide common objectives

For the purpose of this RD&E strategy, the sector-wide research priorities endorsed by the FFPC in 2008 (Appendix 1) have been condensed into a smaller set of 21 agreed objectives or priorities to serve as a basis for cooperation and collaboration between RD&E providers and industry (Table 9). The objectives are grouped in three areas across the sector business chain, integrating the elements of production, use and sustainability.

Table 9: Objectives of RD&E, forest and wood products sector

FOREST AND LANDSCAPE MANAGEMENT
• Improve plantation and native forest productivity and product quality • Improve technology adoption and efficiency in harvesting and transport • Improve the protection of forest assets from fire • Improve the biosecurity of forest assets • Expand the ability to predict and manage forest water use and carbon stocks and dynamics • Assist the design of robust and resilient mixed-use landscapes, from socioeconomic and conservation perspectives • Improve the capacity to respond to climate change, for both mitigation and adaptation

[45] Ideally this would be linked to a forest and wood products sector industry plan, but such a plan remains to be developed.

PRODUCT DEVELOPMENT AND USE

- Increase the value recovered from available forest resources
- Adopt/adapt best-available technology to optimise production and profitability
- Improve recovery rates and wood use from the by-product and secondary product streams and the post-consumer and urban green waste streams, including as biofuel
- Identify new and emerging market opportunities
- Understand the life-cycle impacts of wood use and opportunities for improvement in sustainable construction
- Demonstrate the capability of wood products to meet the performance requirements of building construction

INDUSTRY ADAPTATION AND RESPONSIBILITY

- Improve investment models for industry development, resource security and sustainability
- Enhance sustainability accountability and freedom to operate
- Sustain current and future employment opportunities
- Enhance foresight on and adaptation to emerging issues and market opportunities, including the response to climate uncertainty and changes in construction demand
- Assist the development of robust and sustainable built environments
- Improve the role of forest management and forest products in mitigating and adapting to climate change
- Demonstrate the competitive environmental advantages of using forests and wood products

Meeting the challenge: future capabilities

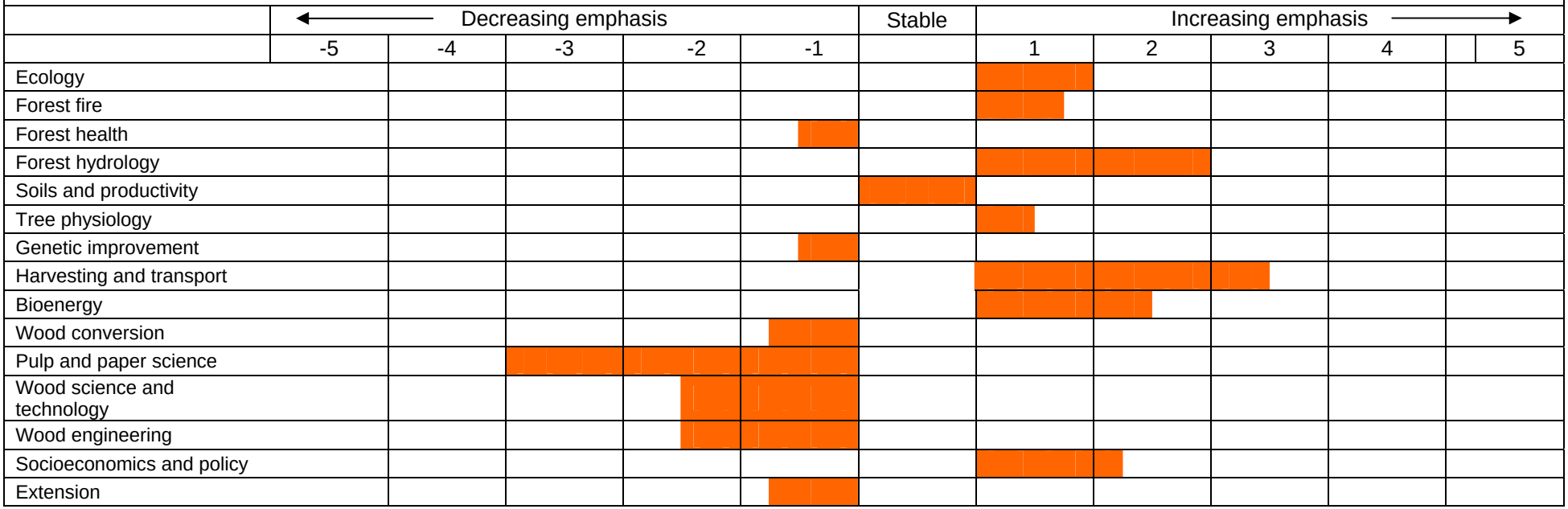
To gain an insight into the demand for future RD&E, 13 RD&E providers[46] were asked to forecast future capability needs over the next five years against the same research capability areas used in the analysis of current capability.

While this analysis can only be regarded as indicative, Table 10 shows that capability is projected to decline in biosecurity and forest health, genetic improvement, wood science, and pulp and paper science. Projected declines in some key areas where capacity is already assessed as inadequate (e.g. wood engineering) should raise significant concerns with industry. Priorities for increased capability were seen in bioenergy, forest harvesting and transport, and hydrology.

Further analysis would increase confidence in these projections as well as the understanding of their implications for the sector and for national RD&E coordination and cooperation. Nevertheless, the table highlights the need for deeper thinking in the sector about future skills needs and the availability of appropriate future RD&E capability and its alignment with R&D priorities and sector development opportunities

[46] ANU, CRC for Forestry, CSIRO, DEEDI, UM, FPC/DEC, ForestrySA, Forestry Tasmania, Forests NSW, I&I NSW-S&I, NAFI, SCU, UTAS.

Table 10: Projected RD&E capability, 5 years into the future, based on a survey of key RD&E providers



Are existing coordination mechanisms adequate?

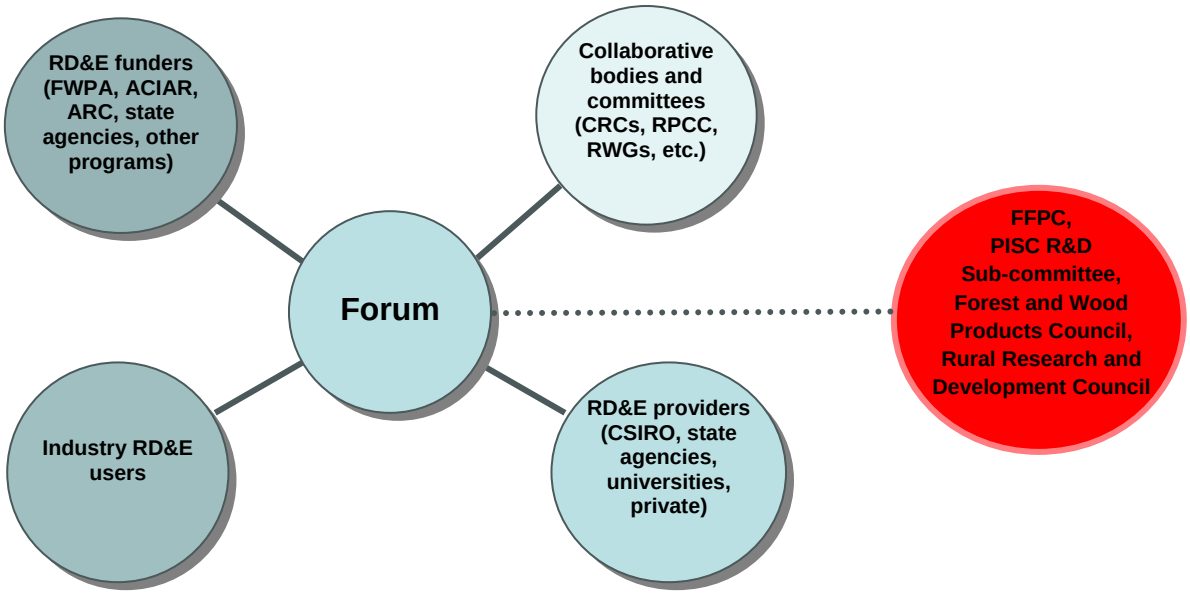
Throughout the development of this strategy there was general agreement among contributors on the need to explore options for change; align investment; and integrate service delivery wherever possible. Existing mechanisms were seen as providing inadequate engagement for this purpose, leading to proposals for a forum with suitable terms of reference that would engage in a level of ongoing detailed discussion and action on collaboration and coordination between funders, providers and users that has not been seen as necessary in the past.

No other strategic idea gained significant traction with stakeholders. Moreover, it is likely that other possible changes in RD&E arrangements will be successful only if supported broadly and workshopped through such a Forum. Thus the Forum is seen as a necessary first step in a longer process.

Forest and Wood Products RD&E Forum

On endorsement of the strategy, therefore, a national-level Forest and Wood Products RD&E Forum will be established consisting of key funders, providers and users of forest and wood products sector RD&E. The chairmanship of the Forum will rotate between the three main groupings (i.e. funders, providers and users) on an annual basis, and a part-time coordinator will be employed to service the needs of the Forum. Depending on interest in participation there may be a need for a Forum executive group to provide continuity in directing the work of the Forum. Participants will pay their own costs of participation as well as a small subscription fee (on the basis of cost-recovery) to fund a part-time coordinator. Other Forum-initiated work will be funded on a project basis. Figure 6 shows the proposed arrangement and linkages for RD&E coordination.

Figure 6: Proposed arrangement and linkages for RD&E coordination



The Forum will be established for an initial three-year period, with the possibility of extension. During the initial period the Forum will consider options for a further restructuring of coordination and cooperation mechanisms in the forest and wood products sector with a view to achieving greater consolidation of and efficiency among existing mechanisms *a*nd, at the end of the period, will recommend its preferred option(s). During the preparation of this strategic framework there was considerable discussion about which organisation should take responsibility for, and provide a home for, the Forum. As RD&E is intimately linked to industry futures, an industry body was seen as more appropriate than policy committees such as the PISC R&D Sub-committee or the FFPC, although there needs to be in communication with them. The industry options were considered to be FWPA and the CRC for Forestry. As the latter is time-bound it was concluded that FWPA would be the most representative and appropriate host agency.

FWPA will convene the Forum in consultation with other key players in the sector, including the CRC for Forestry, FFPC and universities. The initial meeting will decide on the process for appointing the part-time coordinator and on subsequent financial and administrative arrangements. Participants in the initial meeting will also consider and finalise the Forum's modus operandi and governance structure.

The Forum will:

1. Be responsible for the continued development and implementation of the forest and wood products sector national RD&E strategy
2. Provide a national forum for consultation, communication and coordination between the forest and wood products industry and RD&E funders and providers
3. Provide input to FFPC, the Australian Government Minister's Forest and Wood Products Council, PIMC, PISC, the Rural Research and Development Council, and other forums of relevance to RD&E
4. Monitor and work to maintain forest and wood products sector RD&E capability, investment and cost-effectiveness, including by defining the research capability needed in the sector and developing mechanisms to deliver this
5. Review, on an ongoing basis, common priorities for RD&E in the sector
6. Communicate RD&E outcomes to policymakers and the general public
7. Ensure communication between other primary industry sectors on RD&E priorities, particularly with respect to farm forestry.

The Forum will operate on the basis of:

- a willingness to engage in coordination, collaboration and communication
- delivery of benefits to industry and researchers
- integration across the sector's value chain
- efficient operation and minimal administrative burdens and transaction costs
- acknowledgement of the importance of innovation, RD&E coordination at the national level, and consideration of the needs of RD&E customers, funders and providers.

The Forum will act to promote negotiation among its participants over opportunities in RD&E. It will be inclusive, participatory and voluntary, and will promote a diversity of approaches to and ideas about innovation.

Initial actions

Key elements of the RD&E agenda for change will form the initial actions of this strategy to be promoted and overseen by the Forum. They are:

- Expand the sharing of strategic objectives and plans between relevant parties as a basis for developing new collaborative initiatives on a state, regional, or national level (or any other appropriate basis, such as species, discipline or commodity) and to minimise individual organisational changes that prejudice national capability and capacity in RD&E.

- Support the continuity of existing collaborative research bodies such as the CRC for Forestry and the Bushfire CRC and the development of potential new collaborative opportunities through state or federal government funding, such as Australian Research Council centres of excellence.

- Support greater engagement and coordination between the FWPA and the CRC for Forestry, as two organisations with national scope and responsibilities for RD&E with a focus on forests and wood products.

- Review the availability of and access to research infrastructure to support future knowledge development in the sector and consider initiatives to focus investment in key nodes.

- In areas identified for national collaboration, seek to maintain or build nationally coordinated (but not necessarily nationally managed or led) programs using internal and external resources.

- Encourage research providers and industry to regularly assess opportunities/broker coordinated participation in broader research funding initiatives that, while not necessarily sector-specific, can deliver benefits to the sector in terms of resources and knowledge.

- Consolidate and review material available across agencies (including but not restricted to cost–benefit analyses) that can demonstrate the benefit of investment in RD&E in the sector.

- Explore options for additional contributions to FWPA for special programs to receive matching funding from the federal government.

- Identify capability gaps and strategies for filling them, including by strengthening links with ForestWorks and other relevant skills-development agencies.

- Develop more strategic approaches to international science collaboration and the rapid introduction of new technology that can assist the competiveness of the sector by focusing on key areas of sector interest through cooperation between providers and funders.

- Assess options for, and the feasibility of, improving the storage, analysis and sharing of nationally relevant R&D data.

What will be different in three years?

Assuming agreement to establish the Forum is reached in the first quarter of 2010, by 2013 the Forum will have facilitated the following changes in the national coordination of RD&E:

- improvement in national, state and regional collaboration in existing and emerging areas
- development of new initiatives to address capability gaps
- more coordinated capacity in the sector to respond to new directions in knowledge need and to derive benefit from new funding initiatives
- publication of a new, sector-wide research priorities analysis
- publication of a full analysis of national research capability, and regional development and extension capabilities, including gap analyses
- adoption or refinement of within-sector performance measures for RD&E.

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ORGANISATION ENDORSEMENT

National Primary Industries Research, Development & Extension Framework **RD&E STRATEGY FOR THE FOREST AND WOOD PRODUCTS SECTOR**		
Organisation		
Does this organisation have an interest in the strategy? (Please circle)		Yes
		No
Organisation position (please circle, and, for options 2 and 3, provide comments)		
1. Endorsed		
2. Endorsed with comments		
3. Not endorsed		
Signature block		
Name		
Position		
Signature		

APPENDIX 1: *Research Priorities and Coordination Committee Forestry Sector Research Strategic Directions 2008–2011*

Mitigation of and adaptation to climate change in Australia

Outcome 1.1

Policy makers, communities and industry are aware of and understand the positive impacts of forest management on the carbon cycle, and the role of forests in ameliorating the impacts of climate change

Key strategies

1.1.1 Produce research outputs that better inform policy makers, communities and industry of the significant potential contribution that forests and forest products make to the amelioration of climate change through carbon sequestration and through the production of renewable energy sources from sustainable managed plantations and forests.

1.1.2 Develop research to demonstrate that climate change provides an opportunity for better integration of forestry into Australian landscapes and society in a range of environments

1.1.3 Strengthen linkages between tree growers and the forest products sector in the context of the carbon cycle and emissions management.

Priority research

- Continue to investigate the potential for climate change mitigation through reforestation and changes to forest management, considering limitations of productivity, competition for land and, especially, competition for water.

Outcome 1.2

The forest industry is adequately prepared for a carbon trading environment at local and national levels

Key strategies

1.2.1 Continue research and development into carbon accounting systems to provide industry with the knowledge and tools suitable for use at scales appropriate for effective and efficient carbon trading.

1.2.2 Build capacity in socio-economic analysis for assessment of the efficiency and effectiveness of policy, including market-based instruments, in mitigating the impacts of climate change.

1.2.3 Provide accurate scientific data and information to support efficient and effective implementation of market-based instruments such as carbon penalties or emissions trading, that increase the relative costs of using emission-intensive technologies and encourage uptake of alternative technologies such as biomass energy generation. Financial incentives, performance and emissions standards and information programs can also be used to encourage the use of energy-efficient and low-emission technologies.

Priority research

- Further develop carbon accounting tools (models and systems) suitable for use at a regional scale that provide forest managers with the knowledge to engage in carbon trading, supported by refinements to models of forest growth that underpin these tools

- Understand the changing risks of pests and diseases, cyclone, drought and fire so that the appropriate level of risk can be factored into forest management and carbon accounting systems

Outcome 1.3

Biomass energy production systems enhance energy security and reduce carbon emissions

Key strategies

1.3.1 Support development of biomass energy technologies in line with introduction of carbon emission trading in 2011-12.

1.3.2 Investigate social and biodiversity social impacts of biomass energy generation. These impacts may be different for communities near the source of production and from those at more distant locations. For example, issues such as local air quality and road traffic congestion need to be included among the costs and benefits of biomass energy, together with employment creation and reliable power supply.

Priority research

- Develop economically and socially feasible, and ecologically appropriate, biomass energy production systems and integrated timber and biomass production systems for different forest production conditions for a range of energy consumers.
- Research to mitigate potential impacts of increased biomass utilisation on biodiversity, forest productivity and other forest values.

Adapting forest management to climate change

Outcome 1.4

Forest and water resource managers can predict and manage the impact of climate change on water yields from forested catchments.

Key strategies

1.4.1 Focus research efforts in forested catchments that supply water to Australia's major population centres to assess the impacts of changed rainfall patterns and increased temperatures on future water supplies.

1.4.2 Develop tools to predict, monitor and measure climate change impacts on fire regimes in water supply catchments and their potential impacts on water yield and quality.

1.4.3 Assess the impact of predicted changes in climate on water resources for timber plantations and other land uses in selected regions.

Priority research

- Develop calibrated and tested process-based models and other landscape-level analytical tools to explore likely changes in water use by important forest types (including plantations) in key regions of Australia under different climate change scenarios, different types of management strategies and different fire regimes.
- Analyse the interaction of alternative forest management options, including timber harvesting and the use of prescribed fire, and impacts of climate change on water yield and quality

Outcome 1.5
Fire management systems are adapted to changed climate conditions

Key strategies

1.5.1 Evaluate possible economic, environmental and social impacts of altered fire regimes associated with changed climatic conditions, rising temperatures and changing rainfall patterns.

Priority research

- Conduct a detailed study of the elements that determine fire risk and how they are projected to change under future climate scenarios
- Analyse climate change scenarios to assess the extent to which climate change alters the risk of bushfires in different regions of Australia.
- Determine appropriate management options to reduce bushfire risks to forests, plantations, biodiversity and the community under changed climatic conditions.

Outcome 1.6
Landscapes are designed and managed for resilience

Key strategies

1.6.1 Understand the vulnerability of forest species and ecosystems to climate change, for example, those with relatively narrow spatial distributions within areas characterised by relatively uniform climatic conditions. Develop management strategies for vulnerable native and plantation species and ecosystems.

1.6.2 Assess the impact of more frequent or prolonged drought on establishment, survival and growth of trees planted for commercial or environmental purposes in both traditional and dryland regions.

1.6.3 Evaluate consequences of the effects on biodiversity of disturbances induced by climate change, such as changed fire regimes, prolonged drought and increased prevalence of pests and diseases.

Priority research

- Studies of vulnerability of native and plantation forest ecosystems to climate change and factors limiting species distributions (such as extreme climatic events or other correlated factors such as the incidence of fire), to identify species or ecological communities at greatest risk.
- Identify possible management options to minimise the adverse effects of climatic changes including “assisted migration” of species to new habitats that may become suitable under changed climatic conditions
- Identify areas where plantations with currently marginal water supply have been established and with the aid of climate models analyse the impact of future climate scenarios on plantation productivity and water availability in these regions
- Determine the impact of management responses, such as thinning and fertility management, on stand survival
- Evaluate alternative species that may be suitable for plantations in areas now or soon to become available for planting, as climate change begins to take effect.

Quality and yield of Australia’s water resources

Outcome 2.1
A balanced and equitable basis for allocating water that does not unfairly impede growth of the forestry sector and recognises the economic and environmental benefits that forests provide

Key strategies

2.1.1 Provide the knowledge base for water allocation mechanisms that account for the total environmental and economic impacts of plantation forests within a catchment or region relative to the environmental and economic impacts of other land uses including those dependent on irrigation. This can be achieved through collaboration among all stakeholders supported by, multi-disciplinary research

2.1.2 Strengthen capacity in modelling and related areas, especially for scaling up plot-based data and information to catchment and regional scales to estimate water use by different land uses.

Priority research

- Develop full water-balance accounts to evaluate the impact of forests and other land uses on the quantity and quality of water resources, in the context of other environmental factors including biodiversity, salinity and carbon sequestration as well as economic and social outcomes of changes, This requires accounting for interactions between climate change, hydro-geological processes, local and regional water interception and social and economic processes

Outcome 2.2

Native and planted forests are managed in a sustainable manner using information based on knowledge of limitations within a changing climate.

Key strategies

2.2.1 Develop improved knowledge of growth performance of plantation species' growth performance to optimise productivity per unit area and optimise water-use efficiency.

2.2.2 Develop improved understanding of native forest water use under current and future climate conditions and different types of management regimes.

Priority research

- Species selection for environments with variable rainfall which have suitable wood properties for industrial use and which generate competitive returns
- Develop plantation design and management systems that maximise water availability and optimise water-use efficiency. Focus on water-use efficiency under a range of environments with particular emphasis on management systems for drier environments.
- Research on native forest water use at tree, site and catchment scales.

Policies and processes to strengthen the capacity of forests to deliver multiple objectives

Outcome 3.1

Better-informed policy decisions to-meet the multiple demands on forests

Key strategies

3.1.1 Determine future demand for goods and services from Australia's native and planted forests, including where and how they can be effectively and efficiently provided and what supply risks are likely to occur.

3.1.2 Develop monitoring and reporting mechanisms for forests to demonstrate the outcomes of active forest management

Priority research

- Investigate opportunities for expansion of Australia's plantation estate based on analysis of economic, environmental and social research inputs.

- Research to support a more comprehensive approach to risk management for forests, identifying key risks to the different forest resources and development of suitable treatments to effectively manage those risks
- Efficient tools for monitoring the different values and uses of forests.
- Evaluate socio-economic impacts of alternative land management systems involving forest plantations.

Outcome 3.2

The contribution of active forest management to biodiversity conservation at different scales is understood by communities, governments and industry

Key strategies

3.2.1 Develop knowledge and information about landscape-scale effects of particular land-use options and management strategies to inform public debate about forest use. Values to be considered should include wood production, biodiversity, visual amenity, catchment management, water yield and quality and other values and services.

3.2.2 Develop and implement improved methods for monitoring and quantifying the impacts of timber production and other management practices on forest biodiversity.

3.2.3 Develop and demonstrate more effective management and mitigation of negative impacts of timber production.

3.2.4 Assess the response to disturbance and recovery by native plants and fauna

Priority research

- Conduct multi-disciplinary analyses of strategies, and develop decision support tools, to integrate or segregate production and conservation at different scales and in different forest types.
- Research into improved monitoring and reporting for forest biodiversity and habitat surrogates.
- Long-term, operational-scale, ecological and management experiments to determine the effects of repeated cycles of forest management activities, and time to recovery, for sensitive species of plants and animals.

Outcome 3.3

Forest management is physically, economically and environmentally integrated into agricultural production systems

Key strategies

3.1.1 Assess the economics of integrated farming systems where trees are grown in association with agricultural crops and grazing systems for short-term and long-term forest product options

3.1.2 Develop catchment-scale and farm-scale models of integrated agroforestry systems

Priority research

- Investigate systems to integrate short-rotation and long-rotation tree species grown in association with cropping and grazing production systems for increased economic, environmental and social benefits
- Research on plantation designs, configuration and placement in the landscape to maximise biodiversity outcomes in rural landscapes

Protecting the health and biosecurity of Australia's forests

Outcome 4.1

Australia's natural and planted forests are included in national and state biosecurity plans jointly supported and implemented in a proactive and integrated manner by governments and industry

Key strategies

4.1.1 Develop a national biosecurity plan for native forests to complement the existing plantation industry plan. The transfer of management responsibility for native forest from production forestry to conservation and environment agencies, places an onus on those agencies to address forest biosecurity. These agencies must contribute to the national biosecurity framework and to development of a better understanding of threatening processes and their potential impacts and the development of contingency plans.

4.1.2 Forest biosecurity issues that can impact on non-traditional forest industries are identified and better understood.

4.1.3 Ensure that forestry is addressed in state biosecurity plans and all forest management agencies are engaged and investing in coordinated research and development and contingency planning to address biosecurity threats.

4.1.4 Evaluate models for national engagement of agencies to support forest health and biosecurity research such as the Industry Pest Management Group (IPMG) and Sub-Tropical Forest Health Alliance (SFHA)

Priority research areas

- Analysis of the potential impacts of pests and disease threats on non-commercial values (biodiversity, recreation, water and other values) in forests.
- Investigation of appropriate policy and management arrangements across jurisdictions and forest ownerships to effectively respond to biosecurity risks.

Outcome 4.2

Forest managers are equipped with biologically, economically and environmentally effective tools for managing pest and disease threats within Australia.

Key strategies

4.2.1 Effective control strategies are developed for the large number of pests and pathogens that threaten forests. New control strategies may be needed to replace existing strategies made redundant by environmental or economic factors.

4.2.2 Use scientific research to assist in identification of threats and in risk assessment and management for plantation and natural forests . As genetic diversity in planted forests declines the risk profile changes. Climate change and international trade patterns also change the likelihood of pest and disease incursions.

4.2.3 Build capacity in critical areas of detection and diagnosis of pests and diseases in relation to biosecurity

4.2.4 Explore interactions between silviculture, disease management, wood production and wood quality

Priority research

- Research into risk management and development of predictive models to help forest managers and owners improve preparation and mitigation strategies. This research should embrace assessment of costs and benefits of different strategies.

- Improved methods for surveillance and early detection of exotic and established or indigenous forest pests and pathogens, including spatial analysis and environmental data to target resources, sentinel/hazard site surveillance and trapping technologies
- Continue development of remote sensing technology coupled with ground survey, to provide methods to support health surveillance programs across native forests and plantations
- Research on the life cycle, impacts and responses to priority pests and diseases in forest and wood products

Forest product development and use

Outcome 5.1

Timber resources are of sufficient quantity and quality for profitable value-adding within Australia.

Key strategies

5.1.1 Declining availability of natural forest hardwood timber resources is increasing pressure to add value to available resources within Australia. The best available technology should be used to optimise production from these resources.

5.1.2 Improve recovery rates and utilisation of wood from waste streams to maximise the use of the available resource. Negative perceptions associated with re-use and recycling wood can be addressed through education programs.

Priority research

- Quantify the wood utilisation characteristics of the younger plantation resource, which has very different properties to mature native-forest wood.
- Investigate the relationships between genetics, site conditions and silvicultural management, and wood production and quality with the objective of maximising the capacity to add value to the resource.

Outcome 5.2

The opportunity to add value to Australia's wood fibre resource is enhanced by access to harvesting and processing techniques and technologies.

Key strategies

5.2.1 Increase the proportion of forest products research investment going to projects with longer-term, higher-value and more widespread benefits for the Australian forest sector.

Priority research areas

- Investigate opportunities to add value to timber from both plantations and natural forests, particularly for smaller regrowth logs
- Develop replacements for increasingly unacceptable preservative systems, adhesives and coatings (e.g., metal components, emissions of volatile organic compounds)
- Support development of modified or novel products and/or processes that are more suited to the known properties of the near-term and medium-term future resource, including development of non-pulp products capable of being produced from hardwood plantations, providing a financial incentive for longer rotations and higher plantation management costs (e.g. thinning, pruning)
- Develop new timber composite products with higher added value
- Develop improved, intelligent, efficient harvesting and processing technologies for the current resource, to reduce transport and processing costs and improve recovery and product value, including reduced energy consumption in harvesting, transport, sawing, drying, machining and protection systems.

Outcome 5.3

Value-adding to wood resources in Australia is optimised in social, economic and environmental terms

Key strategies

5.3.1 To move the product focus further along the value chain and maximise opportunities for adding value in Australia. To achieve this, a number of constraints have to be overcome, by investment in efficient wood processing infrastructure; community acceptance of large-scale processing locally and nationally, compliance with strict environmental codes and standards in line with product demand, and overcoming competition from low-cost wood processing in developing countries. This will critically define where Australia's competitive advantage lies in wood processing.

Priority research

- Development of integrated approaches to value-added processing, utilisation and end-use for Australian forest products.
- Whole-of-life comparisons between wood and substitute materials and systems, including durability models leading to the development of design-based solutions to minimise the environmental impacts of various construction systems
- Research to support market mechanisms that better connect growers and processors and provide for widespread participation in forest product markets, including for small-scale growers and for environmental services.

Outcome 5.4

Australia's timber industry strengthens its position in the construction market by aligning itself with future opportunities determined by climate, economic, political and social change.

Key strategies

5.4.1 Develop better information on the green credentials of timber construction in terms of greenhouse gas footprint of wood products relative to other construction materials

Priority research

- Investigate the potential benefits of timber relative to non-wood building materials, in relation to embedded energy, greenhouse gas emissions and other aspects of environment, community health and sustainability
- Develop and adopt multi-disciplinary approaches to sustainable housing, embracing skills in the areas of architecture, energy consumption, renewable natural resources, resistance to natural disasters, and recycling capacity[47]

[47] Source: RPCC (2008). *Forestry Sector Research Strategic Directions 2008–2011*, Forest Research and Coordination Committee, Melbourne.

APPENDIX 2: *FWPA investment strategies*

Thirteen investment priorities, reflecting the interests of the FWPA members across the value chain, have been developed to ensure R&D results will either increase productivity, improve the value chain or reduce risk.[48] Other needs, outside the 13 priorities, may arise and will be considered on a case-by-case basis.

Defining the investment priorities ensures that the research community is aligned to the same issues and outcomes as industry. The priorities list illustrates the connection between the segments of the industry as they are categorised according to where they sit in the value chain, moving from the market through processing back to the resource.

1. **Information, analysis and interpretation of domestic and export markets**

   This knowledge allows industry to provide products that anticipate and satisfy market needs. Activities include detecting and monitoring trends and purchasing behaviour at specifier, trade and consumer levels.

2. **Timber construction in residential buildings**

   Research is required to assess the residential design and construction market needs and ensures that the industry is aware of, and responds to, changes in building codes and regulations. This knowledge will also help building professionals to work more efficiently with timber, and industry and the supply chain to respond better to issues as they arise.

3. **Timber construction in commercial and industrial buildings**

   Despite the strength of the Australian market and the quality of Australian timber products, and contrary to the emerging international trend, there has been limited use of wood as a construction material in buildings higher than three storeys. Investment in research in this area will lead to the knowledge, technology and products needed to develop this relatively untapped market.

4. **Appearance timber products and markets**

   Reliable information on the supply and demand for products such as furniture and flooring will ensure that future requirements can be anticipated and met. Research into maintenance and performance, the appearance of woods and methods of installation will help the industry to build on the increasing awareness of the environmental advantages of wood.

5. **Wood products in sustainable buildings**

   Carbon footprints, thermal values and environmental considerations are playing a greater role in building codes and policies — and creating opportunities for wood. This topic has been the subject of the initial FWPA investment plan. The four-year program is examining, for example, life cycle analysis for residential construction — completion of a comparison of the environmental impacts in embodied and operational energy for different types of construction. The investment plan aims to achieve voluntary or regulatory preferred specification of timber products over alternative materials.

[48] Source: *Forest and Wood Products Australia Annual Report, 08/09*.

6. **Development of secondary products and markets for them**

   Improving and increasing the use of the whole tree through developing value-added secondary products will minimise waste and maximise the return from each tree harvested. R&D investments in this area are identifying and analysing secondary products and their markets.

7. **Solid wood, engineered wood and pulp and paper products: Performance and yield**

   Recognising and responding to market needs enables the forest and wood products industry to design efficient systems and maximise production of appropriate products. This supports the wood industry's aim to create a better product by optimising production systems for energy use, drying, cutting, grading and sorting of wood. Developing quality control systems will give the end user a more consistent product, particularly for structural applications. For example, improved measuring and grading for strength and elasticity, and more accurate display of these qualities encourages broader use of wood and increased market acceptance.

8. **Maximising product yields and values from current resources**

   Increasing the yield of commercial products from each tree will increase profitability and reduce waste. Research into the characteristics, properties and variability of wood resources and identifying the most commercially viable applications and products realises maximum value and reduces unnecessary processing. Practices such as non-destructive testing to screen logs before processing, and segregation techniques at the mill gate can help maximise yields.

9. **Improving wood quality and yield, and tools for forest management**

   Forest managers need to optimise their forest management systems to make logs that processors value. Increasing the efficiency of inputs such as fertiliser and pesticides adds value to the industry. Improved management of forests — spacing, pruning and species choice — leads to better products and increased volume. Breeding and management can increase yield and thus the financial return to growers. Developing tools to measure or more accurately predict the quality and volume of standing forest reduces risk, and increases the usefulness and value of the product.

10. **Genetic improvement and delivery for increased wood yield and quality and for managing risks**

    Planting is the first opportunity to control the quality and volume of commercial timber. This investment priority focuses on genetic-based tree breeding which can significantly reduce the time it takes to improve a strain. Better selection techniques such as cross-breeding, screening, breeding programs for desirable traits and to improve fitness in the environment have lowered the time required to improve a planting. R&D will also investigate how new strains are deployed in plantations, as seedlings or seeds, faster generation of planting stock and a choice of clonal or progeny reproduction combine to produce the improved products sooner, reducing risk for growers.

11. **Water-use efficiency, access to resources and balanced policy outcomes**

    Increased awareness of climate trends and projections are resulting in industry requiring more information about water. Ensuring that water policy is informed by science maximises the volume of wood produced by a given volume of water. Data on how the

industry sources and uses water for silviculture will generate value throughout the chain and increase awareness of environmental impacts. It will also identify opportunities for efficiencies in site selection and silviculture.

12. **Forest biosecurity and preparedness**

    Increased international trade and production resources concentrated into discrete regions will increase risk. Risk can be reduced by an awareness of the immediate environment and its own risks, and the available controls, including biological controls. Developing risk profiles of pests and forest diseases will lead to informed risk management strategies. Developing responses to prioritised risks will ensure the best outcome for industry and the environment. Pest and disease outbreaks affect both commercial forests and public reserves so the application of the outcomes to multiple-use forest landscapes is an additional benefit of this priority program.

13. **Mitigation of, and adaptation to, climate change and the management of the carbon cycle in plantation and native forests**

    Assessing the impact of climate change on plantation productivity will increase understanding of the non-commercial values of carbon in plantation and native forests, and help industry make its long-term planning decisions. Measuring the carbon in forests and increasing the understanding of the carbon cycle can help industry adapt to, and plan for, the forecast climate changes. Combining the data with economic modelling, and using it to generate maps of the effects of climate on growing conditions for established forests, will give the industry information that it needs to prepare for and manage any change.