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# Forest and Forest Products Research Expenditure in Australia 1981-1982 to 2001-2002





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***Publication: Forest and Forest Products Research Expenditure in Australia  
1981-1982 to 2001-2002***

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Project no: PN03.3711

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# **Forest and Forest Products Research Expenditure in Australia 1981-1982 to 2001-2002**

Prepared for the

**Forest & Wood Products  
Research & Development Corporation**

by

**John Turner and Marcia Lambert**

*The FWPRDC is jointly funded by the Australian forest and wood products industry  
and the Australian Government.*

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## **Summary**

The expenditure in production-oriented forest and forest products research was assessed within Australia for 2001/02 and compared with a series of research expenditure reviews completed over the past 20 years to analyse changes and provide a historical perspective on research investment patterns over that period. The expenditure on forest research was \$50.51 million and for forest products research was \$19.73 million, a total overall of \$70.24 million. This represented an increase in forest research from \$24.32 million in 1981/82 to \$50.51 million in 2001/02, however, when expenditure over this period was adjusted for inflation by the Consumer Price Index (CPI), there was both a significant and continual decline to 2001/02. Expenditure on forest products in 2001/02 of \$19.73 million/year represented an increase from \$14.30 m in 1981/82. Again, when adjusted by the CPI, there was a decline from \$35.63 million in 1981/82 to \$19.73 million in 2001/02.

Considering the total forest research expenditure by the main sectors (Commonwealth, Companies, State agencies, Universities) from 1981/82 to 2001/02, the Commonwealth proportion has increased from about 41.1% to 45.2%, and the University proportion increased from 4.4% to 6.7%. The proportional input to research by organisations with the responsibility for managing forests, that is, State agencies and companies, reduced from 54.5% to 48.1%. Changes for the Commonwealth are mainly a result of increases in expenditure through the Cooperative Research Centres (CRCs) and the Forest and Wood Products Research & Development Corporation (FWPRDC). There appears to have been significant increases in the relative proportion of research expenditure on management (including administration) up to the equivalent of 31% of total forest research expenditure in 2001/02. This appears high when compared with equivalent costs of about 7% in the US Forest Service.

The relative importance of different categories of research changed between 1981/82 and 2001/02. In 1981/82, about 42.8% of forest research expenditure was on exotic species plantations, 41.8% on native forests, 12.9% on environmental research, and 2.5% on plantations of native species. In 2001/02, 35.0% was on exotic species plantations, 25.2% on native forests, 8.4% on environmental research and 31.4% on plantations of native species. There appears to have been a major increase in the expenditure reported on forest surveys and monitoring, especially in the native forests category. In 2001/02, the expenditure on exotic species plantations was equivalent to \$18.76/ha, while on native species plantations, native forests, and the environment (assuming this mainly related to native forests), it was \$23.20/ha, \$0.77/ha and \$1.02/ha respectively. Expenditure on surveys was about \$0.33/ha.

Research on forest products in 1981/82 was undertaken mainly by Companies (49.7%), followed by Commonwealth organisations (38.2%), State agencies (8.9%) and Universities (3.2%). By 2001/02, this had changed significantly, with the Commonwealth proportion increasing to 46.3% and Universities to 12.0% while State agencies had decreased to 7.1% and Companies to 34.6%. The expenditure was equivalent to about \$0.81/tonne of harvested timber. A significant part of the reduction by Companies reflects downsizing to concentrate on core business activities and the development of CRCs and other cooperative arrangements.

When expenditure on research was considered in relation to the industry supporting research, forestry research expenditure varied according to the sector. In 2001/02, expenditure on forestry research was equivalent to 3.29%, 30.0% and 2.27% of the estimated gross value of forest production in native forests (including environment), native species plantations and coniferous species plantations respectively. Expenditure on forest products research in 2000/01 was about 0.28% of industry turnover.

The FWPRDC allocation to forest and forest products research in 2001/02 was about \$7.1 million which represents 10% of total expenditure on forest and forest products research in Australia. When considering that FWPRDC attempts to obtain at least equivalent input from research providers and industry collaborators, the FWPRDC is influencing at least 20% of the research services undertaken on behalf of its stakeholders.

## **Introduction**

Expenditure on research is an investment in the future of an industry. However, the level of expenditure on research which is appropriate or optimum for an industry is difficult to determine and the level will change over time as the nature and structure of the industry itself changes. The forest and forest products industries are technically based, and research is essential for continued improvements in forest management and utilisation. The present report is an analysis of the estimates of expenditure on forest and forest products research within Australia in 2001/02 in comparison with levels in previous years. While there are no universal criteria for determining or guiding appropriate levels of expenditure, regular reviews of expenditure allow analyses to be made on trends together with changes in the sectors contributing to the expenditure.

In an analysis of forest research in the United States of America (USA), Giese (1988) reported on a number of trends which included the supply of new scientists for forest research in the USA which had been declining for more than 10 years (prior to 1987) as had general support for forest research in financial terms. This decline was occurring despite an increasing long term need to understand the ecosystem processes and economics associated with the use of forests. At that time, Giese (1988) concluded that the scientific community, which traditionally had been available to deal with the issues as they arose, was being slowly but steadily dismantled. In the US Forest Service, the annual research budget (unadjusted for inflation) declined between 1977 and 1986 from US\$129 million to US\$100 million, and the number of scientists declined from 949 to 747. A comparable decline in federally funded expenditure for university forest research occurred over the same time. This information was updated by Guldin (2002) and is referred to later.

In addition to the actual resources, Giese (1988) identified the consequences of a deteriorating system of forest research as:

- *“Loss of synergy that results from teams of diverse scientists working to solve large-scale and long-term problems.*
- *Knowledge that has been gained through negative results or experiments and usually not yet published, being lost through cut-backs or retirements (that is, loss of corporate knowledge). The natural consequence is that, in the future, experiments will be re-done.*
- *Foregoing of long-range benchmark projects, such as hydrological projects and the Hubbard Brook type ecosystem-level study, by re-directing funding to more fashionable research.*
- *Incapacity to address difficult emerging problems.*
- *Inability to identify and understand the cumulative long-term effects of increasing demands for multiple use of forests.*
- *Lack of understanding of effects as part of a global economy and ecology.*
- *Inability of alternative disciplines (for example, agriculture) to answer specific forestry questions”.*

The patterns and effects of such changes are relevant to Australia, especially in relation to the changes in structure and systems within the forest based industry.

The present analysis is a review of research expenditure in 2001/02 on forest and forest products and an assessment of the trends over the past 20 years by reference to previous published studies (Standing Committee on Forestry 1982, Quick and Booth 1987, Lambert and Turner 1992, Turner and Lambert 1997) and others which are specifically identified. Reporting by ABS (2003a,b) is relevant to the present analysis, however, forest research and forest products research were not separately identified, the broad categories of research were not considered and their analyses took a much broader view of research, as for example, they did not separate monitoring and surveys from research.

## ***Methods***

The two broad areas of interest are expenditure on forest research and on forest products research. Forest research was defined as scientific investigation into fields associated with the establishment, management, protection, improvement and environmental effects of commercial native or planted forests. Research undertaken on areas managed specifically for conservation (for example, forests within national parks) was not included. Research was divided into the categories of native and exotic species plantations (primarily *Pinus* spp.), native forests, and environment (based on the initial analysis of Quick and Booth (1987) which was primarily soil erosion and hydrology research spanning more than one forest management type). Survey work included field assessments such as fauna and flora surveys. Costs of monitoring where available, such as on forest growth, health, nutrition and/or biodiversity were not included in research, but were tracked separately and reported within the survey category. Costs of research management (forest and forest products) were tracked as a separate component. Forest products research in its broadest sense involves research into value adding of wood. Work on final product development (for example, furniture production), production runs in mills, environmental monitoring, or quality control assessments were not included. Detailed analysis of pulp and paper research was not undertaken.

The information was obtained from direct contact with organisations (personal, telephone, mail, Email) using a standard set of questions and was supported by documentation such as annual reports where available. The discussions with individual organisations were important to ensure consistency since that which is considered to be routine assessment by one organisation may be identified as research by another.

Annual expenditure on research activities in 2001/02 by organisations directly undertaking research constituted the primary data (the contacted organisations are listed in the Acknowledgements). That is, the focus was on expenditure on research undertaken, as opposed to the organisations providing funds for research. Where multiple organisations were involved in funding a research program, the data from each source were tracked separately to avoid double counting. Individual organisations have not been identified and all data have been pooled. The Cooperative Research Centres (CRCs), the Forest and Wood Products Research & Development Corporation (FWPRDC) and CSIRO were accounted for within the Commonwealth category with care being taken to ensure there was no double counting.

The primary focus was on investment in research but where available, information on technical services, administration and management of research were also compiled as closely as possible to match the original definitions of Quick and Booth (1987). The sum of the costs of these components has been reported under the category of management. Technical services were defined as scientific services including laboratory, computing services supporting research, and library services but did not include an area such as information technology services provided in general to the organisation. All such services may be provided by a research or technical division within an organisation and be identified as a cost of providing technical services but for the purposes of this analysis, they were reported separately from research. The reported expenditure was that provided by the contacted organisations (listing in Appendix 1) and in the case of staff, included salaries and staff overheads. Costs of accommodation, higher level company management, and that which may be defined as central services were not included.

The data for 2001/02 together with information from previous assessments of research expenditure, were compiled within Excel spreadsheets. Analyses of the data included changes with time, changes in expenditure according to sector, changes in the CPI over time, and changes in expenditure in terms of the forest estate or quantity of timber harvested. The areas of *Araucaria* spp. were included in the calculations for native forest plantations.

The level of output from research is difficult to assess in a standard manner across a range of organisations. One method is to assess the listings of scientific publications. In this regard, the scientific publications listed in Annual Reports by CSIRO Divisions, State agencies, Universities and some companies have been reviewed. When Annual Reports were not available, publication lists were obtained from librarians or publicity staff. The scientific publications in each specified year were categorised as forest-based or forest products-based and divided into refereed (those in refereed scientific journals) and 'in-house' (these being reports published by the organisation, or in conference proceedings, and some unrefereed journals). Company or client reports, and unpublished reports with limited circulation, were not included. Care was taken to not double count joint authorship across organisations. The publications were not formally divided into fields of study. The approach did not cover the total number of publications by organisations in any year but was a standard sampling of defined publications.

## Results

### • Forest Research

The estimates of expenditure on forest research, together with trend information for all the study periods according to sector, are presented in Table 1. The annual changes are also presented together with the overall estimate of costs of research management as an additional component.

The value of forest research (unadjusted for CPI) has increased from \$24.32 million per year in 1981/82 to \$50.51 million in 2001/02. Between 1981/82 and 1985/86, the annual average rate of increase in expenditure was 6.9%, but between 1994/95 and 2001/02, this had declined to 1.3% (Table 1). The proportion of expenditure varied between sectors over the period of the study. The Commonwealth component was about 40.9% in 1981/82, declining in the following two periods, then increasing to 45.2% in 2001/02, the increases largely being a result of inputs to CRCs and the FWPRDC. Expenditure by Universities rose from 4.4% in the initial period to about 6.7% of total expenditure in 2001/02. The expenditure by State agencies and companies has generally declined over the period of the studies. Initially, the combined estimate was 54.7% and is now 48.1%. These two latter sectors together represent the major entities responsible for the management of forests.

**Table 1.** Summary of expenditure (million \$ unadjusted for inflation) on forest research between 1981/82 and 2001/02.

Sector	1981/82 <sup>1</sup>		1985/86 <sup>2</sup>		1989/90 <sup>3</sup>		1994/95 <sup>4</sup>		2001/02 <sup>5</sup>	
	(\$)	(%)	(\$)	(%)	(\$)	(%)	(\$)	(%)	(\$)	(%)
Commonwealth	10.00	41.1	12.11	38.9	14.91	38.0	19.52	42.2	22.84	45.2
Companies	2.02	8.3	2.71	8.7	4.51	11.5	3.82	8.3	3.50	6.9
State agencies	11.24	46.2	14.35	46.1	17.62	44.9	20.25	43.8	20.80	41.2
Universities	1.07	4.4	1.94	6.2	2.22	5.7	2.65	5.7	3.37	6.7
Total	24.32		31.11		39.26		46.24		50.51	
Annual change (%) *		6.9		6.6		3.6		1.3		
Management **	5.37	22	7.47	24	10.60	27	12.95	28	15.87	31

<sup>1</sup> Standing Committee on Forestry (1982)

<sup>2</sup> Quick and Booth (1987)

<sup>3</sup> Lambert and Turner (1992)

<sup>4</sup> Turner and Lambert (1997)

<sup>5</sup> Present study

\* Annual change between two periods

\*\* Management and administration of research have not been included in the total of forest research but the expenditure is expressed as an indicative percentage of the total expenditure

In general, there was an increase in the cost of research management and administration from 22% to 31% over the 20-year period. This component consistently increased over the 20-year period and is attributed to identification of non-research managers (for example, business managers, IT managers) and research coordinators being appointed within organisations, many of whom coordinate and direct research rather than directly undertake research.

The broad categories of forest research expenditure are presented below in Table 2. Research in native forests (primarily silvicultural research) has declined from 41.8% of total expenditure in the first period (1981/82) to 25.2% in the most recent estimate. Much of the environmental research in 1981/82 was undertaken in native forests and the combination of this with research in native forests represented 54.7% of the research in 1981/82 but had declined to 33.6% in the most recent period. Research on exotic species plantations was an area of strong interest between 1981/82 and 1994/95 and was typically between 41.2% and 44.7%, but had declined to 35.0% in the most recent period. The category with a consistent and very significant increase in expenditure has been research into plantations of native species (hardwood and *Araucaria*) increasing from 2.5% in the first period to 31.4% in the 2001/02 assessment year. Of note also is the increase in surveys (including monitoring) from the equivalent of 2.3% of research expenditure in the first period to 10.7% in the final period. Much of the decline in research in native forests and environment appears to have been replaced by survey work and research on native species plantations.

**Table 2.** Broad categories of forest research expenditure (million \$ unadjusted for inflation) between 1981/82 and 2001/02.

Category	1981/82 <sup>1</sup>		1985/86 <sup>2</sup>		1989/90 <sup>3</sup>		1994/95 <sup>4</sup>		2001/02 <sup>5</sup>	
	(\$)	(%)	(\$)	(%)	(\$)	(%)	(\$)	(%)	(\$)	(%)
Exotic species plantations	10.42	42.8	12.97	41.7	17.56	44.7	19.05	41.2	17.68	35.0
Native species plantations	0.61	2.5	1.04	3.3	1.95	5.0	5.61	12.1	15.86	31.4
Native forests	10.16	41.8	12.44	40.0	13.95	35.5	15.87	34.3	12.75	25.2
Environment	3.14	12.9	4.66	15.0	5.80	14.8	5.71	2.3	4.22	8.4
Total	24.32		31.11		39.26		46.24		50.51	
Surveys* (including monitoring)	0.55	2.3	0.91	2.9	1.96	5.0	3.26	7.1	5.41	10.7

<sup>1</sup> Standing Committee on Forestry (1982)

<sup>2</sup> Quick and Booth (1987)

<sup>3</sup> Lambert and Turner (1992)

<sup>4</sup> Turner and Lambert (1997)

<sup>5</sup> Present study

\* Surveys have not been included in the total of forest research but the percentage is expressed as an indicative percentage of the total expenditure

Expenditure in the broad research areas was adjusted according to the CPI to provide a comparison in 2002 dollars (Table 3). Total adjusted expenditure in 1981/82 was \$60.59 million and there has been a steady decline to \$50.506 million in 2001/02, this representing about a 20% decrease or about 0.5% each year. In adjusted dollars, the main area of increase over the study period has been in native species plantations. Expenditure on surveys has also increased consistently.

**Table 3.** *Broad categories of research expenditure (million \$ adjusted for inflation to 2002 dollars) between 1981/82 and 2001/02.*

<b>Category</b>	<b><u>1981/82</u><sup>1</sup></b> <b>(\$)</b>	<b><u>1985/86</u><sup>2</sup></b> <b>(\$)</b>	<b><u>1989/90</u><sup>3</sup></b> <b>(\$)</b>	<b><u>1994/95</u><sup>4</sup></b> <b>(\$)</b>	<b><u>2001/02</u><sup>5</sup></b> <b>(\$)</b>
Exotic species plantations	25.95	23.99	23.88	22.67	17.68
Native species plantations	1.51	1.93	2.65	6.68	15.86
Native forests	25.31	23.02	18.97	13.89	12.75
Environment	7.81	8.61	7.89	6.79	4.22
<b>Total</b>	<b>60.59</b>	<b>57.55</b>	<b>53.39</b>	<b>55.03</b>	<b>50.51</b>
Surveys (including monitoring)	1.38	1.68	2.64	3.69	5.41

<sup>1</sup> *Standing Committee on Forestry (1982)*

<sup>2</sup> *Quick and Booth (1987)*

<sup>3</sup> *Lambert and Turner (1992)*

<sup>4</sup> *Turner and Lambert (1997)*

<sup>5</sup> *Present study*

The total expenditure on research surveys and research management (including costs of administration and management) (Table 4) indicates that a smaller proportion of the funds available for research and related services, is being spent on actual research.

**Table 4.** *Total expenditure (million \$ unadjusted for inflation) on research, surveys and research management (including costs of administration and management) in forest research.*

<b>Period</b>	<b>Total Expenditure on Research, Surveys &amp; Management</b>	<b>Proportion of Research (%)</b>
1981/82	\$30.25 m	80
1985/86	\$39.48 m	79
1989/90	\$51.82 m	76
1994/95	\$62.44 m	74
2001/02	\$71.79 m	70

Although not tabulated, the 'CPI adjusted' expenditure was assessed according to sector. The largest change over the period was in company research which has declined in adjusted terms by 30.6% or about 1.5% each year. Adjusted expenditure by State agencies has declined by 21.9% or about 1% each year, and for the Commonwealth there was a total decline of 8.4% or 0.4% each year. University research had increased by about 27% or 1.3% each year. This latter increase reflects inputs from CRCs and more Universities being involved in some aspects of forest research.

Expenditure on forest research per managed hectare was analysed within each category (Table 5). The areas were compiled and reported by ABARE (2002) but the small areas of farm forestry plantations were not included. The areas in each individual category of exotic species plantations, native species plantations, and production native forests (that is, those forests available for multiple use management including timber production) were collated and divided into the expenditure for that category to give an estimate of research expenditure per hectare.

The actual expenditure (unadjusted for inflation) on all categories increased from 1981/82 to 1994/95 and then declined in 2001/02. Expenditure on exotic species plantations increased from \$14.2/ha in 1981/82 to \$22.2/ha in 1994/95 but decreased to \$18.76/ha in 2001/02. Actual expenditure on native species plantations increased from \$6.98/ha in 1981/82 to \$27.5/ha in 1994/95 and decreased to \$23.2/ha in 2001/02. There was a significant area of native species plantations in 1981/82 as in that period, the *Araucaria* plantations were included in addition to *Eucalyptus*. In terms of expenditure (adjusted for the CPI), there was a decline in most categories from 1981/82 to 2001/02 with the notable exception of research on native species plantations for which there was an increasing trend to 1994/95 but a decrease in 2001/02 which is attributed to the relatively large extension of the plantation estate in the past decade. Expenditure on research in native forests was in the range of \$0.6/ha to \$1.0/ha and when environment was included, this increased to \$1.79/ha in 2001/02.

**Table 5.** Expenditure in terms of dollars per managed hectare for each category. Both actual (based on dollars in the time period) and adjusted (adjusted for inflation according to the CPI) estimates are shown.

Category		<u>1981/82</u> <sup>1</sup> (\$/ha)	<u>1985/86</u> <sup>2</sup> (\$/ha)	<u>1989/90</u> <sup>3</sup> (\$/ha)	<u>1994/95</u> <sup>4</sup> (\$/ha)	<u>2001/02</u> <sup>5</sup> (\$/ha)
Exotic species plantations	Actual	14.22	16.49	21.44	22.19	18.76
	CPI Adjusted	35.41	30.50	29.15	27.51	18.76
Native species plantations	Actual	6.98	12.09	15.11	27.51	23.20
	CPI Adjusted	17.38	22.37	20.55	32.74	23.20
Native forests	Actual	0.56	0.68	0.80	0.96	0.77
	CPI Adjusted	1.39	1.26	1.09	1.15	0.77
Environment	Actual	0.73	0.94	1.14	1.31	1.02
	CPI Adjusted	1.82	1.73	1.55	1.56	1.02
Surveys (including monitoring)	Actual	0.03	0.05	0.11	0.19	0.33
	CPI Adjusted	0.08	0.09	0.15	0.24	0.33

<sup>1</sup> Standing Committee on Forestry (1982)

<sup>2</sup> Quick and Booth (1987)

<sup>3</sup> Lambert and Turner (1992)

<sup>4</sup> Turner and Lambert (1997)

<sup>5</sup> Present study

- **Forest Products Research**

Analysis of expenditure (unadjusted for inflation) on forest products research (Table 6) indicated that the total had increased from \$14.30 million in 1981/82 to \$19.73 million in 2001/02. The total expenditure (adjusted for the CPI) was \$35.63 million in 1981/82 and this decreased to \$19.73 million in 2001/02. Effectively this was a 44.6% decrease. In 1981/82, companies undertook the largest proportion of research (49.7%) followed by the Commonwealth sector (38.2%). By 2001/02 the Commonwealth sector represented 46.3% of expenditure and Companies represented 34.6%.

**Table 6.** Summary of expenditure on forest products research (million \$ unadjusted for inflation) between 1981/82 and 2001/02.

Sector	1981/82 <sup>1</sup>		1985/86 <sup>2</sup>		1989/90 <sup>3</sup>		1994/95 <sup>4</sup>		2001/02 <sup>5</sup>	
	(\$)	(%)	(\$)	(%)	(\$)	(%)	(\$)	(%)	(\$)	(%)
Commonwealth	5.46	38.2	5.85	38.5	6.18	34.9	9.47	47.2	9.13	46.3
Companies	7.11	49.7	7.39	48.6	9.11	51.5	7.85	39.1	6.82	34.6
State agencies	1.27	8.9	1.41	9.3	1.77	10.0	2.16	10.8	1.41	7.1
Universities	0.46	3.2	0.56	3.7	0.63	3.6	0.59	2.9	2.37	12.0
Total	14.30		15.21		17.69		20.07		19.73	
Annual change (%)*		1.6		4.1		2.7		- 0.7		
Total CPI adjusted	35.63		28.13		24.06		23.88		19.73	
\$/tonne harvested (unadjusted)	0.72		0.77		0.81		0.81		0.81	
\$/tonne harvested (adjusted by CPI)	1.80		1.42		1.11		0.96		0.81	

<sup>1</sup> Standing Committee on Forestry (1982)

<sup>2</sup> Quick and Booth (1987)

<sup>3</sup> Lambert and Turner (1992)

<sup>4</sup> Turner and Lambert (1997)

<sup>5</sup> Present study

\* Annual change between two periods

The expenditure on forest products research was assessed in relation to the quantity of wood harvested (\$/tonne). In terms of direct expenditure (unadjusted for inflation), there was limited variation over the period of study (from \$0.72/tonne in 1981/82 to \$0.81/tonne in 2001/02). In terms of expenditure adjusted by the CPI, there has been a decline from \$1.80/tonne in 1981/82 to \$0.81/tonne in 2001/02.

• **Outputs and Costs of Scientific Publications**

In general, the total number of publications on forest research increased in the period from 1982 to 2002 (Table 7). Using the data for total expenditure on forest or forest products research, we calculated the cost per publication. This represents the investment in research to produce a publication (essentially, the total of the average amount of field or experimental work, analyses, production, etc) and in the case of a forest research publication, was about \$221,830 in 2002. The number of referred publications on forest products research has decreased in total from 82 per year in 1981/82 to 62 per year in 2001/02. Using an evaluation similar to that for forest research, we determined that the investment in research for a publication in forest products equated to about \$318,220.

**Table 7.** *Estimated number of scientific publications produced by the main forest research organisations in Australia in selected years together with the index of \$ per publication based on indexed figures of total expenditure on research.*

<b>Category</b>	<b>1982</b>	<b>1986</b>	<b>1990</b>	<b>1995</b>	<b>2002</b>
Refereed forest research	117	108	127	155	142
Unrefereed forest research	71	47	55	77	85
Total forest research	188	155	182	232	227
\$/Publication	129,370	200,680	215,710	199,320	221,830
Refereed forest products	45	44	56	36	37
Unrefereed forest products	37	48	31	29	25
Total forest products	82	92	87	65	62
\$/Publication	174,430	165,280	203,330	308,770	318,220

The assessment of sources of publications was intended to be consistent over all the years but not exhaustive. That means that if new, very productive sources of publications developed over the period it would have impacts on fiscal outcomes. The unit of \$/publication does not imply a direct cost of a publication but includes all research costs related to the project in the year assessed. There appears to be a steady increasing output in forestry research and a decrease in forest products. The efficiency of undertaking research needs to be evaluated in relation to these figures and also the alternative ways of disseminating research (for example, the decline in forest products publications may be related to increases in the number of confidential client reports).

## ***Discussion***

Analyses of expenditure on forest and forest products research have been undertaken over the period 1981/82 to 2001/02. The 1981/82 estimates were based on submissions to the then Standing Committee on Forestry (1982) and formed the basis for Quick and Booth (1987) undertaking a more comprehensive analysis, a major objective of that assessment being to identify categories of research. The definition of research is always subject to some interpretation, but the objective has been to assess the actual effort expended on research excluding surveys, assessments and research management.

During the period of the study (from 1981 to 2002), a number of changes have taken place within the forest industry and they have directly affected the research effort and the resources to which the research is applied. Key changes in the industry include:

- Continuing expansion of softwood and hardwood plantations for wood supply and reductions in native forests for harvesting. As a result, there is an increased focus on inputs rather than outputs.
- A reduced rate of planting of exotic conifers but an increased emphasis on native hardwood plantations.
- Investment companies taking a greater role in the establishment of plantations, especially with regard to hardwood plantations.
- Significant mergers and acquisitions of plantation companies.
- Changes in the available land planting base, including changes from primarily planting on previous forest sites to planting on pasture sites and second rotation areas (Turner 1998).
- Changes from State-managed plantations to corporatised structures or sale of State-managed plantations to companies.
- Greater competition from alternative products.
- Processes such as the development of Regional Forest Agreements and the Montreal Process leading to resources being moved from research to survey, monitoring and assessment.
- A move to certification with increased emphasis on survey and monitoring activities.
- Greater use of technology to obtain information and increased reliance on the Information Technology sector.
- Greater pressure on Companies in terms of land use allocations and restrictions on land use.

- Greater internationalisation in terms of ownership of the industry.

At the same time, changes occurring in R&D have included:

- The establishment of CRCs which incorporate the expertise and resources of CSIRO, Universities, Companies and other research organisations. This has led to additional Commonwealth funds being made available (beyond direct funding), however, it may have also been accompanied by an overall decrease in expenditure by companies.
- The demise of some organizations, such as the Timber Advisory Council in NSW, that previously supported research
- The establishment of the FWPRDC that resulted in increased inputs from Government to match funds levied from industry. The levy paid by Companies may be the ceiling for research expenditure by many companies.
- Increase in the number of Universities with interests in forest and forest products research leading to a diversity in research programs.
- Commonwealth and State forest research organisations being re-structured. This has usually led to an overall reduction in the spread and depth of competencies and capabilities.
- Increased commercial focus of research organisations.

Forest research over the period from 1981/82 to 2001/02 increased (in unadjusted dollars) from a total of \$24.32 million per year to \$50.51 million per year. During that period, there has been an increase in the expenditure on forest surveys and also on research management. The Australian Bureau of Statistics (2003a) reported that the total expenditure in Australia on applied research in 2000/01 in the category of *“Agricultural, veterinary and environmental sciences”* was \$587.8 million. By comparison, the total expenditure of \$50.51 million on forest research was 8.6% of that total.

Expenditure on forest products research in 2001/02 was estimated as \$19.739 million and when management overheads were included, this was about \$24.90 million. This is comparable with the labour costs of \$25.29 million reported by the Australian Bureau of Statistics (ABS 2003b). However, that report also included a further \$52.86 million which is considered to be related to mill runs and related material costs, and these were specifically not included in the current estimates.

Cooperative Research Centres now undertake an increased proportion of the research. Few companies appear to undertake significant levels of research in addition to that undertaken through CRCs, and hence the Boards of CRCs and industry-led Boards have significant influence on research directions. The FWPRDC allocated \$7.1 million for research on forestry and forest products in 2001/02 and this was 10.1% of total forest and forest products expenditure (\$70.235 million). When the participants were included, the FWPRDC influences more than 20% of annual research (total of forest and forest products) expenditure.

The changes that have taken place within the forest industry historically represent rapid changes in the nature of the resource and the requirements for management, and this suggests an increasing requirement for research to ensure continued improvement in all aspects of the industry. However expenditure, especially by the various forest management organisations, is in fact declining in real terms. Overall, there appears to be a lower recognition of the importance of investing in continued research in forests and forest industries. Development of CRCs has moved the responsibility of research from forest growers and processors to a third party.

Sutton (1986) recognised three forms of research orientation and reported that the most likely source of initiation for problem, service and innovative research was from management, management or scientist, and scientist respectively, and the level of management acceptance was in the same order:

- **Problem** (Research into relatively easily-defined problems).
- **Service** (Research designed to help management do their job better).
- **Innovative** (Research into new ways and systems).

He indicated that the highest level of risk is in innovative research but this also has the potential for greatest returns. While not demonstrable in the data, anecdotal evidence suggest there has been a trend away from significant interest in innovative research to a preponderance of 'problem oriented research' with low risk and modest potential returns.

- **Comparison with other Countries**

General estimates of research expenditure in New Zealand in 2001/02 (direct expenditure not adjusted for inflation) were obtained from the New Zealand Forest Industries Council (2002) for the wood-fibre based research, excluding market research, from private and government funding sources. The combined estimate (industry plus government) was about NZ\$62.3 million of which NZ\$34.8 million (56%) was from the industry. This industry component has increased over the last three years although not to the level in 1997/98. About NZ\$33.6 million was spent on post-harvest forest products research and this equated to about NZ\$1.56/m<sup>3</sup> harvested. This has been declining since the previous surveys (Lambert and Turner 1992, Turner and Lambert 1997) from NZ\$2.50/m<sup>3</sup> in 1989/90 and NZ\$1.98/m<sup>3</sup> in 1994/95. A total of NZ\$28.65 million was spent in 20001/02 on tree improvement and management of forests (including indigenous forests). When research expenditure on indigenous forests was separated out, about NZ\$17.64/ha was spent on planted forests. This is comparable with the A\$18.76/ha on Australian exotic plantations but lower than the A\$23.20/ha on native species plantations.

The US Forest Service regularly monitors and reports on the resources it applies to research (Guldin 2002) (Table 8). Their analysis did not include research resources from other organisations such as Companies and Universities. In the period from 1982 to 2000, the actual research appropriation increased by 80% to more than US\$200 million while in terms of a constant baseline (1985), the increase was 0.2% overall (Giese 1988). From 1985 to 2000, the number of research staff declined by 44% and there were additional re-adjustments within the staff categories. For example, the number of foresters declined from 350 in 1985 to 140 in 2000 while the number of ecologists increased from 9 to 55 in the same period. The data indicated that the number of scientific publications by the US Forest Service (comparable with the categories used for assessing publication outputs in Australia) increased from 1,909 in 1982 to 3,021 in 1995, representing an increase in output by researchers of about 2.33 publications per researcher in 1985 to 4.98 respectively in 1995. The input to research per managed hectare of forest in actual terms increased from US\$0.38/ha in 1982 to US\$0.69/ha in 2000 but there was no change when expenditure adjusted for inflation.

The data for the US Forest Service indicate a decline in resources for research and this parallels the situation in Australia. Simultaneously, there has been a shift in emphasis in the discipline areas. The reported costs of research management/administration have declined from the equivalent of 10.0% of research costs in 1982 to 6% equivalent in 2000, while in Australia the reverse is the situation. Considering the output of publications in relation to research expenditure, the relative cost per publication was about US\$65,310 while in Australia, the expenditure was four times this in relative dollar terms. There are some difficulties in using the number of publications produced and the costs of publications as a productivity index, especially as a comparison between organisations, however, it provides a basis for analysis of potential changes.

**Table 8.** Resources (expenditure in US\$ unadjusted for inflation) applied by the US Forest Service to forest and forest products research (Guldin 2002). Appropriations do not include management and administration. The scientific refereed papers were listed as accomplishments and covered all categories of research.

	1982	1985	1990	1995	2000
<b>Appropriation (US\$ million)</b>					
Actual	112.1	121.7	144.7	197.3	202.5
Annual change (%)	2.8	3.8	7.3	0.53	
Constant baseline (1985)	126.8	121.7	121.1	140.4	127.1
Annual change (%)	-1.3	-0.1	3.2	-1.89	
<b>Total Number of Researchers</b>					
		985	726	607	549
Number of publications	1,909	2,299	2,165	3,021	
Publications/researcher		2.33	2.98	4.98	
Publication value	58,722	52,936	66,836	65,310	
Managed area (million ha)	292	292	293	293	295
Research US\$/ha (actual)	0.38	0.42	0.49	0.67	0.69
Research US\$/ha (CPI adjusted)	0.43	0.42	0.41	0.48	0.43

The Australian Forest and Wood Products Statistics produced by the Australian Bureau of Agricultural Research economics (ABARE) provide estimates of the gross value of turnover by the forest industries and the gross value of forest production as an indicator of the forestry component. The estimates for the forest industries were based on wood and wood products and did not include paper and paper products. The forestry component was divided into native forests (including the environment component), native species plantations and coniferous plantations. In the case of forest products, data are available for the forest industries for the periods of 1994/95 and 2001/02, and for 2001/02 in the case of forest production (Table 9). The estimates of research expenditure in the present study were compared with the turnover estimates to give an indication of the proportional expenditure in these sectors. The percentage of research compared with the industry turnover in 1994/95 in the forest products sector was 0.31% but this had declined to 0.28% in 2000/01 despite a growth in the industry. Expenditure on research in native forests (including environment), native species plantations and coniferous species (compared with gross forest production) was 3.29%, 30.0% and 2.27% respectively. Compared with the total gross value of forest production, total research was 3.76%.

**Table 9.** Research expenditure in relation estimates of industry turnover (based on ABARE Australian Forest and Wood Products Statistics for March-June Quarter 2003).

<i>Period</i>	<i>Industry Sector</i>				
	<i>Forest Products</i>	<i>Forest Production</i>			
		<i>Native forests (including environment)</i>	<i>Native species plantations</i>	<i>Exotic species plantations</i>	<i>Total</i>
<b>1994/95</b>					
- Industry turnover (m\$)	6408				
- Research (m\$)	20.07				
- Research/turnover (%)	0.31				
<b>2000/01</b>					
- Industry turnover (m\$)	7126				
- Research (m\$)	19.72				
- Research/turnover (%)	0.28				
<b>2001/02</b>					
- Estimated gross value of forest production		515.5	52.8	775.8	1344.1
- Research		16.97	15.86	17.68	50.51
- Research/Turnover (%)		3.29	30.0	2.27	3.76

## **Conclusions**

- Expenditure on forest research over the past 20 years, has increased (unadjusted for inflation) from \$24.32 million to \$50.51 million. When considered in terms of CPI-adjusted expenditure, resources applied to forest research have declined from 1981/82 to 2000/01.
- The distribution of research expenditure across research categories has changed, with a greater emphasis in recent years on native species plantations. Resources for surveys (including monitoring) have increased at the expense of those for research.
- A larger proportion of overall expenditure has been devoted in recent years to research management/ administration. When the total expenditure on research, surveys and their related management is considered, a lower proportion has been expended on scientific research.
- The distribution of expenditure by organisations undertaking research (Commonwealth, State agencies, Companies, Universities) has changed with a lower proportion of expenditure being undertaken by State agencies and companies. There is an indication that for many companies, research investment is largely limited to that undertaken by CRCs and projects sponsored by the FWPRDC. This may be interpreted as the private sector relying on its levies and CRC contributions to support R&D.
- Forest products research expenditure was \$19.73 million in 2001/02, an increase in unadjusted terms, from \$14.30 million in 1982. However, in CPI-adjusted terms there has been over a 40% decrease over the period. The expenditure on research per harvested cubic metre of timber increased from \$0.72/tonne to \$0.81/tonne over the period, but declined from \$1.80 to \$0.81 in CPI adjusted terms.
- Expenditure by the FWPRDC was \$7.1 million in 2001/02 and this represented about 10% of total expenditure on forest and forest products research in Australia. When leverage was considered, FWPRDC is providing its stakeholder input to more than 20% of forest industries research in Australia.
- Some categories of research have become focused in specific organisations (for example, in CRCs) and there appears to have been a shift to categories with low risk (and relatively small potential return) such as surveys and support for programs such as RFA assessments. The support base for innovative research has declined.
- There is no objective and proven method to establish the level of research that should be undertaken at State and national levels. However, we believe the results from the present survey when viewed in both absolute and historical terms sound alarm bells for the forest industry. There is little doubt that the industry is rapidly being exposed to increased scrutiny in terms of its sustainability, competition from substitutes, in terms of trade, and the effects of

improvements in technology. The underpinning science will be fundamental to such important considerations and future industry development. The level of funding available to CRCs and FWPRDC and kindred RDCs (for example, RIRDC, LWRDC) will provide a strategic base but must not be solely relied upon to ensure the industry reaches its full potential from State, national and global perspectives.

## ***Acknowledgments***

The authors are grateful for the assistance provided by the Forest and Wood Products Research and Development Corporation. We wish to thank Dr Glen Kile and unknown reviewers for comments on a draft of this report. We also thank Dr David Flinn of David Flinn Consulting Services for valuable discussions at the commencement of the review and for his valuable comments on earlier drafts. The following cooperating organisations provided valuable information and assistance all of which is gratefully acknowledged: Australian Bureau of Agricultural and Resource Economics; Plywood Association of Australasia; ACT Forests; Auspine Ltd; Australian National University; Australian Paper; Boral Ltd; Bureau of Rural Sciences; Carter Holt Harvey Ltd; CSIRO Forestry and Forest Products; CSIRO Land and Water; CSIRO Sustainable Ecosystems; CSIRO Plant Industry; CSIRO Molecular Science; CSIRO Manufacturing and Infrastructure Technology; CSIRO Entomology; CRC for Catchment Hydrology; CRC for Sustainable Production Forestry ; CRC for Functional Communication Surfaces; CRC Wood Innovations; CRC for Greenhouse Accounting; CRC for Plant Based Management of Dryland Salinity; Queensland Department of Primary Industry & Environment; ForestrySA ; Forest Enterprises Group; Forestry Tasmania; Great Southern Plantations; Gunns Plantation Limited; Hancock Victorian Plantations P/L; Harris-Daishowa (Aust) P/L; Hyne & Son P/L; Integrated Tree Cropping Ltd; Monash University; Murdoch University; Norske Skog (Australasia) P/L; Department of Natural Resources Darwin; PaperlinX; Southern Cross University; Southern Tree Breeding Association; State Forests of NSW; Sydney University; Sylvatech Australia P/L; Timbercorp Australia Ltd; Treecorp; University of Melbourne; University of New South Wales; University of Queensland; University of Tasmania; University of Technology; University of Western Australia; Victoria Department of Natural Resources & Environment; Visy Industries; Western Australia Department of Conservation & Land Management; Weyerhaeuser Australia P/L; Willmott Forests Ltd; Wollongong University; Yates Ltd.

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