Market Access

A meta-analysis of Benefit-Cost-Assessments for Australian forest and wood products RD&E investments

Project number: PRE495-1920

April 2020

Forest & Wood Products Australia

A meta-analysis of Benefit-Cost-Assessments for Australian forest and wood products RD&E investments

Prepared for

Forest & Wood Products Australia

by

Hardaker, T. & Chudleigh, P

Project No: PRE495-1920

IMPORTANT NOTICE

This work is supported by funding provided to FWPA by the Department of Agriculture and Water Resources (DAWR).

ISBN: 978-1-920883-97-3

Researchers:

Hardaker, T. & Chudleigh, P

Agtrans Research

Contents

Executive Summary

Over the past 15 years, Forest and Wood Products Australia Limited (FWPA) and other Australian research organisations and funding bodies, have funded a wide range of RD&E for the benefit of the forest and wood products industry. To assist FWPA and the Australian Forest Products Association to communicate the benefits of ongoing investment in RD&E to stakeholders and funding partners (including government), FWPA contracted Agtrans Research to assemble a detailed meta-analysis of BCAs of RD&E investment undertaken within the forestry and wood processing industry over the past 15 years.

Data from 36 BCAs conducted on such forestry RD&E investments over the past 15 years were assessed and aggregated for the 2019 FWPA BCA meta-analysis. The analysis found that investment in collaborative forestry research has produced significant benefits for the Australian forest and wood products industry and the Australian economy with positive BCRs ranging from 1.2 to 69.50 to 1 and an estimated aggregate NPV of $645.18 million (2018/19 dollar terms). Though the sample of BCAs for each industry investment area was small, results reported in the BCAs indicated that investments in the wood processing and manufacturing area (6 projects) have performed best with a simple average BCR of 15.0 to 1.

Aggregate investment criteria were estimated indirectly, derived from the nominal RD&E investment costs and NPVs reported in each BCA. The aggregate weighted average BCR for all 36 BCAs was estimated to be 5.1 to 1. The result is positive and in line with performance results reported across all 15 Australian Rural RDCs where an estimated, aggregate BCR of 5.5 to 1 was reported in 2019.

Comparison of individual BCA results, and interpretation of aggregate results from the meta-analysis should be made with caution because of the small sample size, and the range of evaluation methodologies used. However, the overall results indicate the positive value of ongoing investment in forestry RD&E and should provide confidence to industry, government and other forest and wood product stakeholders and funding partners.

1. Introduction

Forest and Wood Products Australia Limited (FWPA) was established in 2007 under the Commonwealth's Forestry Marketing and Research and Development Services Act 2007 and is the rural Research and Development Corporation (RDC) for the Australian forest and wood products industry (GHD, 2017). FWPA is a not-for-profit company that provides national, integrated research and development (R&D) services. The company facilitates collaboration between government and industry, within industry, and across Australian rural industries (FWPA, 2019).

Over the past 15 years, FWPA (and its forerunner, the Forest and Wood Products RDC) and other Australian research organisations and funding bodies, such as CSIRO, universities and various state government departments, have funded a wide range of research, development and extension (RD&E) activities for the forest and wood products industry. The aim of the research has largely been to improve the productivity, profitability and sustainability of Australia's forest and wood products industry.

FWPA has regularly commissioned analyses of its investments to assess and communicate the performance of its RD&E investments. Such analyses have been in the form of benefit-cost analyses (BCAs), economic evaluations and/or impact assessments. Other forest and wood product RD&E funding bodies have also undertaken similar analyses over the past 15 years.

To assist FWPA and the Australian Forest Products Association[1] (AFPA) to reinforce the benefits of ongoing investment in RD&E to stakeholders and funding partners (including government), FWPA contracted Agtrans Research to assemble a detailed meta-analysis of BCAs of RD&E investment undertaken within the forestry and wood processing industry over the past 15 years. The purpose of the meta-analysis was to estimate and present an aggregate return on investment in collaborative RD&E associated with the forest and wood products industry.

Project Objectives

The specific objectives of the 2019 FWPA BCA meta-analysis project were to:

1. Review and report on known BCAs for forest and wood industry research projects/ programs over the past 15 years.
2. Identify and report key differences in the methodologies used across the known BCAs included in the analysis.
3. Aggregate the individual BCAs to estimate and report the overall return to industry investment in RD&E and, where possible, summarise investment performance over time.
4. Where possible, estimate and report returns to investment for the following industry investment areas:
    1) Forest to mill door,
    2) Wood processing and manufacturing, and
    3) Timber in service (growing, processing and market).
5. Provide FWPA with a final report describing the meta-analysis method, BCAs included, and results.

---

[1] The AFPA is the peak national industry body representing the resources, processing, and pulp, paper and bioproduct industries covering the forest products value chain. For more information see: https://ausfpa.com.au/about/

2. Method

The principal challenge of the 2019 FWPA CBA meta-analysis was to analyse and aggregate the various individual assessments/ evaluations/ BCAs that have been carried out by different analysts that may have involved variations in approaches and protocols.

The analysis followed the following steps:

1. **Identification of relevant forestry RD&E BCA reports**

In July 2019, Chris Lafferty (R&D Manager, FWPA) contacted a range of forest and wood product RD&E organisations by phone and email to request permission to use any available past RD&E BCAs in the FWPA meta-analysis. The organisations included:
- Sustainable Timber Tasmania
- The Department of Agriculture and Fisheries Queensland
- The Forestry Corporation of New South Wales
- The Department of Primary Industries, New South Wales
- The University of Tasmania
- CSIRO
- Sylva Systems Pty Ltd
- AFPA

Organisations that had relevant BCA reports, and granted permission to use such reports in the meta-analysis, then provided digital copies of the report documents to FWPA. Twelve reports containing 43 individual investment analyses were identified and submitted to Agtrans Research for potential inclusion in the 2019 FWPA BCA meta-analysis (see Appendix 1). The reports submitted spanned a period from 2006/07 to 2018/19 and were conducted by four, independent analyst/consultant organisations.

2. **Familiarisation with BCA report documentation and confirmation of BCAs for inclusion in the meta-analysis**

After documentation for all 12 BCA reports had been submitted to Agtrans Research, the meta-analysis team reviewed each of the 43 analyses to become familiar with the range of techniques used and the results reported. A discussion was then held with FWPA personnel to confirm a final list of BCAs for potential inclusion in the 2019 FWPA BCA meta-analysis.

Of the 43 individual analyses, only two were eliminated at this preliminary stage. The two BCAs were ex-ante evaluations conducted by FWPA in 2012. This left 41 individual BCAs for potential inclusion in the meta-analysis.

3. **Data collection (including methodological differences)**

A data entry template was developed to record key data from each of the 41 BCAs. The template included provision to capture data for the following areas:
- Title of the RD&E investment evaluated
- Project code (where applicable)
- The analyst/consultant/organisation that completed the analysis
- The year the analysis report was submitted (financial year)
- Total nominal investment (cash and in-kind)
- FWPA nominal investment (where applicable)

- Investment period (start and end dates for each investment – financial years)
- Investment criteria[2] including the present value of benefits (PVB), present value of costs (PVC), net present value (NPV), benefit-cost ratio (BCR), internal rate of return (IRR), and modified IRR (MIRR) (where available)
- The discount rate used
- The real dollar terms used
- Investment criteria (as listed above) for specific forestry RD&E investment areas such as forest to mill door, wood processing and manufacturing, and timber in service (growing, processing and market) (where applicable)

Each of the 41 individual BCA reports then was studied and data entered in the template as appropriate. Further, during the data capture process, the meta-analysis team recorded information about the particular methods and processes used within each individual BCA for later comparison.

4. Data clean up

The raw data collected from each of the 41 individual BCAs were collated and cleaned in preparation for aggregation and analysis. Through this process, a further four individual BCAs were identified that were then excluded from the 2019 FWPA BCA meta-analysis because they did not report any quantitative results (i.e. no benefits were estimated, thus no NPV or BCR was reported). This left 37 individual BCAs for aggregation and analysis, a description of the BCAs included in the meta-analysis can be found in Section 3.

5. Consultation with FWPA personnel to identify key RD&E investment areas

In order to estimate and report findings for particular industry investment areas (forest to mill door, wood processing and manufacturing, and timber in service (growing, processing and market)) Agtrans Research consulted with FWPA personnel to identify the investments across the 37 BCAs that could be attributed to each investment area.

Twenty-five of the 37 BCAs included in the meta-analysis were identified as having FWPA project codes and were subsequently allocated to one of the three key industry investment areas described previously (see Appendix 2).

Through the consultation process, FWPA identified one BCA as an outlier. Project PNC135-0809 (Active genetic conservation and utilisation of native radiata pine germplasm) was evaluated by Sylva Systems Pty Ltd in 2018/19 and reported an estimated BCR of 429.0 to 1 and an NPV of $373.0 million. As the scale of benefits reported was likely to skew the aggregate results for the current meta-analysis, FWPA elected to exclude the PNC135-0809 BCA from the aggregate analysis (see Appendix 3, Item 11, for further details). Thus, 36 BCAs were included in the final meta-analysis.

---

[2] For further explanation of the economic terms, please refer to the Glossary of Economic Terms at the end of this report.

6. Aggregation and analysis

Data collected from the 36 BCAs were assessed and, where possible, key investment criteria (such as the BCR and/or NPV) were updated to current, real dollar terms and then aggregated.

7. Report findings

Results of the meta-analysis, including the range of individual BCA investment criteria and estimated aggregate investment criteria, were summarised and reported.

3. Summary of BCAs Included in the Meta-analysis

Table 1 summarises the headline information for each of the 36 individual BCAs included in the 2019 FWPA BCA meta-analysis.

Table 1: BCA Summary Information[a]

Analyst/ Consultant	BCA Report Title	Title/ Name of RD&E Investment(s) Analysed	Date Report Submitted
Agtrans Research & eSYS Development Pty Ltd	Evaluation of Benefits Delivered from FWPRDC Sponsored R&D Projects PR07.5058	[1] Development of the Australian Forestry Standard (8 projects)	May 2007
		[2] Development of New Design Properties for Radiata Pine (10 projects)	
		[3] Evaluation of Investment in Pine Breeding Projects (7 projects)	
		[4] Reassessment of Lyctid Susceptible Sapwood and Methods of Control (PN03.1313)	
		[5] The Development of NDE Technologies for Use in the Hardwood Sawmilling Industry (P03.1317)	
		[6] Best Practice Timber Drying Compendium (PN01.1307)	
	Economic assessment of Selected Investments of the Cooperative Research Centre for Forestry	[7] Improved forest inventory through high resolution remote sensing (subproject 1.1.3, program 1)	Dec 2008
		[8] Association genetics for solid-wood properties: Eucalyptus globulus and E. nitens (subproject 2.1.2, program 2)	

		[9] Silviculture-processing studies on Eucalyptus nitens and E. globulus (subproject 2.3.1, program 2)		
		[10] Optimised log merchandising with mechanical harvesters (program 3)		
		[11] Evaluation of electric/diesel hybrid technology on a converted 6x6 truck (program 3)		
		[12] Identification and adaptation of leading technology for tracking and management of Australian forest operations (program 3)		
		[13] Trees in the landscape (program 4 - whole program)		
URS Australia Pty Ltd	FWPA R&D Program Evaluation	[14] Fertiliser usage in forestry: current status and prospects for increasing its efficiency and profitability (PRC072-0708)	Jun 2010	
		[15] TREEPLAN, MATEPLAN AND SEEDPLAN genetic programs (PN03.1915 & PN07.4025)		
		[16] Moisture correction factors (PN04.2002 & PN07.2045)		
		[17] Wood quality initiative (PN04.2004)		
		[18] Assessing the performance of wood poles exposed to bushfires (PNA014-0708)		
		[19] Strategy for large span second storey timber and wood products (PNA020-0809)		

	Benefit cost analysis of selected projects within the FWPA R&D program (2011)	[20] Managing sub-tropical exotic pine plantations for improved wood production (PNC057-0809)	Feb 2012
		[21] Screening of commercial forestry species for myrtle rust (PRC179-0910)	
		[22] MOE and MOR assessment technologies for improving graded recovery of exotic pines in Australia (PNB040-0708)	
		[23] Comparison of face bond quality tests for structural glulam (PN06.2029)	
		[24] Pine timber roof environments in WA and its susceptibility to EHB (PNA023-0809)	
eSYS Development Pty Ltd	Cost-Benefit Analysis of Three Selected FWPA Projects: On board computers, formaldehyde testing of wood panels and vineyard post treatment	[25] Development of a selection and implementation guide for the use of onboard systems for Australian forest operations	Apr 2013
		[26] Five-year inspection of preservative treated vineyard posts	
		[27] Measurement of formaldehyde and other VOC emissions from wood panels using the 1M3 chamber and desiccator test methods	
	Cost-Benefit Analysis of Three Selected FWPA Projects: Contemporary sound and fire rated timber, industry standards for recycled timber and utility of molecular breeding	[28] Contemporary sound and fire rated timber framed construction practices for low rise building	Apr 2014
		[29] Industry standard recycled timber - visually graded recycled decorative products	

		[30] Utility of molecular breeding in forestry	
Agtrans Research	Economic assessment of six research, development and extension investments by the Department of Agriculture and Fisheries (Queensland)	[31] Managing Risks Associated with Range Expansion of Sirex Wood Wasp	Aug 2018
		[32] Protecting Queensland's timber resource from pest and disease incursions	
	Evaluation of research, development and extension investments by the collaborative partnership between the Department of Agriculture and Fisheries (Queensland) and the University of the Sunshine Coast	[33] Improving returns from Southern Pine plantations through innovative resource characterisation	Oct 2018
		[34] Biological control of galling insect pests of eucalypt plantations in the Mekong Region and the Biological Control of Eucalypt Pests Research Alliance (BiCEP)	
Sylva Systems Pty Ltd	FWPA Cost Benefit Analysis	[35] Evaluation of super-heated steam vacuum drying viability and development of a predictive drying model for four Australian hardwood species (PNB045-0809)	Jun 2019
	FWPA Cost Benefit Analysis	[36] Predictive relationships to assist fertiliser use decision-making in eucalypt plantations (PNC304-1213)	

(a)   Organised according to the financial year in which each report was submitted.

4. Summary of Different BCA Approaches

The 36 individual BCAs listed in Table 1 were obtained from 10 separate evaluation reports completed by four, independent analysts/consultants. The various methods used across the pool of analyses are described in Appendix 3. The following section briefly summarises the key similarities and differences between the evaluation approaches.

Similarities and Differences Between BCA Methods Used

Similarities

The 36 BCAs within the 10 evaluation reports selected for inclusion in the 2019 FWPA BCA meta-analysis all used conventional BCA frameworks that included describing the RD&E investments in terms of their total inputs, activities and outputs, outcomes and actual or potential impacts. Where impacts were quantified, this was achieved with respect to one or more counterfactual scenarios.

Almost all of the evaluations were conducted with some reference to the prevailing CRRDC or CRRDCC impact assessment guidelines (with the exception of the evaluations conducted in 2006/07 prior to the first publication of the formal guidelines, and the evaluations conducted in 2008/09 for the forestry CRC). Each of the evaluations reported results in real dollar terms and discounted benefit and cost cash flows using a 5% discount rate and reported the NPV and BCR investment criteria.

Key Differences

There were a number of key methodological differences that may affect comparison or aggregation of results across the 36 forestry BCAs recorded.

1. **Identification and treatment of costs**

Identifying and estimating the total costs associated with an investment and delivery of its impacts is an important component of any BCA. All costs, including cash and in-kind, initial investment, management and administration, adoption and implementation costs as well as unintended costs to external parties (e.g. externalities) should be taken into account.

Each of the 36 BCAs identified the nominal RD&E investment costs associated with each relevant RD&E project/program being assessed and all acknowledged implementation costs where appropriate. However, implementation costs were not estimated in all cases leading to total costs to be potentially understated. Also, only five of the 36 BCAs explicitly reported the inclusion and/or consideration of management, administration and/or extension costs.

A further complication was associated with the treatment of costs. In most BCA approaches all costs (initial investment, administration and management, and implementation/adoption costs) are treated as a whole and discounted to estimate the PVC. However, for the evaluation of RD&E investments it has become common to use only the initial RD&E investment (and associated management and administration costs) to estimate the PVC. Other costs associated with the investment's impacts (e.g. implementation/adoption costs) are subtracted from the gross benefits and therefore estimated as part of the net PVB. This method of reporting returns against only the RD&E investment costs is the preferred method under the current CRRDC Impact Assessment Guidelines (CRRDC, 2018).

None of the 36 BCAs reported the specifics of the PVC estimation method used. Analysis of the PVCs reported indicated that most of the BCAs did use the RD&E investment cost only method. However, in some cases it was apparent that other costs had been incorporated into the PVC. Further, many of the BCAs (13) did not report a PVC at all.

The treatment of costs impacts the BCR result (where additional costs are included in the PVC the BCR reported will be lower than if the PVC includes only the RD&E investment costs). However, the NPV ought to be unaffected by the treatment of costs.

2. Adjustment for real dollar terms

Each of the 36 BCAs estimated benefit and cost cash flows and reported results in real dollar terms. There are several methods for adjusting nominal dollars to real dollar terms. The most commonly used in the 36 BCAs were adjustments using the Australian CPI or the implicit price deflator for GDP. In some cases, the method of adjustment was not explicitly stated.

3. Benefit time horizons

The BCAs included in the meta-analysis were, in general, considered ex-post analyses. That is, the analyses were conducted after the primary RD&E investment had been completed. However, in some cases the assessments were conducted prior to completion of the initial investment. Further, for 26 of the 36 BCAs, the assessments took place only one to two years after the last year of the RD&E investments. As a result, each of the 36 BCAs estimated actual and/or prospective/expected benefits across various time horizons.

The most common benefit time horizon reported was 30 years from the last year of RD&E investment, in line with the CRRDC guidelines. However, given the nature of forestry RD&E some BCAs used time frames ranging from 20 years to 60 years. Also, some BCAs estimated benefits from the first year of RD&E investment where others estimated benefits from the last year of investment. Such differences are likely to affect the total PVB and therefore the NPV and BCR investment criteria reported.

4. Results reporting

There was very little consistency of reporting between the 10 evaluation reports submitted for the meta-analyses. Each analyst/consultant reported using a somewhat different report format and reported the methods and results differently. The following inconsistencies were noted:

- Some evaluations did not report the nominal investment by year
- The NPV and BCR were the only investment criteria consistently reported across all 36 BCAs. The PVB, PVC and internal rates of return were frequently not reported.
- Most reports did not explicitly report the year to which benefit and cost cash flows were discounted.
- Some reports failed to identify the method used to adjust nominal dollars to real dollar terms.

5. Other differences

In general, though similar BCA frameworks were used across all 36 BCAs (e.g. cash flow analysis, estimation of benefits against a counterfactual scenario, etc.) it is important to remember that each BCA relies on a unique set of valuation assumptions, different underlying datasets, and different counterfactual scenarios. Thus, any comparison between BCAs of RD&E investments, even where the investments may be associated or refer to a similar research area, should be made with some caution.

5. Meta-Analysis Results

Despite a relatively small sample size (36 BCAs) and a range of methods used across the analyses, the meta-analysis team was able to estimate results that may be useful to demonstrate the benefits of investment in forestry RD&E. The following sections describe the findings of the meta-analysis.

General Observations

Across the 36 BCAs, the nominal RD&E investment analysed ranged from $36,000 to $37.2 million and occurred between 1998/99 and 2017/18 (a period of 20 years). The evaluation reports were submitted between 2006/07 and 2018/19 and were completed by four, independent analysts/consultants. Seventeen of the 36 BCAs were randomly selected and 17 were specifically selected for evaluation. For two of the BCAs the selection method was not reported.

Reported Investment Criteria

All 36 BCAs reported results for the BCR and NPV in present value terms, discounted to a particular base year.

BCRs across the 36 BCAs ranged from 1.2 to 69.5 to 1. The simple average BCR was approximately 11.5. The NPVs across all 36 BCAs ranged from $0.04 million to $133.73 million. The simple average NPV was approximately $14.43 million.

Results Reported Over Time

Table 2 reports the simple, average NPV and BCR for the years in which the BCA evaluations were submitted. It is important to note that the results may not be representative of the actual performance of forestry RD&E investments over time as the investments evaluated cover a broad range of investment periods, were selected for evaluation using different methods, and were analysed using different methodologies by different analysts.

Table 2: Average Investment Criteria Reported Over Time

Year ended 30 June[a]	2007	2009	2010	2012	2013	2014	2019
Total, Nominal RD&E Investment Assessed ($m)	12.88	44.17	4.98	2.94	1.26	0.80	6.80
Average NPV ($m)	30.50	20.02	10.62	2.10	2.87	12.81	12.52
Average BCR	12.79	16.73	6.12	3.74	4.05	21.90	14.69
Number of BCAs Submitted (Total = 36)	6	7	6	5	3	3	6

(a) Year BCA report was submitted.

Results by Industry Investment Area

Of the 36 BCAs included in the meta-analysis, 24 were completed for FWPA project investments. Agtrans Research consulted with FWPA and, using the project codes for the 24 FWPA analyses, and allocated each of the investments to one of the following priority industry investment areas:

1) *Forest to mill door*: RD&E associated with breeding, plantation management (nutrition & silviculture), variety selection, pest and biosecurity surveillance/ activities, and felling, haulage and logistics. RD&E focused on sustainably providing resource availability, planning and the risk of supply (Jarrod Gooden, FWPA, pers. comm., 2019).
2) *Wood processing and manufacturing*: RD&E associated with the optimisation of processing and manufacture of forestry products and by-products/ waste. RD&E focused on assisting value chain optimisation (Jarrod Gooden, FWPA, pers. comm., 2019).
3) *Timber in service (growing, processing and market)*: RD&E associated with forest and wood products in the market (e.g. increasing market demand, marketing research, extension materials etc.). RD&E focused on best aligning products to market needs so as to grow the products in the market (Jarrod Gooden, FWPA, pers. comm., 2019).

Once the allocation was completed (see Appendix 2), the investment criteria for each investment area were assessed and reported. Table 3 summarises the results by investment area.

Table 3: Reported Investment Criteria by Key Industry Investment Area

Industry Investment Area	No. of BCAs	Total nominal investment ($m)	Simple Average NPV ($m)	Min. NPV ($m)	Max. NPV ($m)	Simple Average BCR	Min. BCR	Max. BCR
1) Forest to mill door	9	12.93	22.26	0.04	133.73	7.29	1.20	16.50
2) Wood processing and manufacturing	6	4.04	10.78	0.06	47.00	15.00	1.50	69.50
3) Timber in service	9	5.95	8.01	0.05	33.25	12.43	1.53	44.00

Though the sample of BCAs for each industry investment area was small, results reported in the BCAs indicated that investments in the wood processing and manufacturing area (6 projects) have performed best with a simple average BCR of 15.0 to 1.

Aggregate Results (Derived)

As each of the BCAs reported results in dollar terms relevant to the year the investment was analysed, it was prudent to attempt to update the results of the individual BCAs to current, 2018/19 real dollar terms so that the results could be better compared and potentially aggregated.

Net Present Value

The individual NPVs were updated to 2018/19 dollar terms using the implicit price deflator for GDP (Australian Bureau of Statistics, 2019). Once updated, the NPVs across the 36 BCAs ranged from $0.05 million to $184.34 million (present, 2018/19 dollar terms). The simple average NPV was $17.92 million.

The total, aggregate NPV across all 36 BCAs was estimated to be $645.18 million in present, 2018/19 dollar terms. This aggregate NPV resulted from a total, nominal RD&E investment of approximately $73.8 million.

This is a highly positive result, however the aggregate NPV should be interpreted with some caution as the results aggregated were sourced from BCAs that used a range of methods and were conducted by a number of different analysts.

Benefit-Cost Ratio

The BCR is the ratio of the present value of benefits (PVB) to the present value of costs (PVC). The BCRs reported across the 36 BCAs recorded for the meta-analyses used a number of different methods to adjust nominal to real dollar terms and often did not report the total PVB and PVC along with the investment criteria (BCR and NPV) reported. However, the total, nominal RD&E investment was reported for all 36 BCAs and, in most cases was reported by financial year.

To provide an estimate of the aggregate BCR, as well as the range of BCRs based on current, 2018/19 real dollar terms, the meta-analysis team reviewed the nominal investment cash flows for each BCA recorded and used this, in conjunction with the updated NPVs in 2018/19 dollar terms, to estimate the individual PVCs and PVBs for each of the BCAs.

The total nominal investment across all 36 BCAs was approximately $73.82 million. The investments spanned the period from 1998/99 to 2017/18. The raw nominal investment cost data from each investment analysed were entered into the data collection template (see Section 2 for a description of the data collection method and template). There were two evaluation reports (of ten) that did not report the nominal investment costs by financial year. The investment costs in these BCAs was handled in the following ways:

- 2010 URS BCAs: investments were randomly selected and included FWPA investment after April 2002 and were completed by July 2009. For each investment assessed the total, nominal investment was distributed evenly between 2002/03 and 2008/09.
- 2012 URS BCAs: the first and last financial year of the RD&E investment for each investment assessed were reported. The total nominal investment for each RD&E investment assessed was evenly distributed between the first and last year of investment reported.

Once entered in the data collection template the nominal investment costs were aggregated across all 36 RD&E investments and adjusted to 2018/19 dollar terms using the implicit price deflator for GDP. The total, aggregate investment in the 36 forestry RD&E investments was estimated to be $92.88 million in 2018/19 dollar terms.

The real, aggregate RD&E investment then was discounted to 2018/19 using a 5% discount rate to estimate the aggregate PVC for all 36 RD&E investments. Once the costs were discounted to take into account the time-value of money, the aggregate PVC for all 36 RD&E projects was estimated to be $159.02 million (real, present value terms).

Given that the net present value is defined as the total present value of benefits less the total present value of costs, the estimated, aggregate PVC was added to the estimated, aggregate NPV figure of $645.18 million. This gave a rough estimate of the total PVB across all 36 RD&E investments. The aggregate PVB was estimated at $804.20 million (real, present value terms). This, in turn gave an estimated, aggregate weighted average BCR of 5.06 to 1.

Results Summary

Table 4 summarises the suite of individual and aggregate BCA results estimated from the 2019 FWPA BCA meta-analysis.

Table 4: Summary of Key Results (36 BCAs)

Result/ Investment Criteria		Value		
		Minimum	Simple Average	Maximum
Reported				
Aggregate, nominal RD&E investment ($m)			73.82	
Total, nominal RD&E investment ($m)		0.04	2.05	37.16
NPV ($m)		0.04	14.43	133.73
BCR		1.20	11.54	69.50
Reported by Industry Investment Area (24 FWPA BCAs only)				
1) Forest to mill door	Total, nominal RD&E investment ($m)		12.93	
	NPV ($m)	0.04	22.26	133.73
	BCR	1.20	7.29	16.50
2) Wood processing and manufacturing	Total, nominal RD&E investment ($m)		4.04	
	NPV ($m)	0.06	10.78	47.00
	BCR	1.50	15.00	69.50
3) Timber in service	Total, nominal RD&E investment ($m)		5.95	
	NPV ($m)	0.05	8.01	33.25
	BCR	1.53	12.43	44.00
Derived[a]				
Aggregate, real RD&E investment ($m)			92.88	
Aggregate NPV ($m)			645.18	
Estimated Aggregate PVC ($m)			159.02	
Estimated Aggregate PVB ($m)			804.20	
Estimated Aggregate Weighted Average BCR			5.06	

(a)   All derived results are reported in real, 2018/19 dollar terms.

6. Conclusion

Over the past 15 years, FWPA and other Australian research organisations and funding bodies, have funded a wide range of RD&E for the benefit of the forest and wood products industry. BCAs conducted on such forestry RD&E investments over the past 15 years have demonstrated that investment in collaborative research has produced significant benefits for the Australian forest and wood products industry and the Australian economy with positive BCRs ranging from 1.2 to 69.5 to 1 and an estimated aggregate NPV of $645.18 million (2018/19 dollar terms). Though the sample of BCAs for each industry investment area was small, results reported in the BCAs indicated that investments in the wood processing and manufacturing area (6 projects) have performed best with a simple average BCR of 15.0 to 1.

Aggregate investment criteria were estimated indirectly, derived from the nominal RD&E investment costs and NPVs reported in each BCA. The aggregate weighted average BCR for all 36 BCAs was estimated to be 5.1 to 1. The result is positive and in line with performance results reported across all 15 Australian Rural RDCs where an estimated, aggregate BCR of 5.5 to 1 was reported in 2019.

Approximately half (17) of the BCAs compiled for the meta-analysis were randomly selected for evaluation, whereas the other half were specifically selected (17) or the selection method was not reported (2). Comparison of individual BCA results and interpretation of aggregate results from the meta-analysis, should be made with caution because of the small sample size, and the range of evaluation methodologies used. However, the positive results indicate the positive value of ongoing investment in forestry RD&E and should provide confidence to industry, government and other forest and wood product stakeholders and funding partners.

Glossary of Economic Terms

Benefit-cost analysis: A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.

Benefit-cost ratio: The ratio of the present value of investment benefits to the present value of investment costs.

Discounting: The process of relating the costs and benefits of an investment to a base year using a stated discount rate.

Internal rate of return: The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.

Investment criteria: Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.

Modified internal rate of return: The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).

Net present value: The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.

Present value of benefits: The discounted value of benefits.

Present value of costs: The discounted value of investment costs.

Acronyms & Abbreviations

AFPA	Australian Forest Products Association
BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
CPI	Consumer Price Index
CRRDC	Council of Rural Research and Development Corporations
CRRDCC	Council of Rural Research and Development Corporations Chairs
DAF	Department of Agriculture and Fisheries Queensland
FWPA	Forest and Wood Products Australia Limited
GDP	Gross Domestic Product
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
NPV	Net Present Value
PVB	Present Value of Benefits
PVC	Present Value of Costs
R&D	Research and Development
RD&E	Research, Development and Extension
RDC	Research and Development Corporation

References

Australian Bureau of Statistics. (2019, September 4). *5206.0 - Australian National Accounts: National Income, Expenditure and Product, Jun 2019*. Retrieved from Australian Bureau of Statistics: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5206.0Jun%202019?OpenDocument

Council of Rural Research and Development Corporations. (2018). *Cross-RDC Impact Assessment Program: Guidelines.* Canberra, ACT: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf

Forest and Wood Products Australia Limited. (2019). *Strategic Plan 2019-2024.* Melbourne, VIC: Forest and Wood Products Australia Limited. Retrieved from https://www.fwpa.com.au/images/corporatedocuments/2019/FWPA-Strategic-Plan-2019-2024.pdf

GHD. (2017). *Forest and Wood Products Australia Limited FWPA - Review of Performance.* Melbourne, VIC: Forest and Wood Products Australia Limited. Retrieved from https://www.fwpa.com.au/images/corporatedocuments/-_2017/FWPA_Performance_Review_Final_Report.pdf

McLeod, R. (2013). *Cost-Benefit Analysis of Three Selected FWPA Projects: On board computers, formaldehyde testing of wood panels and vineyard post treatment - April 2013.* Melbourne, VIC: Forest and Wood Products Australia Limited.

URS Pty Ltd. (2010). *Report: FWPA R&D Program Evaluation.* Melbourne, VIC: Forest and Wood Products Australia Limited.

Appendix

Appendix 1: Summary of Potential BCAs for Inclusion in the 2019 FWPA Meta-Analysis

No.	Analyst	BCA Title	Investments Analysed	Date Submitted
		Collected and Submitted by FWPA		
1	Agtrans Research & eSYS Development	Evaluation of Benefits Delivered from FWPRDC Sponsored R&D Projects PR07.5058	Development of the Australian Forestry Standard (8 projects)	May-07
2			Development of New Design Properties for Radiata Pine (10 projects)	
3			Evaluation of Investment in Pine Breeding Projects (7 projects)	
4			Reassessment of Lyctid Susceptible Sapwood and Methods of Control (PN03.1313)	
5			The Development of NDE Technologies for Use in the Hardwood Sawmilling Industry (P03.1317)	
6			Best Practice Timber Drying Compendium (PN01.1307)	
7	Ross McLeod	Cost-Benefit Analysis of Three Selected FWPA Projects: On board computers, formaldehyde	Development of a selection and implementation guide for the use of onboard systems for Australian forest operations	Apr-13

8		testing of wood panels and vineyard post treatment	Five-year inspection of preservative treated vineyard posts	
9			Measurement of formaldehyde and other VOC emissions from wood panels using the 1M3 chamber and desiccator test methods	
10		Cost-Benefit Analysis of Three Selected FWPA Projects: Contemporary sound and fire rated timber, industry standards for recycled timber and utility of molecular breeding	Contemporary sound and fire rated timber framed construction practices for low rise building	Apr-14
11			Industry standard recycled timber - visually graded recycled decorative products	
12			Utility of molecular breeding in forestry	
13	URS Australia Pty Ltd	FWPA R&D Program Evaluation	Fertiliser usage in forestry: current status and prospects for increasing its efficiency and profitability (PRC072-0708)	Jun-10
14			Genetic variation and improvement of *E. dunnii* and *E. pilularis* (PN04.3003 & PN06.3017)	
15			TREEPLAN, MATEPLAN AND SEEDPLAN genetic programs (PN03.1915 & PN07.4025)	
16			Moisture correction factors (PN04.2002 & PN07.2045)	
17			Acoustic wave velocity and kraft pulp yield (PNC053-0708)	
18			Wood quality initiative (PN04.2004)	

19			Assessing the performance of wood poles exposed to bushfires (PNA014-0708)	
20			Strategy for large span second storey timber and wood products (PNA020-0809)	
21			Enhancing the perception of timber as a suitable construction material in termite prone areas (PN03.1213)	
22		FWPA - Ex-ante BCA assessment of R&D proposals	[Ex-ante] Carbon stocks and flows in native forest and harvested wood products in southeast Australia (PRP621)	Sep-12
23			[Ex-ante] Remote sensing of land-use-specific actual evapotranspiration of entire catchments containing plantations (PRP616)	
24		Benefit cost analysis of selected projects within the FWPA R&D program (2011)	Managing sub-tropical exotic pine plantations for improved wood production (PNC057-0809)	Feb-12
25			Screening of commercial forestry species for myrtle rust (PRC179-0910)	
26			MOE and MOR assessment technologies for improving graded recovery of exotic pines in Australia (PNB040-0708)	
27			Comparison of face bond quality tests for structural glulam (PN06.2029)	
28			Pine timber roof environments in WA and its susceptibility to EHB (PNA023-0809)	

29			Maximising impact sound resistance of timber framed floor/ceiling systems (PN04.2005)	
30	B.M. Jenkin (Sylva Systems Pty Ltd)	FWPA Cost Benefit Analysis	Evaluation of super-heated steam vacuum drying viability and development of a predictive drying model for four Australian hardwood species (PNB045-0809)	Jun-19
31		FWPA Cost Benefit Analysis	Predictive relationships to assist fertiliser use decision-making in eucalypt plantations (PNC304-1213)	Jun-19
32		An impact assessment of FWPA project PNC135-0809	Active genetic conservation and utilisation of native radiata pine germplasm (PNC135-0809)	Jun-19
Other Known BCAs for Consideration				
33	Agtrans Research	Economic assessment of six research, development and extension investments by the Department of Agriculture and Fisheries (Queensland)	Managing Risks Associated with Range Expansion of Sirex Wood Wasp	Aug-18
34			Protecting Queensland's timber resource from pest and disease incursions	
35		Evaluation of research, development and extension investments by the collaborative partnership between the Department of Agriculture and Fisheries (Queensland) and the University of the Sunshine Coast	Improving returns from Southern Pine plantations through innovative resource characterisation	Oct-18
36			Biological control of galling insect pests of eucalypt plantations in the Mekong Region and the Biological Control of Eucalypt Pests Research Alliance (BiCEP)	
37	Agtrans Research & eSYS Development	Forestry CRC	Improved forest inventory through high resolution remote sensing (subproject 1.1.3, program 1)	Dec-08

38			Association genetics for solid-wood properties: Eucalyptus globulus and E. nitens (subproject 2.1.2, program 2)	
39			Silviculture-processing studies on Eucalyptus nitens and E. globulus (subproject 2.3.1, program 2)	
40			Optimised log merchandising with mechanical harvesters (program 3)	
41			Evaluation of electric/diesel hybrid technology on a converted 6x6 truck (program 3)	
42			Identification and adaptation of leading technology for tracking and management of Australian forest operations (program 3)	
43			Trees in the landscape (program 4 - whole program)	

Appendix 2: Allocation of FWPA RD&E Investments by Industry Investment Area

BCA/RD&E Investment/Project No.	RD&E Investment Area (1) Forest to mill door, (2) Wood processing and manufacturing, and/or (3) Timber in service (growing (3G), processing (3P) and market (3M))
Development of the Australian Forestry Standard (cluster – projects listed below)	
PN02.2400	3G
PN02.2401	3G
PN02.2403	3P
PN03.2406	3P
PN03.2407	3G
PN04.4004	3M
PN04.4008	3M
PN06.4012	3G
PN01.1301	3G
PN04.4001	3G
PN04.4006	3G
The review of Forest Certification in Australia (Hamish Crawford)	Not applicable
Development of New Design Properties for Radiata Pine (cluster – projects listed below)	
PN02.1905	2
PN03.1913	3P
PN04.2003	3P
PN05.1023	3M
PN05.1026	3M
PN05.2020	3M
PN05.2024	2
PN05.2025	3M
PN06.2032	3M
PN06.1033	3M
Evaluation of Investment in Pine Breeding (cluster – projects listed below)	
PN03.1916	1
PG98.400	3G
PN01.1904	1
PN02.1910	3P
PN03.1915	1
PN012.96	1
PNO5.3012	1
Reassessment of Lyctid Susceptible Sapwood and Methods of Control	

PN03.1313	3G
Best Practice Timber Drying Compendium	
PN01.1307	2
Fertiliser usage in forestry: current status and prospects for increasing its efficiency and profitability	
PRC072-0708	1
TREEPLAN, MATEPLAN and SEEDPLAN genetic programs	
PN03.1915 and PN07.4025	1
Moisture correction factors	
PN04.2002 and PN07.2045	2
Wood quality initiative	
PN04.2004	2
Assessing the performance of wood poles exposed to bushfires	
PNA014-0708	3
Strategy for large span second storey timber and wood products	
PNA020-0809	3
Managing sub-tropical exotic pine plantations for improved wood production	
PNC057-0809 (2008/09 to 2010/11)	1
Screening of commercial forestry species for myrtle rust	
PRC179-0910 (2009/10)	1
MOE and MOR assessment technologies for improving graded recovery of exotic pines in Australia	
PNB040-0708 (2006/07 to 2008/09)	2
Comparison of face bond quality tests for structural glulam	
PN06.2029 (2004/05)	2
Pine timber roof environments in WA and its susceptibility to EHB	
PNA023-0809 (2007/08 to 2009/10)	1
Development of a selection and implementation guide for the use of onboard systems for Australian forest operations	
PNC119-0809	1
Five-year inspection of preservative treated vineyard posts	
PNB049-0809	3
Measurement of formaldehyde and other VOC emissions from wood panels using the 1m3 chamber and desiccator test methods	
PNB035-0506	3
Contemporary sound and fire rated timber framed construction practices for low risk building	
PNA011-0708	3
Industry Standard Recycled Timber - visually graded recycled decorative products	
PN06.1039	3
Utility of molecular breeding in forestry	
PNC220-1011	1

Evaluation of super-heated steam vacuum drying viability and development of a predictive drying model for four Australian hardwood species	
PNB045-0809	2
Predictive relationships to assist fertiliser use decision-making in eucalypt plantations	
PNC304-1213	1

Appendix 3: Summary of Methods Used in the Individual BCA Reports

1. **Evaluation of Benefits Delivered from FWPRDC Sponsored R&D Projects PR07.5058 – Agtrans Research & eSYS Development Pty Ltd (2006/07)**

Prepared for FWPA in 2007, the report included analysis of six RD&E investments made by FWPA over the period 1998/99 to 2007/08. The six investments analyses included both clusters of projects (two or more RD&E project investments assessed jointly) and individual RD&E project investments. The investments subjected to evaluation were selected by FWPA from FWPA's RD&E portfolio for the period 2001 to 2006.

The evaluations followed a logical framework approach where each RD&E investment was first assessed qualitatively in terms of its inputs, activities and outputs, outcomes and impacts. Impacts identified then were categorised in a triple bottom line framework as economic, environmental or social impacts. Some, but not all, of the impacts identified then were valued in monetary terms and a BCA was carried out.

For the quantitative component of the evaluation the analysts used a cash flow approach. All benefit and cost cash flows were discounted to 2005/06 using a 5% discount rate. All past and future benefits and costs were expressed in 2005/06 real dollar terms adjusted using the Consumer Price Index (CPI).

Total expected benefits were estimated against one or more counterfactual scenarios (that is, what would most likely have happened in the absence of the RD&E investment). Benefits and costs were estimated and reported for different time periods after the first year of the RD&E investment. In most cases a 30 year time horizon was used, however a 50 year time horizon was implemented for a tree breeding RD&E investment. Investment criteria reported included the PVB, PVC, NPV, BCR and IRR for the total investment for each of the six RD&E investments analysed.

2. **Economic Assessment of Selected Investments of the Cooperative Research Centre (CRC) for Forestry – Agtrans Research & eSYS Development Pty Ltd (2008/09)**

The Forestry CRC required BCAs for a number of its RD&E investments to demonstrate the contribution of the CRC's RD&E to Australia's industrial, commercial and economic growth. Analyses were conducted on seven CRC RD&E investments across four program areas. The evaluations were conducted at the level of an individual RD&E project/subproject and for one whole program (e.g. Trees in the landscape, CRC Program 4 evaluation). The RD&E investments were selected by CRC management personnel (after consultation with the consultants) and included investments made between 2005/06 and 2011/12.

The evaluations followed a logical framework and triple bottom line approach (as described previously for the 2006/07 evaluations by the same consultants). The approach used was reported to be consistent with the CRC Association's prevailing monitoring and evaluation framework developed by Deloitte in 2007.

Where impacts were assessed quantitatively and BCAs were conducted, the consultants discounted benefit and cost cash flows to 2007/08 using both a 5% and 10% discount rate. All costs and benefits were expressed in 2007/08 real dollar terms adjusted using the CPI and a 30 year time horizon from the first year of RD&E investment was used to estimate total expected benefits. Benefits also were estimated with respect to one or more counterfactual scenarios.

Results reported included the PVB, PVC, NPV, BCR and IRR for each investment analysed and subjected to BCA.

3. Report: FWPA R&D Program Evaluation – URS Pty Ltd (2009/10)

Prepared for FWPA in 2010, the URS report evaluated a total of nine FWPA RD&E investments. Six project investments from each of FWPA's major investment categories (growing, processing and marketing) were randomly selected. These were then shortlisted to three project investments that represented each of high, low and average cost projects, all of which commenced after April 2002 and which were completed and delivered before July 2009. The short-list was then discussed with FWPA to help refine the selection to the nine investments ultimately assessed (URS Pty Ltd, 2010). Some of the investments assessed were individual project investments while others where two similar project investments assessed jointly.

A BCA framework was used that involved defining a base case (counterfactual) and then considered the total funds invested (cash and in-kind) in a given project relative to the total benefits that the projects have conferred to Australian society as a whole. Economic, environmental and social impacts were identified and quantified where possible. It was reported that the BCA methodology implemented was aligned with the prevailing impact assessment guidelines of the Council of Rural Research and Development Corporations Chairs (CRRDCC).

The URS report did not explicitly state the years in which each RD&E investment occurred. Benefit and cost cash flows were expressed in 2008/09 dollar terms using a CPI adjustment factor and discounted using a 5% discount rate. The year to which cash flows were discounted was not stated.

Of the nine RD&E investments evaluated, benefits for six were quantified and had investment criteria estimated. Investment criteria reported for the six quantified investments were reported using a 50 year time horizon from the last year of RD&E investment and included the NPV, BCR and IRR.

4. Final Report (Revised) Benefit cost analysis of selected projects within the FWPA R&D program (2011) – URS Pty Ltd (2011/12)

In the second half of calendar 2011, FWPA provided URS with six RD&E investments that had been selected for evaluation. The six projects were randomly selected from within each of FWPA's research themes (growing, processing, and market-facing research). The projects selected included FWPA investment over the period 2003/04 to 2010/11.

URS used a similar BCA approach to that used in the 2009/10 evaluations (described above). However, benefit and cost cash flows were expressed in 2009/10 dollar terms using a CPI adjustment factor. URS did not report the method used to adjust nominal dollars to real dollar terms.

Five of the six RD&E investments were assessed quantitatively. Where quantification occurred, cash flows were discounted using a 5% discount rate however the year to which cash flows were discounted was not explicitly stated. Investment criteria were reported for a 20 year time horizon from the last year of RD&E investment and included the NPV, BCR and IRR.

5. Cost-Benefit Analysis of Three Selected FWPA Projects: On board computers, formaldehyde testing of wood panels and vineyard post treatment PRA306-1213– eSYS Development Pty Ltd (2012/13)

eSYS Development conducted an evaluation of three, randomly selected RD&E project investments for FWPA in 2013. The evaluation framework was based on BCA methods using cost and benefit projections over standardised time frames, discount rates, incorporation of a counterfactual scenario and explicit statement of risk (McLeod, 2013). Economic, environmental

and social impacts were described as well as any spillover impacts to other industries, consumers and overseas parties.

The BCAs were conducted in line with the 2007 CRRDCC impact assessment guidelines. Benefit and cost cash flows were discounted to 2012/13 using a 5% discount rate. All benefits and costs were expressed in 2012/13 real dollar terms, though the method of adjustment from nominal to real dollar terms was not reported. Results were reported for a 30 year time horizon from the last year of RD&E investment and included the PVB, PVC, NPV, BCR and IRR.

6. **Cost-Benefit Analysis of Three Selected FWPA Projects: Contemporary Sound and Fire Rated Timber, Industry Standards for Recycled Timber & Utility of Molecular Breeding PRA314-1314 – eSYS Development Pty Ltd (2013/14)**

In 2014, eSYS Development conducted a similar analysis to that conducted in 2013 (described above) on another three, randomly selected RD&E project investments by FWPA. In this case, however, the BCA framework was conducted in line with the Guidelines for Evaluation of Research and Development (Version 1 – August 2012) as well as the 2007 CRRDCC guidelines.

Benefit and cost cash flows were discounted using a 5% discount rate, however the year cash flows were discounted to was not documented. All benefits and costs were expressed in 2013/14 real dollar terms, though the method of adjustment from nominal to real dollar terms was not reported. Results were reported for a 30 year time horizon from the last year of RD&E investment and included the PVB, PVC, NPV, and BCR. Also reported was the MIRR (instead of the standard IRR).

7. **Economic Assessment of Six Research, Development and Extension Investments by the Department of Agriculture and Fisheries (Queensland) – Agtrans Research (2018/19)**

Agtrans Research was commissioned to complete economic analyses of six, selected RD&E investments co-funded by the Department of Agriculture and Fisheries Queensland (DAF). Two of the six investments involved forestry related RD&E and thus, with DAF's permission, were included in the 2019 FWPA BCA meta-analysis.

The evaluations were conducted using the 2014 Council of Rural RDCs (CRRDC, formerly known as the CRRDCC) Impact Assessment Guidelines. The evaluation process involved identifying and briefly describing project objectives, activities and outputs, and potential and actual outcomes and impacts using a logical framework approach. The principal economic, environmental and social impacts were then summarised in a triple bottom line framework. Some, but not all, of the impacts identified were then valued in monetary terms and a BCA completed for each investment assessed.

All benefit and cost cash flows were expressed in 2016/17 dollar terms, adjusted using the implicit price deflator for Gross Domestic Product (GDP). All costs and benefits were discounted to 2017/18 using a 5% discount rate. Results were reported for a 30 year period after the last year of RD&E investment and included the PVB, PVC, NPV, BCR, IRR and MIRR.

8. **Evaluation of Research, Development and Extension Investments by the Collaborative Partnership Between the Department of Agriculture and Fisheries (Queensland) and the University of the Sunshine Coast – Agtrans Research (2018/19)**

As part of a contract extension to the August 2018 assessment of six RD&E investments for DAF, Agtrans Research carried out a number of further evaluations of RD&E funded under a collaborative partnership between DAF and University of the Sunshine Coast. Two of the RD&E

investments evaluated were the same forestry related RD&E projects from the original six DAF evaluations, however an additional two forestry RD&E investments also were assessed.

The additional analyses used the same methods and guidelines as the previous DAF evaluations. All benefit and cost cash flows were expressed in 2017/18 dollar terms, adjusted using the implicit price deflator for GDP. All costs and benefits were discounted to 2017/18 using a 5% discount rate. Results were reported for a 30 year period after the last year of RD&E investment and included the PVB, PVC, NPV, BCR, IRR and MIRR.

9. **Cost Benefit Analysis: FWPA Project PNB045-0809: Evaluation of super-heated steam vacuum drying viability and development of a predictive drying model for four Australian hardwood species – Sylva Systems Pty Ltd (2018/19)**

In 2019, Sylva Systems Pty Ltd carried out three impact assessments on FWPA RD&E investments. It was not reported whether the investments were randomly selected or chosen by FWPA for evaluation. The first assessment followed the 2014 CRRDC Impact Assessment Guidelines adapted for the Australian hardwood sawmilling sector. Impacts of the RD&E investment were estimated with respect to a business as usual (counterfactual) scenario.

Cash flows were discounted to 2017/18 using a 5% discount rate. Cash flows were reported in 2017/18 dollar terms adjusted using actual inflation rates (assumed to as measured by the CPI). Investment criteria were reported to 2030/31 and 2050/51 (approximately 20 years and 40 years from the last year of RD&E investment respectively). Investment criteria reported included the NPV and BCR only.

10. **Cost Benefit Analysis: FWPA Project PNB045-0809: Evaluation of super-heated steam vacuum drying viability and development of a predictive drying model for four Australian hardwood species – Sylva Systems Pty Ltd (2018/19)**

A second 2019 impact assessment conducted by Sylva Systems used a similar methodology to the first (number 9 above) adapted to the long-term nature of forestry plantations. Cash flows were discounted to 2017/18 (the base year) using a 5% discount rate. Cash flows were reported in 2017/18 dollar terms adjusted using the implicit price deflator for GDP. Results were reported to 2035/36 (approximately 22 years from the last year of RD&E investment respectively). Investment criteria reported included the NPV and BCR only.

11. **An impact assessment of FWPA project PNC135-0809 Active genetic conservation and utilisation of native radiata pine germplasm – Sylva Systems Pty Ltd (2018/19)**

A third 2019 impact assessment conducted by Sylva Systems used a similar methodology to the first two (aligned with the 2014 CRRDC impact assessment guidelines) adapted to the long-term nature of forestry plantations. Cash flows were discounted to 2017/18 (the base year) using a 5% discount rate. Cash flows were reported in 2017/18 dollar terms adjusted using the implicit price deflator for GDP. Results were reported using a 60 year time horizon from the last year of the RD&E investment. Investment criteria reported included the NPV and BCR only.

Note: The evaluation of project PNC135-0809 reported an estimated NPV of $373.0 million (present value terms) and a BCR of 429.0 to 1. FWPA identified the results of this evaluation as an outlier with respect to the investment criteria reported across all of the BCAs collected for the 2019 FWPA BCA meta-analysis. The scale of the benefits reported for PNC135-0809 would skew the aggregate results of the current analysis. Therefore, the BCA of investment in PNC135-0809 was excluded from meta-analysis.