New Zealand research and experimental development statistics : all sectors, 1993/94 / Ministry of Research, Science and Technology.

New Zealand Research and Experimental Development Statistics

All Sectors

1993/94

Ministry of Research, Science and Technology

Te Manatu Putaiao

Publication No. 15

Cover: Significant areas of R&D (Clockwise)

1. Government sector: Research to enhance the productivity of mussel farms; the FRV "Kaharoa" working in Mills Bay, Kenepuru Sound, Marlborough Sounds.

2. Business enterprise sector: High speed motor winding in the production of the Smart Motor for automatic washing machines at Fisher and Paykel.

3. University research: "Examining the sample"; an often essential part of health research even in this age of technological innovation.

Ministry of Research,
Science and Technology
Te Manatu Putaiao

25 November 1996

NEW ZEALAND RESEARCH AND DEVELOPMENT STATISTICS, ALL SECTORS, 1993/94

I enclose a complimentary copy of this report of the latest national R&D survey, for the use of your organisation.

This survey is repeated on an annual basis to provide information necessary for the development of science and technology policy including the setting of research priorities, monitoring human resources in science and technology and Government research funding levels. This is the fifth year for which this information has been collected to international standards.

The research covered by this survey includes that funded by business and research associations, the public good science fund and operational research funded under departmental votes and university research. It is gratifying to find that organisations are willing to take the time to provide information which will assist in the promotion of the national research effort.

Collection of data for the 1995/96 year is under-way at the present time as you may be aware. Your assistance with these surveys is appreciated. We can expect that trends may be identified as the collection proceeds over time that will assist in the assessment of New Zealand's capabilities and opportunities.

Further copies may be obtained from this Ministry at $15.00 per copy. Further information about the science system is available on the Internet through the Ministry's web site at http://www.morst.

Please forward any information requests or suggestions for other information you would like to see in next year's report to me at the above address or email to walkerp@morst.govt.nz.

Yours sincerely

Pam Walker.

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New Zealand Research and Experimental Development Statistics

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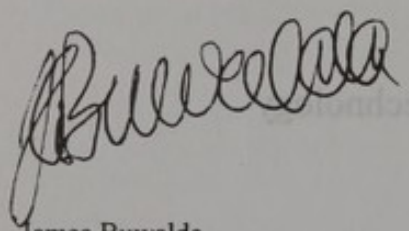
This document is the report of the joint survey of business and government sector R&D carried out by the Ministry of Research, Science and Technology and Statistics New Zealand, and the Ministry's own survey of R&D in the higher education sector. The report was compiled by the Ministry's Information Services Unit.

Approved for general release.



James Buwalda
Chief Executive

FOREWORD

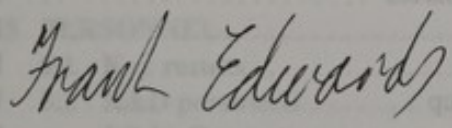
This survey of research and development (R&D) is the fifth in a series of R&D surveys to be undertaken by the Ministry of Research, Science and Technology. It was carried out jointly with Statistics New Zealand. It will provide valuable information to policy makers in government and business.

The process for carrying out these R&D expenditure surveys was developed with the assistance of an advisory group whose members were drawn from key sectors of the science and science user communities.

The government and business sectors were generally very willing to provide the information and to participate in the survey. I would like to thank Ron Maddox and Rob Tinkler at Statistics New Zealand who managed, along with this Ministry, the many queries and checks which a complex and technical survey of this nature generated. Universities were surveyed by the Ministry for the second time in this series (following the 1993 pilot survey), in conjunction with the universities Vice-Chancellors' Committee. I would like to thank Professor Warren Young in particular for his invaluable assistance.

The information on research carried out in New Zealand in 1993/94 is complemented by reference to other countries' patterns of research expenditure. Information on OECD countries was taken from the Structural Analysis (STAN/ANBERD) and Main Science and Technology Indicators (MSTI) databases.

The value of this information on R&D increases the longer the time frame over which it is collected. It is therefore the intention to repeat this survey at least every two years.



Frank Edwards
Manager, Information Services
Ministry of Research, Science and Technology

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Executive Summary

This report documents the fifth annual survey of Research and Development (R&D) undertaken in New Zealand*.

New Zealand's gross domestic R&D expenditure in 1993/94 was $825 million, or 1.02% of GDP (using 1993 GDP of $80,865 million). The corresponding figure for the mean of the six OECD reference countries (see section E) is 1.95%. R&D carried out by the private sector was $248 million or 0.31% of GDP (1.21% for OECD reference countries), or 30% of the total R&D (61.8%). The Government sector carried out R&D of $343 million, or 0.42% of GDP, while university R&D totalled $234 million or 0.29% of GDP. Together, the latter two sectors carried out R&D expenditure of 0.71% of GDP, compared with an average of 0.73% for government and university sectors in OECD reference countries.

In terms of R&D performers, R&D carried out by the business sector increased by $43 million, or 21%. The main increase was in information and communications (up $16 million, a 61% increase on 1993 estimates). Fruit and crops, dairy processing and energy R&D increased by more than $3 million each. Construction, materials and industrial processing R&D increased by more than $2 million each.

Business R&D was concentrated in: primary product processing (35%), infrastructure and services, including software R&D (25%), and materials, engineering and telecommunications (22%). These results illustrate the focus of business R&D on secondary industry and of Government R&D on primary production.

R&D carried out by the government sector increased by $25 million, or 8% over 1992/93 results. Environmental protection and land use and, flora and fauna R&D increased by more than $3 million each. Plantation forestry and other food processing R&D increased by more than $2 million.

Government R&D was concentrated in a few areas; 42% in primary production (a drop from 1992/93), and 24% in the environment and natural resources.

R&D carried out by the higher education sector increased by $1.1 million or 0.5%. Research in the social sciences took 26% of university R&D expenditure, followed by medical sciences (22%), engineering and applied sciences (14%), then biological sciences (11%). The natural sciences (physics, chemistry, biological and earth sciences) taken together amounted to 23%.

Thirty-one percent of the funding for university research came from external sources; it is estimated that a further 46% came from general university funds from Government and 23% from the universities' own funds, which include student fees.

**Explanatory note: For the purposes of the R&D survey, all research providers are grouped into one of three sectors: the business, Government and university sectors. Information about R&D expenditure and personnel is reported here according to the sector in which the research was carried out, not by the sector which funded the research. Exceptions are Tables 7 and 13, which provide estimates of business and government funding of R&D. Research carried out in a sector is known as the intramural R&D expenditure of the sector. This is the statistic most commonly used in OECD comparisons.*

Please note that R&D funded by each sector is a different statistic, obtained by splitting intramural R&D expenditure for each sector by its source of funds and adding total funding from each source across the three provider sectors, as in Table 18.

In terms of R&D funders, it is estimated that the business enterprise sector funded $293 million for R&D (including $14 million spent overseas), the government funded $452 million (including part of the EFTs funding to universities), and universities funded $57 million from their own funds (including student fees). Of the total of $825 million research carried out in New Zealand, $15.5 million was paid for with funds from overseas and a further $18 million with private non-profit funds.

The overall breakdown of how the money was spent has not changed since 1991/92; 51% on wages and salaries, 39% on current expenditure, and 9% on capital expenditure.

The total number of personnel spending at least part of their time on R&D as researchers, technicians or support personnel came to 20,638. Comparing this with their time in full-time equivalents spent on R&D, over all sectors 51% of R&D personnel's time was spent on R&D. (Note that university academics spend on average 27% of their time on research.) Aside from researchers employed in universities, 70 to 90% of a researcher's time was spent in research. The highest figure (92%) came from CRIs.

Excluding universities, for whom gender data are not available from the survey, 5,960 (70.4%) of R&D personnel were male and 2,503 (29.6%) were female. Women make up 24.2% of R&D staff in the business sector (25% of research FTEs), 33.4% in CRIs (31.4% of research FTEs), and 38.4% in other government departments (36.8% of research FTEs).

Women, excluding those working in universities, account for 16.9% of researchers (while doing 17.1% of the research), 31.7% of technicians, and 56.8% of support staff. The highest proportion of women researchers are found in other Government departments with 38%. The lowest proportion of women researchers are in business and the CRIs, with 15% and 14% respectively. The highest proportion of women technicians are found in CRIs (37%) and the lowest in other Government departments (18%). The highest proportion of women support staff are found in other Government departments, whereas the lowest is in the business sector.

The highest proportion of PhDs among R&D staff occurs in CRIs (21%). The lowest proportion occurs in business (7%).

Forty-two percent of R&D personnel in the business sector have some kind of Bachelors degree; the equivalent figure for CRIs is 29% and 49% in other Government departments. Thus, in these three groups combined, Bachelor degrees are the most common qualification among R&D personnel (at 37%).

People holding technical qualifications represented 13% of R&D personnel (ranging from 8 to 18% over the sectors). People holding trade qualifications represented 8.6% of R&D personnel.

R&D staff with "other post-secondary" qualifications represented 4%, those with "secondary" qualifications 15% (ranging from 12 to 19% over the sectors), and "other" came to 5%.

Excluding universities, women made up 13% of PhDs and 27% of bachelors degrees (while making up 30% of all staff).

Since 1990/91, the technology balance of payments for business has reversed from -$3 million to a positive balance. For 1993/94, the business sector received a net amount (receipts less payments) of $19.3 million for overseas trade in technical know-how. Government received a net amount of $3.5 million.

Statistical Summary, 1993

	New Zealand	Reference Countries average*	OECD average (excl.NZ)	Increase to reach average of Ref. Countries
1. Gross expenditures on R&D (GERD)				
-National currency $NZ million	$825			
-Equivalent $US million (total)	$546	$14,922	$377,381	
2. New Zealand as % of other countries:				
-GERD		3.7%	0.1%	
-Population		7.8%	0.4%	
-GDP		7.4%	0.4%	
3. Real growth in GERD (1989-1993)	11.6%	11.2%	4.3%	-0.4%
4. Per capita R&D expenditure ($US)	$156	$328	$315	111%
5. Real growth per capita R&D expenditure (1989-1993)	7%	12%	4%	5%
6. Real growth in GDP (1989-1993)	6.0%	-0.2%	5.1%	-6%
7. Per capita GDP ($US)	$12,238	$15,857	$15,774	30%
8. Real growth in per capita GDP (1989-1993)	1.4%	0.2%	0.9%	-1%
9. GERD/GDP	1.02	1.95	1.76	91%
-excl. defence	1.01	1.88	1.70	86%
-excl. defence, envir., social, health	0.89	1.77	1.54	99%
10. Research scientists and engineers (RSE) per 1000 labour force	3.73	6.03	5.07	62%
11. GERD per RSE	$88,093	$112,697	$132,966	28%
12. % of GERD funded by government	55.00	37.53	41.97	-32%
13. Government expenditure as a % of GDP	0.56	0.74	0.68	24%
-excl. defence	0.55	0.66	0.59	20%
-excl. defence, envir., social, health	0.44	0.56	0.51	27%
14. Government per capita expenditure ($US) excluding university funding:			**	
-Agriculture	$21.95	$10.72	$12.08	-51%
-Industry	$10.59	$21.52	$14.87	103%
-Energy	$1.04	$4.15	$4.94	299%
-Earth exploration	$9.41	$3.10	$2.72	-67%
-Industrial infrastructure	$0.95	$5.99	$4.02	531%
-Environmental protection	$2.49	$4.80	$3.51	93%
-Health	$3.69	$5.02	$7.49	36%
-Social	$3.11	$7.94	$4.20	155%
15. Business sector expenditure as % of GDP (BERD/GDP)	0.31	1.21	1.07	290%
16. Manufacturing % of sales spent on research (1992)	0.34	2.02	2.04	494%
-based on NZ industry mix	0.34	1.52	1.34	347%

* Australia, Denmark, Finland, Ireland, Norway, Sweden

** Excludes Japan and Yugoslavia

Figure 1. R&D carried out by each sector in 1993/94, by the grouping used for priority setting 1995

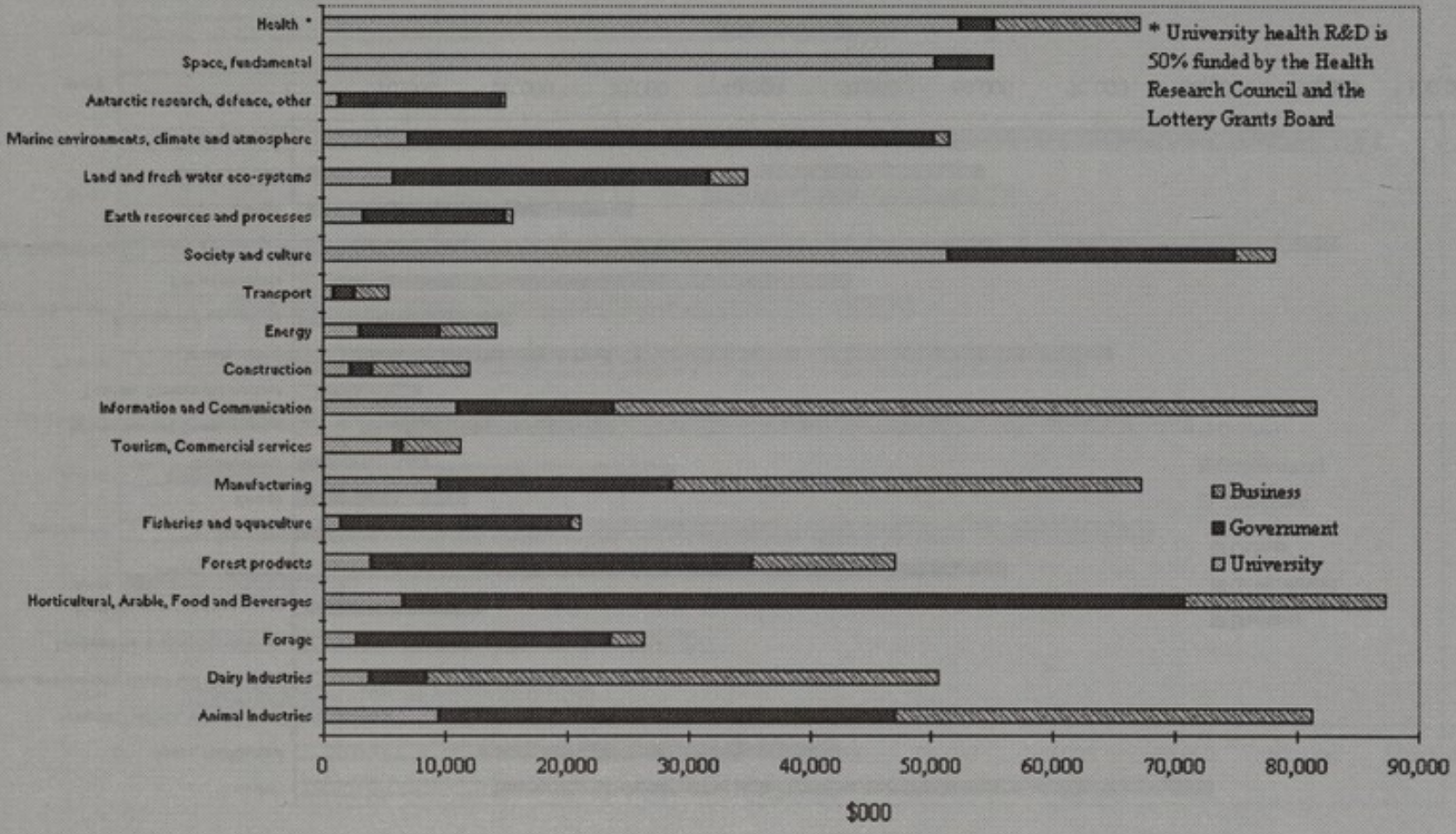


Figure 2. R&D funded by each sector in 1993/94, by the groupings used for priority setting 1995

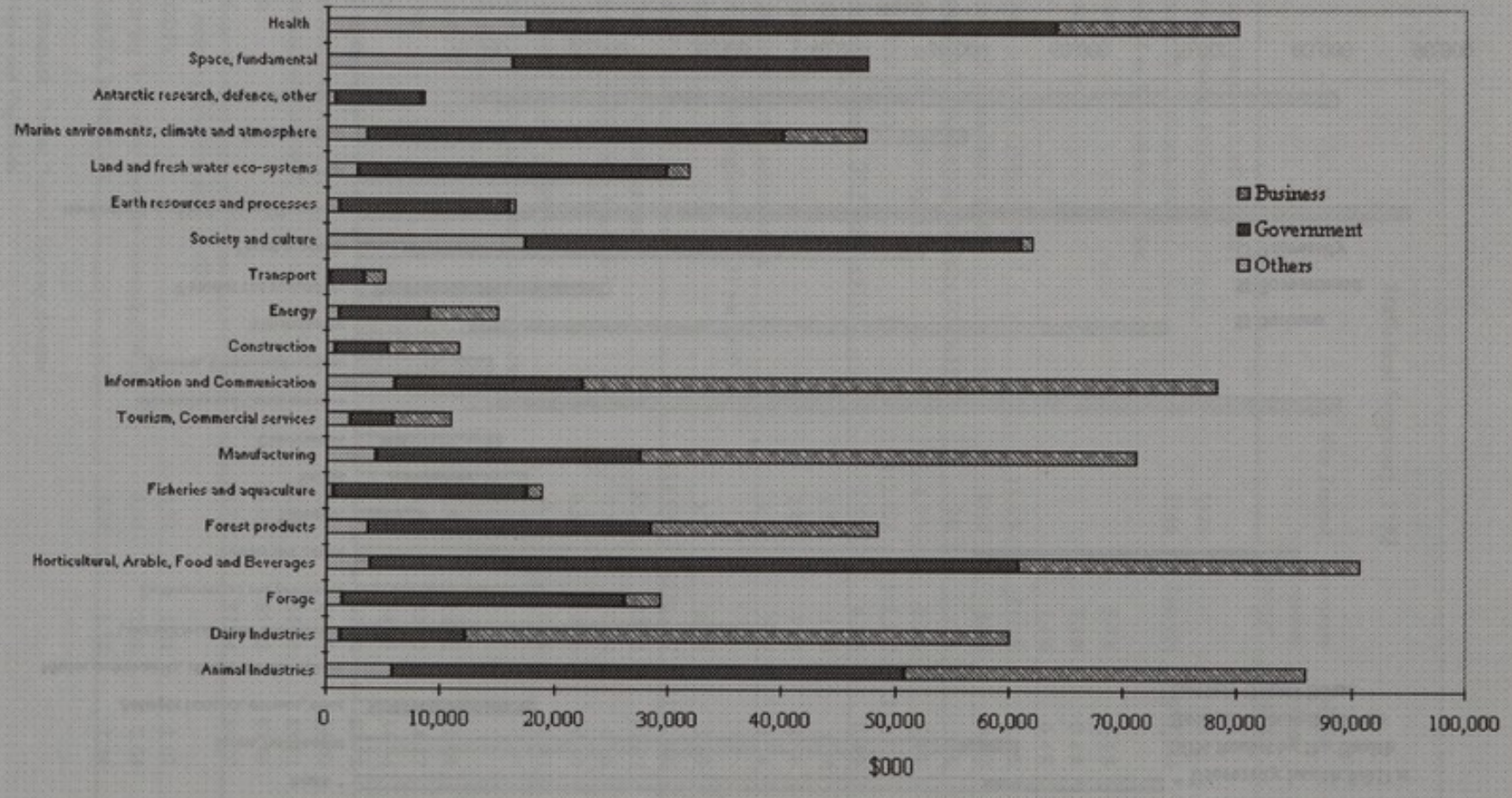
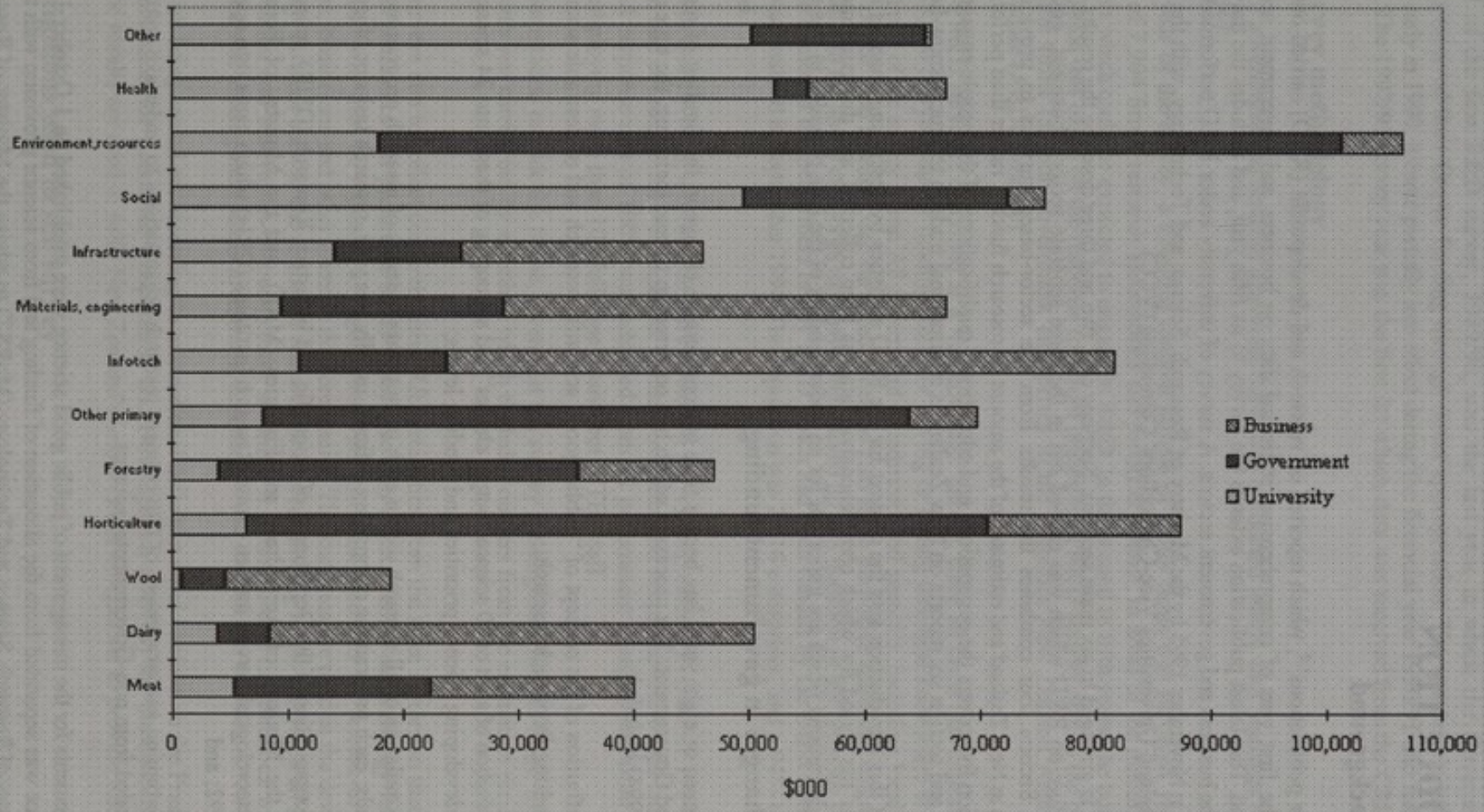


Figure 3. R&D carried out by each sector in 1993/94, by selected groupings of outputs



INTRODUCTION

A Background

Two earlier publications[1,2], which reported on research and development (R&D) carried out in 1989/90, provided the first year of comprehensive statistical data on business and government sector R&D in New Zealand. This latest publication extends the survey to its fifth year, and includes the university sector as well as the business and government sectors. A survey of university sector R&D performed in 1994 was undertaken in November 1995 by the Ministry of Research, Science and Technology, with the assistance of the New Zealand Universities Vice-Chancellors' Committee (VCC).

This report is arranged in six main sections. Sections one, two and three describe the results of the survey of expenditure on R&D which was carried out in the three separate sectors: business, government and university. Section four combines the results from the sector-based surveys to provide total R&D expenditure in New Zealand and estimates of the amount of research funded, rather than performed, by each sector. Section five covers the occupations and educational qualifications of the people engaged in R&D in all sectors, and section six reports on New Zealand's international trade in technical know-how.

The rest of this introduction sets the context for the R&D statistics by describing changes in the science system over the period for which comprehensive data has been collected, and discusses methodological issues and definitions which are important for an understanding of the data provided in this report.

B Changes in government funding

The past seven or eight years has been a time of considerable change in the funding of research by the New Zealand Government. The processes which had occurred up to, and including, the time of this survey (October 1994) included:

- Definition of the concept of "public-good" scientific research and of desirable science outcomes resulting from such research;
- Definition of a set of 40 science "output classes" and a grouping of these into 24 science areas, used in developing science priorities and funding levels;
- Formulation of all research within each output class in terms of research programmes with stated goals; each programme comprising defined, usually one year, research tasks or objectives;
- Reorganisation of the Department of Scientific and Industrial Research (DSIR), research branches of the Ministry of Agriculture and Fisheries (MAF), and the Ministry of Forestry and the Meteorological Service into ten Crown Research Institutes (CRIs) which came into operation 1 July 1992; and
- Continuing encouragement of Government research organisations to undertake commercial work funded from non-Governmental sources.

New arrangements for the management of public good science were established on 1 October 1989. Science policy advice was separated from the allocation of funding and from science provision with the formation of the Ministry of Research, Science and Technology (MoRST) to advise the Minister of Research, Science and Technology, and the Foundation for Research, Science and Technology (FRST) for the allocation of funding on a contestable basis. This replaced the direct allocation of funds by Parliament to the science departments.

The period of the first R&D survey, 1989/90, was the last year in which the Government science departments received their Crown funding through direct appropriation. The contestable bidding system commenced early in 1990. It came partially into effect during the financial year 1990/91 and fully into effect in 1991/92. The 1992/93 survey year was the first for which data was received from the CRIs.

C Survey methodology

The survey of government and business enterprise R&D was conducted jointly with Statistics New Zealand (Statistics NZ).

In the first year of the survey, a stratified random sample of 2,508 firms was surveyed, representing a population of 7,904 firms, research associations and producer boards, in areas of the manufacturing and service sectors which could be expected to engage in R&D. In the second to fifth years, the business sector survey population was based on the response to a brief question on R&D activity sent to the population of about 150,000 firms (all non-government enterprises in the Statistics New Zealand Annual Business Directory Update (ABDU) survey).

The 1993/94 R&D survey is described as a 'full coverage' survey, since all firms that indicate they spent more than $5,000 carrying out or funding R&D, or buying or selling technical knowledge or information abroad, form part of the survey frame. All government departments and agencies, including local government which carry out or fund research, are surveyed. There is also some purposive selection, where enterprises that do not fall into the above categories may have been picked up in a question in the previous survey which asked for the names of the performers of any R&D which had been funded by the respondent. The R&D population was finalised in September 1994. The population was 2,016 enterprises, and a 94% response rate was achieved.

Questionnaires and covering information were posted to survey respondents in October 1994. Reminders for firms that had not responded were sent out in late November and telephone follow-ups commenced in December. A response rate of 100% was achieved from all government agencies and from all business enterprises employing more than 100 full-time equivalent (FTE) staff.

There is no imputation outside the frame, given that the survey is designated full coverage. Imputation for non-respondents was carried out by a method which excluded outliers from the estimation process for non-respondents.

The R&D surveys aim to collect comprehensive R&D statistics from the three sectors so that they can be combined to generate a full picture of R&D. They also aim to establish a methodology for the survey process, which will then be repeated at regular intervals to obtain statistics for release to government organisations, businesses and other users in the community. The statistics are used in the development of science policy, in areas such as the setting of research priorities, funding levels and research strategies, in science education and innovation encouragement schemes. It is hoped that the statistics will also help decision makers in making their R&D investment decisions.

The surveys are being carried out according to international definitions and conform to the Frascati Manual of the Organisation for Economic Cooperation and Development (OECD) for the collection of R&D statistics. The results are used to fulfil New Zealand's international obligations to provide R&D statistics.

D Definitions used in the survey

This report follows the convention used in OECD publications of standard abbreviations for the measures of R&D. Only R&D activities, as defined by the OECD, are included in the survey. Consulting and scientific and technological (S&T) services and market research are excluded.

In line with OECD methodology, statistical information is gathered from the providers rather than the funders of research. This is in order to prevent the same research being reported twice, by both the provider and the funder. Providers are also usually in the best position to determine whether work is R&D or S&T services, and to report on the resources actually expended on research. Information on the sources of funds used by providers is then used to estimate the funding of R&D by each sector.

Most of the tables in this report represent expenditure on R&D *carried out* in each of the three sectors: business enterprise R&D (BERD), government R&D (GOVERD), and higher education R&D (HERD). That part of university funds for research which comes from Vote Education and is part of the employment contract of academic staff is called "general university funds" or "GUF", as distinct from income from student fees and other sources, including research monies allocated by independent funding bodies, such as the Foundation for Research, Science and Technology or the Health Research Council.

Intramural R&D statistics presented in this publication refer to R&D activity *carried out* by an organisation on its own behalf or on behalf of other organisations or individuals. *Extramural* R&D statistics refer to R&D *funded* by an organisation but *carried out* by others.

Total *funding* of R&D by each sector is estimated by subtracting from intramural R&D for that sector the part which is funded from outside the sector and adding any R&D which that sector funds in any other sector. Data from R&D providers are used because estimates given by funders may result in double-counting as the same funds may be provided by one body, allocated by another, and reported by both.

The survey used the OECD definition of R&D: "Research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."

Any activity classified as R&D is characterised by *originality;* it should have *investigation* as a primary objective, the outcome of which is *new knowledge*, with or without a specific practical application, or *new or improved* materials, products, devices, processes or services. R&D ends when work is no longer primarily investigative.

The definition of R&D, in accordance with a change in OECD standards, now includes research into, and development (or substantial modification) of, computer software, such as applications software, new programming languages and new operating systems.

A more comprehensive interpretation of the definition of R&D activity is given in the OECD publication *The Measurement of Scientific and Technical Activities* (the Frascati Manual)[6].

R&D *expenditure* includes: *capital* expenditure on the acquisition of fixed, tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity; *current* expenditure on wages, salaries and other labour costs, materials, repair, travel, etc., attributable to R&D; and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

Human resources devoted to R&D measure the effort of researchers, technicians and other staff *directly* involved with R&D activity. Overhead staff (e.g. administrative and general services employees, such as personnel officers and cleaners) whose work *indirectly* supports R&D activity, are excluded from counts of personnel but their costs are included in overheads.

Researchers are those involved with the conception and/or development of new products or processes. They include project managers, directors, scientists and engineers concerned with project content but exclude those concerned with administrative matters.

Technicians are those performing technical tasks in support of R&D activity, normally under the direction

and supervision of a researcher. These tasks include performing experiments, maintaining and operating advanced equipment, and computer programming.

Other supporting staff are those skilled and unskilled craftspersons, and secretarial, administrative and clerical staff, directly associated with R&D activity.

Technological balance of payments is the collation of those invisible international transactions relating to trade in technical knowledge or know-how. *Technical know-how* is defined as: existing specialised technical knowledge that is required to produce a successful product or implement a process, e.g. patents; licenses; technical data and information; and scientific, technical or engineering assistance that increases technical knowledge and understanding in the organisation.

Payments for technical know-how exclude other costs, such as overseas travel and subscriptions to periodicals, as well as the cost of computer software and scientific, technical or engineering services that are not aimed at increasing the technical knowledge of the organisation.

Receipts for technical know-how exclude contract or commission work carried out on behalf of others.

The *business enterprise* sector includes all enterprises whose primary activity is the production of goods or services for sale to the general public at a price intended to cover at least the cost of production, and the private non-profit institutions mainly serving them.

The organisational unit for the collection of R&D statistics is the enterprise. An *enterprise* is defined broadly as the unit comprising all the operations in New Zealand of a single operating legal entity (e.g. company, partnership or sole proprietor).

The vast majority of enterprises included are private businesses. The remainder are public business enterprises mainly engaged in trading or financial activities, research associations funded by levy or grant, producer boards, private non-profit organisations and local authorities.

The survey population covers a wide range of industries from the *New Zealand Standard Industrial Classification* (NZSIC) 11214 *Landscape Planting and Maintenance Services* to 95991 *Funeral Directors*, and between all divisions from *Forestry and Logging* to *Personal and Household Services*. The survey covered industries from a total population of 171,676** government and private sector enterprises (virtually the entire economy, excluding farming enterprises).

Farming enterprises (i.e. industries in major group 111 of NZSIC, 1987 edition) were not included in the Statistics NZ Business Directory update, so were not canvassed for inclusion in the survey. Farming companies known to be doing R&D were included. Agricultural R&D activity is generally carried out by specialised research associations.

For the purposes of R&D statistics, the OECD recommends that research institutes be classified according to the industry they predominantly serve, and this recommendation has been followed in this report. The predominant output area specified by each research association was used as a guide, and supplementary NZSIC codes assigned and used in all tables for the data provided by the research institute.

Each enterprise is classified to the industry in which it mainly operates even though one or more of its component activity units (factories, shops, etc.) may be classified to other industries. For further comment see the *New Zealand Standard Industrial Classification*, 1987 Edition[8].

** *This population is taken as at February 1994 from "Business Activity 1995", Statistics NZ*

E OECD reference countries

Six countries from within the OECD have been identified by the New Zealand Institute of Economic Research (NZIER) (also see Edwards, 1992[9]) as having a number of similar characteristics to New Zealand regarding population, size of the economy, and stage of economic development. These countries, Australia, Denmark, Finland, Ireland, Sweden and Norway, are used in this report as a basis for international comparison of some of the main results and are referred to as the OECD "reference countries".

F Limitations of the survey data

There are limitations to the level of accuracy that can be expected from an R&D survey. Many respondents do not keep separate account of their R&D expenditure, or they may include R&D with other scientific and technological services, such as consulting. Records may not be kept in the form required for the survey and considerable estimation may be required. Detailed descriptions of what should and should not be included as R&D were provided on the questionnaire form, and phone-in help was available and utilised. However, best estimates were required in many cases. As the survey is repeated, the results can be expected to become more reliable as respondents become more experienced.

The OECD requirement for international comparability means that capital expenditures were requested rather than depreciation. This is in order to avoid comparison of different systems of depreciation internationally. It needs to be borne in mind that large capital expenditures can cause fluctuations in total expenditure from year to year and this can mask a trend or introduce a false trend.

The 1989/90 business enterprise survey was based on a stratified sample; all subsequent surveys except the fourth have had full coverage. The fourth survey (1992/93) included only top providers and funders for the business enterprise sector, plus rated-up estimates for the rest. The government sector was full coverage. Sampling error will no doubt contribute to the fluctuations noted between the 1992/93 survey and the full coverage surveys, and this must be taken into account when making comparisons.

1 BUSINESS

1.1 Key results

- R&D carried out by the business sector increased by $43 million, or 21% in 1993/94. This is the largest increase since the surveys began in 1989/90. The amount of R&D *'funded by'* business enterprises increased by $54.4 million***, or 23%, with the R&D funding that the business sector reported as going to the government and university sectors increasing by $16 million, or 38%.

- Expenditures on R&D by the business sector amounted to $248 million in 1993/94. This was equivalent to 0.31% of GDP. The average for the six OECD reference countries (see section E of the Introduction) was 1.2%, almost four times the level in New Zealand.

- There were 661 enterprises in New Zealand undertaking R&D, as defined in the Frascati Manual. This is one out of every 250 enterprises in New Zealand. A further 90 enterprises were either funding R&D or trading technical know-how abroad. Other businesses may undertake less formal or on-the-job research which was not classified as R&D or could not be identified. However, the New Zealand survey includes enterprises with less than 10 employees, which most overseas surveys do not, and about 9.2% of the total reported R&D was from these small firms.

- Over the last three years, research directed towards primary production and processing increased at the same rate as the overall increase in business R&D, a 28% increase since 1991/92. Within this group, dairy and forestry research experienced a higher rate of growth, at 55% and 53% respectively. In 1993/94 energy and environmental protection research showed the largest increases, but from a very small base, followed by information and communication and commerce and trade each with just over 60% increase in R&D.

- Last year's report noted the large increase in R&D in the electronics industry. In 1993/94, research in this industry was levelling off with a growth of 15% versus 55% in the previous year. However, there is a related area of information and communications research, which includes software, which increased by 61% in 1993/94. Together these industries showed an annual average increase of 29% from 1991/92 to 1993/94.

- New Zealand businesses spent on average just under 0.4% of their sales revenue on R&D. This compares with an average of 2% in the reference countries. Even if the industry structure of the reference countries is adjusted to match that in New Zealand the average expenditures on R&D in the reference countries would amount to an average of 1.2% of sales. In particular, the percent of sales spent on R&D in the paper, paper products and chemical products industries in New Zealand are only one tenth of the level in other countries. The food and beverage industries in New Zealand invest at close to international levels. Textiles is the only one of ten industry groups where research in New Zealand is well above the reference average

- Compared with overseas, fewer researchers work in the private sector in New Zealand. Persons engaged in R&D in the business enterprise sector represented 26% of the total national R&D personnel, compared with an average of 50% for the six OECD reference countries. Total research personnel (head counts) in the business sector were 3,854 (2,780 FTEs). The number of R&D personnel represents 1.7 per 1,000 labour force. This compares with 4.3 per 1,000 labour force in the OECD reference countries.

*** *Based on source of funds information from respondents (see sections 2 and 3 below).*

1.2 Outline of this section

After a brief introduction, which discusses some characteristics of the survey responses, the rest of this section is divided into four parts. The first part, section 1.4, starts with a description of changes in the pattern of R&D expenditure by the major groups of science outputs, or areas of research, since 1991/92. This is followed by more detailed comparison of R&D expenditure for the two most recent surveys.

Section 1.5, shows business sector R&D by industry group, looking at the type of funds (salaries, current and capital), the number of responding firms, and R&D personnel full-time equivalents (FTEs) by industry.

Section 1.6, provides an analysis of the source of funds for R&D carried out in the business sector, and of research carried out in other sectors with business funding, by industry group. Three different methods of estimating total business enterprise research funding are described.

The final part, section 1.7, compares industry R&D expenditure in New Zealand with that in other OECD countries, and in particular with six reference countries. A brief analysis is provided for R&D as a percentage of sales for manufacturing and how this compares internationally taking into account the different mix of industries in the different countries.

1.3 Introduction

The R&D questionnaires were sent to 2,016 enterprises. These enterprises indicated that they spent more than $5,000 carrying out or funding R&D, or buying or selling technical know-how abroad, in the Statistics NZ Annual Business Directory Update (ABDU) survey which was sent out earlier in the year. The response rate to the R&D survey was 94%, with a 100% response rate from business enterprises with more than 100 FTE employees.

Based on the stricter Frascati definition of R&D used in the R&D survey 751 enterprises (0.5% of the total population) stated that they provided or funded R&D or traded in technical know-how. R&D was being carried out by 661 respondents, while 234 were funders, some of whom also carried out their own research. Seventy seven respondents purchased technical know-how abroad, and 64 received income from the overseas sale of technical know-how. The number of enterprises performing or funding R&D has declined compared with previous surveys.

	Carrying out R&D	Funding R&D
1990/91	736	265
1991/92	765	286
1992/93	n/a	n/a
1993/94	661	234

Total R&D carried out in the business sector: total R&D carried out in the business sector was $248 million, up significantly from $205 million in 1992/93 and $193 million in 1991/92, $204 million in 1990/91 and $200 million in the first R&D survey in 1989/90. Business enterprises include industry research associations and producer boards which carried out $59 million of the business sector R&D in 1993/94 ($52 million in 1992/93).

Total R&D funded by the business sector: the business sector funded between $244 and $279 million R&D in 1993/94, depending on the method of estimating funding, plus $14 million which was spent overseas. The amounts the business sector reported as being spent on research in other sectors (giving the lower figure) did not match the funds that respondents in other sectors said they receive from the business sector (giving the higher figure). There is no easy reconciliation between these two estimates, although a

variety of possible explanations could be offered. The lower amount is used in this chapter to match with the responses from the business sector. However, in keeping with the OECD methodology of using provider figures, the higher amount is used in Chapter 4, where data from each of the separate sector surveys is combined.

Excluding research associations and producer boards, the distribution of the R&D expenditure of the business sector was heavily concentrated in a small number of firms. Of the total of $258 million spent on research which was funded by the business sector (but not necessarily carried out in the sector), $70 million was spent by research associations and producer boards. The remaining $188 million was spent as follows:

The top 5 firms spent $45 million, or 24%.
The top 10 firms spent $62 million, or 33%.
The top 70 firms spent $128 million, or 68%.

Each enterprise in the survey was asked to state the output class which best described the *purpose* of its R&D. This is not a common practice amongst OECD countries who normally use this output, or purpose-based, classification only for government sector research. It is used in New Zealand in order to be able to compare private sector R&D with government (and university) R&D in a way that is relevant to the Government's priority setting for public investment in R&D. Output classes are New Zealand Government science funding categories, used in setting priorities and making funding allocation decisions for public good research, either individually or grouped.

Therefore, in addition to classifying R&D by the industry group (NZSIC) to which the enterprise belongs, business sector R&D in New Zealand can also be grouped by science output class. It is recognised that in some instances, firms may confuse the *purpose* with the *nature* of the R&D, e.g. R&D developing agricultural machinery may be coded to Output Class 17 (engineering process, systems and products), instead of to the appropriate agricultural output class. However, this is not considered to be a significant problem.

Forty statistical output classes have been used for collecting data since 1989/90. Fifteen science areas were used to develop science strategies in 1992/93. A priority setting exercise in 1995 used a different grouping of 17 output areas. These 17 groupings, with the addition of categories for health research and for space and fundamental research, are illustrated in Figures 1 and 2 on pages iv and v of the Executive Summary.

Descriptive detail of the 40 science output classes is given in Annex 3.

1.4 Business enterprise R&D (BERD) carried out in each science output class

1.4.1 Overview of changes over time by science output class

The total expenditure on R&D carried out by the business enterprise sector increased between 1992/93 and 1993/94 by $43.1 million, to $247.9 million. This overview describes changes in R&D by the seven subgroups of the 40 output classes. These sub-groups distinguish between R&D for primary production, primary product processing, other manufacturing, infrastructure, social sciences, environment and other research. (Summaries of R&D according to the 40 science output areas, and these seven subgroups, for the business sector compared with the Government sector, and for all three sectors, are given in Table 10 and Table 19 respectively.)

In total, primary production and primary product processing (outputs 1 to 15) have shown a consistent increase in business R&D expenditure since 1991/92. The R&D expenditure in these groups is $108.9 million, $96.5 million and $85.1 million respectively in each of 1994/93, 1992/93 and 1991/92. But its proportion of total intramural business R&D varied. It represented 44% of intramural business enterprise R&D in 1993/94, 47% in 1992/93 and 44% in 1991/92.

Over 20% of the R&D is aimed at outputs 16 to 18, the development of new and improved materials and industrial processes, engineering products and processes, and computing, electronic, telecommunication and instrumentation processes, systems and products. R&D reported in this group increased by $1.7 million to $54.4 million in 1993/94 after a similar increase in 1992/93.

A quarter of the research is aimed at outputs 19 to 24, the development of improved infrastructure and services. These include: construction, commercial and trade services, energy, transport, information and communication services, and urban and rural planning. R&D in these areas showed a big increase between 1992/93 and 1993/94, of 62%.

Table 1. R&D carried out in the business sector by strategic science area

Strategic Science Areas		1993/94		1992/93	1991/92
Output classes	Output Aggregation	Number of firms	R&D expenditure ($000)	R&D expenditure ($000)	R&D expenditure ($000)
1, 2, 11,14	Sheep and beef production, meat, fibre, textile and skin processing	117	32,059	31,064	30,977
3, 12	Dairy production and processing	59	42,212	37,978	27,176
4	Alternative animal species	11	613	225	482
5	Generic animal research	8	1,639	637	250
6	Forage plants	13	2,836	2,553	2,407
7, 8, 13	Horticulture, arable and other plant production, and processing	93	16,751	14,253	13,982
9, 15	Plantation forestry production and processing	39	11,885	9,554	7,771
10, 32	Fisheries, and marine & fresh water	22	2,149	1,007	1,096
16, 17, 18, 19	Materials, industrial processing, engineering, electronics, instruments and construction	311	62,691	58,527	58,363
20, 21, 22, 23, 24	Infrastructure, including commercial and trade services, energy, transport, information & communication, and urban & rural planning	157	54,859	33,222	32,241
25, 26, 27, 28	Social sciences, including history, culture, relationships, politics and economics, and education & training	42	3,317	3,249	4,079
29, 30, 31, 33	Protection, exploration and assessment of the earth (excluding marine and fresh waters)	41	4,178	1,784	2,898
35	Antarctica	n.p.	n.p.	n.p.	n.p.
34, 36	Space and fundamental knowledge	5	218	113	106
37	Health	44	12,033	10,545	9,175
38, 39	Other (including defence)	n.p.	n.p.	n.p.	n.p.
	TOTAL	661	247,890	204,839	193,332

n.p. = not for publication to protect confidentiality of responses

In 1993/94, business enterprises targeted $12 million (4.9% of their total R&D) at health research, similar to the previous year. Research aimed at the protection of the environment (which includes pollution and waste management), research into natural resources and research into fundamental knowledge increased by $3 million in total from 1992/93 to 1993/94. These comprised 2% of intramural business R&D in 1993/94 compared with 1% in 1992/93 and 2% in 1991/92. Reported research on social development, including economic research, showed a small increase, coming after a $0.83 million drop in 1992/93.

The following sub-sections discuss the changes in R&D according to fifteen sector-based groupings used in the 1992/93 priority setting process. These groups combine the science output areas for production and processing for each sector and are useful for comparing expenditure levels between each vertically integrated

sector. Summary totals for these 15 strategic science areas are shown in Table 1. (Note: this is not the same as the amount *funded* by the private sector in each output category which is shown in Table 7.)

1.4.2 Sheep and beef production, meat, fibre, textile and skin processing

Business R&D expenditures in this group are highly concentrated in meat processing, and fibre, textile & skin processing, which represent 49% and 41% of total R&D in this group respectively. The overall R&D expenditures in this group increased by almost $1 million, to $32.1 million in 1993/94. The biggest increase was in meat processing, which increased from $13.9 million in 1992/93 to $15.7 million in 1993/94.

Table 1.1 R&D carried out in outputs 1, 2, 11, 14

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
1. General Sheep Production	2,055	6	-43	3,625	12	-15
2. Beef Production	1,166	4	416	226	1	17
11. Meat Processing	15,662	49	13	13,856	44	-4
14. Fibre, Textile & Skin Processing	13,176	41	-1	13,357	43	11
Total	32,059	100	3	31,064	100	0.3

Beef production has continued to increase its R&D expenditure since 1991/92, and is the only output area in this group to maintain consistent growth in R&D.

1.4.3 Dairy production and processing

R&D expenditure on dairy production and processing increased by $4.2 million, reaching $42.2 million in 1993/94. Both dairy production and processing have experienced considerable growth in their R&D expenditure, rising to $3.2 million and $39 million respectively in 1993/94. R&D in dairy processing is much higher than in dairy production.

Table 1.2 R&D carried out in outputs 3, 12

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
3. Dairy production	3,187	8	43	2,232	6	37
12. Dairy processing	39,025	92	9	35,746	94	32
Total	42,212	100	11	37,978	100	32

1.4.4 Alternative animal species, generic animal research and forage plants

Business R&D expenditure in alternative animal species increased by 172.8%, amounting to $0.61 million in 1993/94, after a 53.4% drop in 1992/93. Generic animal research increased by 154% in 1992/93, with a further 157% increase in 1993/94. R&D in forage plants increased steadily over the period, with spending of $2.8 million on R&D in 1993/94.

Table 1.3 R&D carried out in outputs 4, 5, 6

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
4. Alternative animal species	613	12	173	225	6	-53
5. Generic animal research	1,639	32	157	637	19	154
6. Forage plants	2,836	56	11	2,553	75	6
Total	5,089	100	49	3,415	100	9

1.4.5 Horticulture, arable and other plant production, and processing

R&D expenditure in this group was up to $16.8 million in 1993/94, from $14.3 million in 1992/93. Of this total, other food processing accounted for 76%, horticulture for 13%, and arable for 11%. Spending in other food processing (output class 13) increased by 35%, while horticulture, arable and other plants slipped behind in their R&D expenditures from 1992/93 to 1993/94.

Table 1.4 R&D carried out in outputs 7, 8, 13

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
7. Horticulture	2,133	13	-26	2,878	20	27
8. Arable & other plants	1,901	11	-4	1,985	14	19
13. Other food processing	12,718	76	35	9,390	66	-6
Total	16,751	100	18	14,253	100	2

1.4.6 Plantation forestry production and processing

Total R&D expenditures in this group rose 24.4% in 1993/94, after a 23% increase in 1992/93. The increase in plantation forestry production was quite substantial (37%) compared with that in wood and paper processing (12.2%).

Table 1.5 R&D carried out in outputs 9, 15

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
9. Plantation forestry	6,437	54	37	4,699	49	88
15. Wood & paper processing	5,448	46	12	4,855	51	-8
Total	11,885	100	24	9,554	100	23

1.4.7 Fisheries, and marine and fresh waters

R&D expenditures in this group increased by $1.1 million to $2.1 million in 1993/94. Of the total, marine and fresh waters contributed $1.2 million, accounting for 57.6%. R&D expenditure in the fisheries industry increased 282% between 1992/93 and 1993/94, whilst the marine and fresh water area grew 61% in the same period. The big percentage increase in fisheries R&D from 1992/93 to 1993/94 follows a dip in spending in the previous year.

Table 1.6 R&D carried out in outputs 10, 32

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
10. Fisheries	910	42	282	239	24	-51
32. Marine & fresh waters	1,239	58	61	769	76	26
Total	2,149	100	113	1007	100	-8

1.4.8 Materials, industrial processing, engineering, electronics, instruments and construction

R&D expenditure in this group has been increasing since 1991/92, with a $4.2 million increase in 1993/94. Of the $62.7 million spent by this group, $15.8 million goes on research aimed at new and improved computing and electronic, communication and instrumentation processes, systems and products (output class 18). This is $1.5 million less than was reported in 1992/93. However, the wording of output classes 18 and 23 both relate to R&D in information processing and communications. It is sometimes difficult to be sure that a change in amount of R&D reported in these areas is due to classification difficulties or to a real change. Because software services apply to many different industries, a particular piece of software research may also be classified with the industry area it serves.

New and improved materials, industrial processes and products from chemicals, petroleum and coal, base metals and glass, including plastics, rubber and pharmaceutical (output class 16) accounted for R&D of $11.8 million in 1993/94, a rise of $2.0 million. Engineering processes, systems and products, including manufacturing, automation and production technologies for fabricated metal products, transport equipment, agricultural machinery and mechanisation, appliance and electrical equipment, and industrial and construction machinery and equipment (output class 17) is still the largest output in this group, and amounts to $26.9 million, a slight increase from 1992/93.

Table 1.7 R&D carried out in outputs 16 to 19

Output classes		R&D expenditure					
		1993/94			1992/93		
		($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
16.	Materials and industrial processing	11,761	19	21	9,730	17	-24
17.	Engineering	26,902	43	5	25,680	44	20
18.	Electronics & instruments	15,762	25	-9	17,303	30	3
19.	Construction	8,266	13	42	5,815	10	-21
	Total	62,691	100	7	58,527	100	0.3

1.4.9 Infrastructure

There has been a significant increase in intramural business expenditure in this grouping in 1993/94. This grouping includes R&D in commercial and trade services, which includes tourism, ($4.8 million), energy ($4.7 million), transport ($3.0 million), information and communication ($42.1 million) and urban and rural planning ($0.15 million).

Over three-quarters of the $54.9 million of R&D in this group ($42.1 million) was spent on output class 23, new and improved information and communication services, including computer software, information processing, library and related information services, broadcasting, telecommunications, postal and other communications services. There was an increase in intramural R&D expenditure for this output class of $16 million. Much of the research in this output involves computer software research. When this output is combined with output 18, which represents electronics, including communications hardware, it is clear that information systems comprise a large area of business enterprise sector R&D in New Zealand. The two outputs total $57.9 million in 1993/94 ($43.4 million in 1992/93), or 23.4% of all the business enterprise R&D.

Table 1.8 R&D carried out in outputs 20 to 24

Output classes		R&D expenditure					
		1993/94			1992/93		
		($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
20.	Commercial & trade services	4,848	9	60	3,021	9	-33
21.	Energy	4,685	8	183	1,655	5	-53
22.	Transport	3,030	5	34	2,266	7	33
23.	Information and communication services	42,144	77	61	26,135	79	18
24.	Urban & rural planning	153	0.3	5	145	0.4	-53
	Total	54,859	100	65	33,222	100	3

1.4.10 Social sciences, the environment, and natural resources

Social sciences, the environment and natural resources do not receive much attention from the business enterprise sector. Overall, the social sciences received a similar level of funding to last year ($3.3 million in 1993/94 and $3.2 million in 1992/93), although there was a decrease in the area of politics and the economy (down $0.75 million), and an increase in the social relationships and well-being category (up $0.38 million). R&D on protection, exploration and assessment of the earth has been increased by $2.4 million to $4.2 million in 1993/94.

Table 1.9 R&D carried out in outputs 25 to 33, excluding 32

Output classes	R&D expenditure					
	1993/94			1992/93		
	($000)	% of total	% change on year earlier	($000)	% of total	% change on year earlier
25. History, society & culture	326	4	39	235	5	7
26. Relationships & wellbeing	655	9	128	288	6	-72
27. Political & economic development	1,841	25	-29	2,595	52	21
28. Education, knowledge & training	494	7	275	132	3	-81
29. Environmental protection	2,638	35	103	1,299	26	-22
30. Geological structure	759	10	94	391	8	-66
31. Land based flora & fauna	682	9	930	66	1	7
33. Climate & atmosphere	99	1	249	28	1	7
Total	7,494	100	49	5,034	100	-28

Business sector R&D in space (output 34) and Antarctica (output 35) are too insignificant to be published separately.

1.4.11 Fundamental knowledge, health and defence

Expenditure on R&D in health (output 37) increased a further 14% to $12.0 million in 1993/94, after increasing 15% in 1992/93. Results for the Business Directory Update (published by Statistics NZ) identified several enterprises, not identified in the 1989/90 survey, engaged in health research in 1993/94. These enterprises were added to the 1994 survey after consultations with the Researched Medicines Association. Business sector R&D in fundamental knowledge (output 36) and defence (output 38) are too insignificant to be published separately.

1.5 R&D by industry group

1.5.1 Intramural business sector R&D, by industry group

The previous section gave the allocation of R&D by science output class. This section analyses the results according to the industry to which the enterprises undertaking R&D belong using the New Zealand Standard Industrial Classification (NZSIC). To protect confidentiality while providing the maximum amount of additional information, enterprises are grouped into 11 industry groups. These are given in Table 2.

In this analysis, and throughout this report, the research associations are classified to the industry group they predominantly serve. As the Statistics NZ Business Directory is updated annually, an enterprise may be reclassified to a new NZSIC if its predominant activity has changed.

R&D expenditure showed an increase in most industrial groups in 1993/94, and a 21.0% increase overall. However, within industry groups, major differences were seen. Of the 11 industry groups, nine showed increased expenditure:

- The largest percentage increase occurred in the mining, basic metals and metal fabrication sector and the infrastructure services sector which increased 51% ($3.3 million) and 50% ($8.0 million) respectively;

- The next largest percentage increase (39%) came from other manufacturing (wood, paper, and

Table 2. R&D carried out by the business sector, by industry group

NZSIC group	Industry Group	Number of firms	Expenditure 1993/94 Total ($000)	Expenditure 1992/93 Total ($000)	Expenditure 1991/92 Total ($000)
1000	Agriculture, forestry and fishing	23	9,126	6,917	4,430
2000, 371, 372, 381	Mining, basic metals and metal fabrication	37	9,754	6,440	9,508
351, 352, 352, 354	Chemicals (fertilizers, pesticides, paint, drugs)	35	10,435	11,022	12,503
310, 320, 355, 356	Food, textiles, plastics production	109	84,050	74,732	61,905
3830, 3832	Electrical machinery (electronic, appliances)	47	31,911	27,675	17,823
3820, 3825, 3850	Machinery (industrial, office, instruments)	57	11,699	9,327	12,087
330, 340, 360, 390	Other manufacturing (wood, paper, concrete)	40	8,807	6,341	8,677
384	Transport equipment (railroad etc)	6	957	1,193	1,826
4000-7000	Infrastructure services	92	24,123	16,097	17,609
8000 except 8324	Financial, software development services	76	35,684	28,467	26,266
8324, 9000	Engineering, scientific services	117	21,344	16,626	19,098
1000-9000	TOTAL	639	247,890	204,839	191,732
Producer Boards and Research Associations*		12	*59,273	*52,653	*42,804

* Data included in the "Total" row

concrete), increasing from $6.3 million to $8.8 million;

- The largest area of expenditure is in food, textiles and plastics, which increased by $9.3 million (12%) to $84.1 million;
- Agriculture, forestry and fishing, and engineering and scientific services increased by 32% and 28% respectively; and
- Other increases occurred in financial and software development services, producer boards and research associations, electrical machinery, and other machinery.

Two categories showed reduced R&D expenditure:

- Transport equipment decreased for the second year in a row (by $0.24 million), to $1.19 million; and
- Chemicals dropped in funding by 5%, from $11.0 million to $10.4 million.

Firms are now becoming experienced in responding to the R&D survey and it is expected that consistency of reporting will continue to improve. In the future, improved consistency may mean that data from earlier surveys needs adjusting if long-term trends are to be extrapolated.

1.5.2 Type of R&D expenditure in the business sector

Enterprises were asked to indicate how they spent their R&D funds. Results are given in Table 3. Wages and salaries consumed 51.7% of the $247.9 million allocated to R&D in the business enterprise sector, dropping by 2.7%. Other current expenditures accounted for 33.5%, compared with 35.6% in 1992/93. Capital expenditures were 14.8%, compared with 10.0% in 1992/93.

1.5.3 Number of enterprises and R&D staff, by industry group

In Table 4, statistics are given for the 11 industry groupings on the number of enterprises undertaking R&D, expenditure on intramural R&D, and full-time equivalent R&D personnel.

The survey shows an increase of 334 personnel doing R&D (13.7%). The largest overall increase (from 231 to 307) occurred in financial and software development services. The next largest was in engineering and scientific services (from 238 to 294).

The last columns show the expenditure on R&D per full-time equivalent R&D staff member, an indicator of R&D intensity. This increased, in total, by 6% over the previous year. The highest expenditure, per person, was in other manufacturing (wood, paper, concrete) followed by that of financial and software development services.

Table 3. Type of R&D expenditure, by industry group, 1993/94

Industry of Enterprise		Type of Expenditure, ($000)			
NZSIC group	Description	Wages and Salaries	Other Current Expenditure	Capital Expenditure	Total
1000	Agriculture, forestry and fishing	3,919	4,174	1,033	9,126
2000, 371, 372, 381	Mining, basic metals and metal fabrication	5,228	3,474	1,051	9,754
351, 352, 352, 354	Chemicals (fertilizers, pesticides, paint, drugs)	6,119	3,914	403	10,435
310, 320, 355, 356	Food, textiles, plastics production	42,703	28,456	12,890	84,050
3830, 3832	Electrical machinery (electronic, appliances)	17,253	9,222	5,436	31,911
3820, 3825, 3850	Machinery (industrial, office, instruments)	6,626	3,380	1,694	11,699
330, 340, 360, 390	Other manufacturing (wood, paper, concrete)	3,141	4,481	1,185	8,807
384	Transport	435	213	309	957
4000-7000	Infrastructure services	10,054	5,894	8,176	24,123
8000 except 8324	Financial, software development services	20,390	13,827	1,468	35,684
8324, 9000	Engineering, scientific services	12,353	6,027	2,964	21,344
1000-9000	TOTAL (including Research Associations)	128,220	83,061	36,609	247,890
	Percent	51.7	33.5	14.8	100.0
	Research Associations	31,295	17,838	10,140	59,273
1000-9000	Total (1992/93) (Includes Research Associations)	111,433	72,946	20,459	204,839
	Percent	54.4	35.6	10.0	100.0
1000-9000	Total (1991/92) (Includes Research Associations)	103,250	70,487	17,995	191,732
	Percent	53.9	36.8	9.4	100.0

Table 4. Number of enterprises and R&D staff, by industry group

Industry of Enterprise		Enterprises undertaking R&D				R&D personnel FTE				R&D Expenditure per FTE ($000)			
		1993/94		1992/93	1991/92	1993/94		1992/93	1991/92	1993/94		1992/93	1991/92
NZSIC Codes	Description	all	Producer Boards & Research Assns*	all	all	all	Producer Boards & Research Assns*	all	all	all	Producer Boards & Research Assns*	all	all
1000	Agriculture, forestry and fishing	25	n.p.	25	26	100	26	60	55	91	n.p.	115	81
2000, 371, 372, 381	Mining, basic metals and metal fabrication	39	n.p.	45	47	112	n.p.	95	134	87	n.p.	68	71
351, 352, 352, 354	Chemicals (fertilizers, pesticides, paint, drugs)	37		51	52	130		119	153	80		93	82
310, 320, 355, 356	Food, textiles, plastics production	113	6	136	134	992	617	945	881	85	83	79	70
3830, 3832	Electrical machinery (electronic, appliances)	50		55	55	405		380	307	79		73	58
3820, 3825, 3850	Machinery (industrial, office, instruments)	59		55	56	145		119	164	81		78	74
330, 340, 360, 390	Other manufacturing (wood, paper, concrete)	44	n.p.	61	60	71	n.p.	70	76	124	n.p.	91	114
384	Transport equipment (railroad etc)	6		11	11	11		14	21	87		85	87
4000-7000	Infrastructure services	98	n.p.	90	91	213	19	177	192	113	n.p.	91	92
8000 except 8324	Financial, software development services	80		98	98	307		231	266	116		123	99
8324, 9000	Engineering, scientific services	123	n.p.	124	128	294	40	238	264	73	n.p.	70	72
1000-9000	TOTAL	675	12	751	758	2,780	709	2,446	2,512	89	84	84	76

*Producer Boards and Research Associations are also included in "ALL" data

n.p. = Not published for reasons of confidentiality.

1.6 Funding of R&D expenditure in the business sector

1.6.1 Source of funds for intramural R&D

The business enterprise sector used its own funds, the funds of other firms and government, and overseas sources in order to carry out its intramural R&D of $247.9 million. The funding from these sources is shown in Table 5 for the last three survey years.

Table 5. Source of funds for R&D carried out in the business sector

	1993/94		1992/93		1991/92	
Source of Funds	($000)	%	($000)	%	($000)	%
Own Funding	170,097	68.6	130,948	63.9	128,869	67.2
Related Private NZ Firm	28,402	11.5	29,337	14.3	22,064	11.5
Unrelated Private NZ Firm	22,990	9.3	21,320	10.4	17,377	9.1
Foundation for Research Science & Technology (FRST)	12,555	5.1	11,657	5.7	10,846	5.7
NZ Central Government	4,097	1.7	4,253	2.1	2,772	1.4
NZ Local Government	830	0.3	731	0.4	307	0.2
Overseas Funds from Related Firms	4,009	1.6	3,792	1.9	5,146	2.7
Overseas Funds from Unrelated Firms	4,340	1.8	2,576	1.3	4,164	2.2
Other Sources of Funds (PNP)	570	0.2	224	0.1	186	0.1
TOTAL	247,890	100.0	204,839	100.0	191,732	100.0

Note: NZ Tertiary Education Sector is included in Central Government. Columns will not always agree with totals shown due to rounding of individual estimates.
PNP: Private non-profit

Since 1991/92, the amount of business enterprise R&D that has been funded from the resources of the organisation doing the research has increased. As a proportion of the total, "own funds" decreased in 1992/93, but the actual value went up by 2%. In 1991/92, it was 67.2% of total expenditures on R&D, 63.9% in 1992/93, and 68.6% in 1993/94. In 1993/94, the proportion of funds both from related New Zealand private sector enterprises and from unrelated enterprises, decreased. (Related enterprises are those which share with the survey respondent a direct investment relationship and/or a common management structure.)

Eleven percent of the research performed in the business enterprise sector was funded from outside the sector (from overseas and government), which was slightly less than last year (11.2%). The contribution from the New Zealand Central Government (including FRST) decreased to 6.8% in 1993/94. Contributions from related private enterprises abroad was 1.6%, down from 1.9% in 1992/93, and unrelated private enterprises abroad contributed 1.8%, up from 1.3% in 1992/93.

Of the funds coming from outside the business enterprise sector, $12.6 million came from the Foundation for Research, Science and Technology (FRST) and $4.9 million from central and local government. A further $8.3 million came from overseas. The equivalent 1992/93 figures are $11.7 million from FRST, $5.0 million from the rest of government, and $6.3 million from overseas. Firms have increased funding from their own sources and there appears to be an increase in funds from related and from unrelated overseas firms (up $0.23 million and $1.8 million respectively). There has also been an increase in funds from unrelated firms within New Zealand (up $1.7 million), while there was a decrease in funds from related firms (by $0.84 million). There was a big increase in funds from enterprises' own funds ($39 million), and a small increase from New Zealand Government funds ($0.9 million) and from other unspecified sources ($0.35 million).

The proportion of industry funds used for R&D carried out by the New Zealand business enterprise sector (89.3%) is in line with the six OECD reference countries, where this figure averages 87.4% for the most recent available years. The portion of business enterprise R&D financed by government (including local government) is 7.1%, lower than the average OECD reference country figure of 9.8%

1.6.2 Additional research funded but not performed in the sector (extramural R&D)

In addition to the R&D carried out within the business enterprise sector, business enterprises reported they funded $19.7 million worth of research carried out by government organisations, $9.1 million by the universities, $14.3 million overseas, $1.3 million by other organisations and a little by local authorities. A total of $43.1 million was research funded by the business sector and carried out outside the sector. This compares with $39.8 million in 1992/93.

(Business enterprises stated that they also *funded* $44.8 million of research which was carried out by other business enterprises, i.e. within the business enterprise sector, compared with the reported receipt of $51.4 million from other related and unrelated NZ firms for R&D.)

1.6.3 Extramural R&D, by industry group

Table 6 provides information by industry group about all R&D funded by a business enterprise but carried out by other enterprises, institutions or individuals. This includes R&D funded within other business enterprises (which was presumably reported in intramural R&D by the providers). A total of $87.8 million was spent on extramural R&D, including funds circulating within the business sector. This is a 2.3% increase from last year.

Funders of R&D stated that other business enterprises were funded a total of $44.8 million, of which $35 million went to an enterprise related to the funder. Some of these funds may have been reported twice, as it is not uncommon for funds for research to be sub-contracted or passed to a funding organisation to be allocated; in which case, both funders would report the same R&D.

Another way of estimating extramural R&D funded by business is to aggregate information from the business, government and university surveys about the sources of their funds (see Chapter 4) where the estimate of extramural business-funded R&D would be $123.4 million compared with the $87.8 million reported as being funded extramurally by the business sector survey.

A total of $14.3 million is spent by the business enterprise sector on R&D carried out overseas. $12.8 million of this went to an overseas enterprise related to the funder.

Most of the R&D carried out extramurally was funded by the producer boards ($50.7 million). Producer boards spent $32.8 million funding R&D in private sector enterprises, $7 million in the government sector, and $10.9 million divided between the universities and overseas organisations.

Engineering and scientific services were the next largest funder of extramural R&D. Most of that money (73.5%) was spent in government and other private sector enterprises. Infrastructure services, which was the second largest funder in 1992/93, became the fourth largest in 1993/94.

Table 6. Extramural R&D funded by business enterprises, by industry group, 1993/94

Industry of Enterprises			Sector of Recipient of R&D Funding, ($000)					
NZSIC Codes	Description	Number of Enterprises	Government*	Universities	Other Business Enterprises	Overseas Organis-ations	Total ($000)	Increase since 1992/93 ($000)
1000	Agriculture, forestry and fishing	14	1,824	n.p.	117	n.p.	2,242	322
2000, 371, 372, 381	Mining, basic metals and metal fabrication	15	n.p.	159	241	n.p.	1,837	1,418
351, 352, 352, 354	Chemicals (fertilizers, pesticides, paint, drugs)	15	433	135	1,088	348	2,003	323
310, 320, 355, 356	Food, textiles, plastics production	36	505	538	1,969	1,076	4,088	153
	Producer bds: food, textiles, plastics	8	6,971	n.p.	32,825	n.p.	50,741	-861
330, 340, 360 382-385,390	Electrical and other machinery and other manufacturing	36	2,402	68	1,952	1,567	5,990	-1413
4000-7000	Infrastructure services	47	2,098	1,079	993	1,796	5,965	-4675
8000 except 8324	Financial, software development services	12	n.p.	119	370	n.p.	716	-1542
8324, 9000	Engineering, scientific services	44	5,283	n.p.	5,199	n.p.	14,232	8,287
1000-9000	TOTAL 1993/94	227	19,718	9,059	44,754	14,283	87,815	2,010
1000-9000	TOTAL 1992/93	287	16,069	8,728	45,999	15,008	85,805	-11511
1000-9000	TOTAL 1991/92	283	19,209	8,660	54,974	14,474	97,316	+14757

* Local authorities are included in the Government column

1.6.4 Total R&D funded by the business enterprise sector

Total research funding by the business enterprise sector increased from $221.4 million in 1992/93 to between $258 million and $264.5 million in 1993/94.

This may be calculated by aggregating each firm's "own funds" and "total funded". This gives total research funding of $170.1 million plus $87.8 million, or $257.9 million. This may also be is obtained from total R&D performed ($247.9 million) by subtracting R&D funded from outside ($26.4 million) and adding R&D funded by but not performed in the sector ($43.1 million). The difference is due to a difference of $6.6 million between the aggregate of what firms said they received from other firms and the aggregate of what they said they funded to other firms.

Both of these estimates fall short of the $293.5 million obtained in Table 18 (see section 4), where reports of government providers claim more than $25 million additional funding from the business sector. This is discussed further in section 2.5.

1.6.5 Intramural estimate of total R&D funded by the business enterprise sector, by output area

Table 7 shows estimates of the amount of business sector funds going to R&D in each output area. These estimates do not include the extra business funding reported by the government ($25.8 million) and university ($3.1 million) sectors which could not be allocated to the 40 output areas.

To obtain the estimates for intramural R&D funded solely by business enterprises (see column 2, Table 7), funding from all sources outside the firms was deducted from the value of each enterprise's intramural R&D, in the same proportion per output class as the proportion for total research carried out.

The allocation of business-financed extramural R&D carried out by firms, universities, government organisations or overseas to output classes had to be estimated because the survey asked only for the allocation of total R&D. If the enterprise carried out R&D it was assumed that it would fund in these same output areas. If it simply funded R&D, then the industrial classification was used to allocate the funds to the most likely outputs. The larger producer boards were asked for more information. The resulting estimates of total extramural expenditure on R&D in each output by the business enterprise sector, are shown in the third column.

Dairy processing is the largest single target of private sector R&D funds, with $46 million spent in New Zealand or overseas.

Output classes 18 (electronics and instruments) and 23 (information and communications services) should be considered together. The first includes the "hardware" aspects of computer microprocessor and communications R&D, and the second is "software" R&D into new programming languages and operating systems. These two areas are closely linked. Together they account for 21.5% of private sector funding for R&D (23.4% of all research carried out in the private sector).

Engineering processes - output class 17 ($25.4 million), and other food processing - output class 13 ($18.6 million) are the next largest areas of business enterprise R&D funding.

Table 7. Estimates of business enterprise funding of R&D, by output area, 1993/94

Science output area	R&D funded, ($000) Intramural	Extramural	Total
01 Sheep Production	1,600	5,160	6,760
02 Beef Production	1,090	870	1,960
03 Dairy Production	1,580	510	2,080
04 Alternative Animal Species	610	40	650
05 Generic Animal Research	1,260	140	1,390
06 Forage Plants	2,110	1,150	3,260
07 Horticulture	1,540	2,670	4,210
08 Arable crops and other Plants	1,150	580	1,740
09 Plantation Forestry	3,580	2,960	6,540
10 Fisheries	780	170	940
11 Meat Processing	6,260	6,980	13,250
12 Dairy Processing	11,130	34,840	45,970
13 Other Food Processing	12,370	6,220	18,590
14 Fibre , Textile & Skin Processing	5,360	5,730	11,080
15 Wood & Paper Processing	5,060	2,110	7,170
16 Materials & Industrial Processing	10,230	2,200	12,420
17 Engineering	24,270	1,090	25,360
18 Electronic & Instruments	14,530	340	14,870
19 Construction	5,920	370	6,290
20 Commercial & Trade	4,150	1,120	5,270
21 Energy	2,440	3,080	5,530
22 Transport Services	1,880	30	1,910
23 Information & Communications	39,080	1,530	40,610
24 Urban & Rural Planning	n.p.	n.p.	n.p.
25 History, Society & Culture	40	n.p.	n.p.
26 Relationships & Wellbeing	430	n.p.	n.p.
27 Political & Economic Relationships	270	60	330
28 Education, Knowledge & Training	170	180	360
29 Environmental Protection	980	470	1,450
30 Geological Structure & Process	n.p.	20	n.p.
31 Land use, Flora & Fauna	n.p.	n.p.	n.p.
32 Marine & Fresh Waters	60	n.p.	n.p.
33 Climate & Atmosphere	100	n.p.	n.p.
34 Space	n.p.	n.p.	n.p.
35 Antarctica	n.p.	n.p.	n.p.
36 Fundamental Knowledge	90	30	120
37 Health	9,650	6,440	16,100
38 Defence	n.p.	n.p.	n.p.
Other	290	20	310
TOTAL	170,650	87,260	257,910

Data in this table were rounded to nearest $10,000. n.p. = Not published for reasons of confidentiality

1.7 International comparisons

Traditionally most of business R&D has been carried out in the manufacturing sector (NZSIC major group 3). With the growth in the information technology and financial services sector, attention is turning to R&D in the services sector (NZSIC groups 4-9). Table 8 shows that this shift has been more marked in New Zealand than in other OECD countries. This may be partly due to other countries not extending their R&D survey coverage to include all the services sector.

New Zealand spent 66.5% of its total BERD in the manufacturing sector whilst the OECD countries and reference countries carried out 82.3% and 73.9% respectively in this sector. New Zealand does proportionally more research in the services sector than all other OECD countries and reference countries, spending 28.6% of total BERD compared with 14.7% and 19.9% respectively.

Table 8. Distribution of R&D carried out by business between manufacturing and services

	New Zealand 1993	New Zealand 1992	Reference Countries 1992	OECD (Excl. NZ) 1992
Manufacturing (%)	63.10	66.50	73.90	82.30
Services sector (%)	31.40	28.60	19.90	14.70

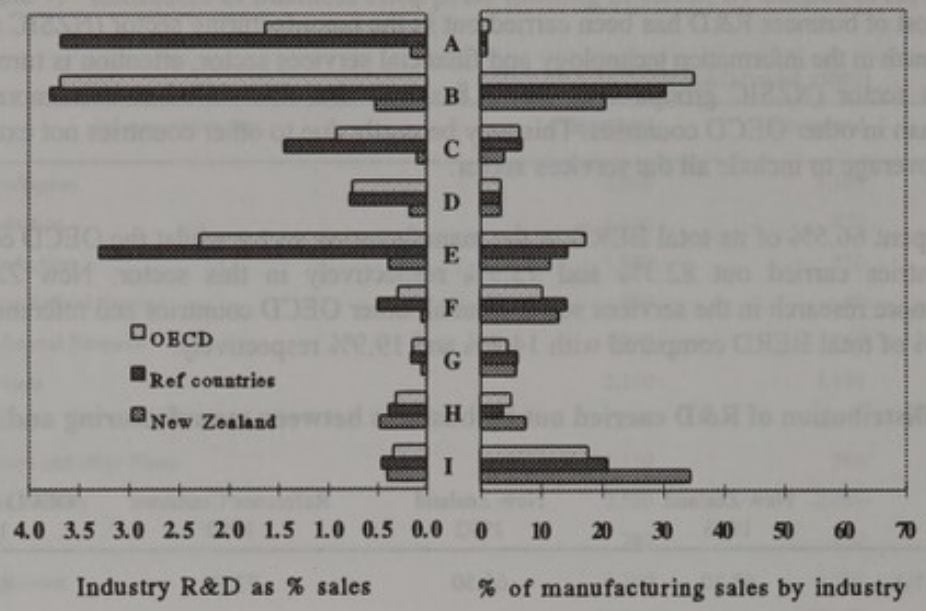
It is important to recognise that the distribution of research spending by industry sector for each country is closely linked with the volume of activity in each sector, as well as being linked with the propensity of firms in each sector to invest in R&D. Detailed data on an industry sector basis is not readily available for all OECD countries. However, the work by the OECD on their Structural Analysis (STAN/ANBERD) database provides some initial insights into the relationship between industry structure and R&D expenditures. The following analysis uses a preliminary version of this database and the results should be considered indicative rather than definitive. Currently this database covers manufacturing and excludes agriculture, infrastructure and services.

New Zealand manufacturing R&D accounted for 0.37% of manufacturing sales in 1993/94. The ratio of R&D to total manufacturing output in New Zealand is much lower than the average level in the reference countries of 2.02% (1992). It could be argued that the high rates in other OECD countries are partly due to their industrial structure (as measured by each industry's percentage of total manufacturing sales) being more oriented towards those industries that invest more heavily in R&D (as measured by their R&D intensity, i.e. R&D as a percent of sales), see Figure 4.

For example, fabricated metal products, which has a high R&D intensity (3.7% for the OECD) has 34% of total manufacturing sales in OECD countries but is only 20% of total manufacturing sales in New Zealand. On the other hand, food, beverage and tobacco products, which have a relatively low R&D intensity (0.46% in reference countries and 0.34% for the OECD) occupy 34% of manufacturing in New Zealand compared to 17-21% for other OECD countries. This means that the structure of New Zealand manufacturing is oriented to the lower R&D-intensive products.

Within the manufacturing sector, New Zealand does proportionally much more R&D on food, beverages & tobacco, and textile, apparel & leather industry groups than other OECD countries or reference countries, and much less on chemical products, and fabricated metal products. New Zealand has only one industry sector, textiles, apparel and leather, whose R&D intensity is higher than the average level in the reference countries (see Figure 4 and Table 9).

Figure 4. Distributions of manufacturing R&D and sales, by industry, 1992



A = Other manufacturing , nec
B = fabricated metal products
C = Basic metal industries
D = Non-metallic mineral products
E = Chemical products
F = Paper, paper products & printing
G = Wood products & furniture
H = Textiles, apparel & leather
I = Food, beverages & tobacco

Table 9. Industrial R&D as a percent of sales

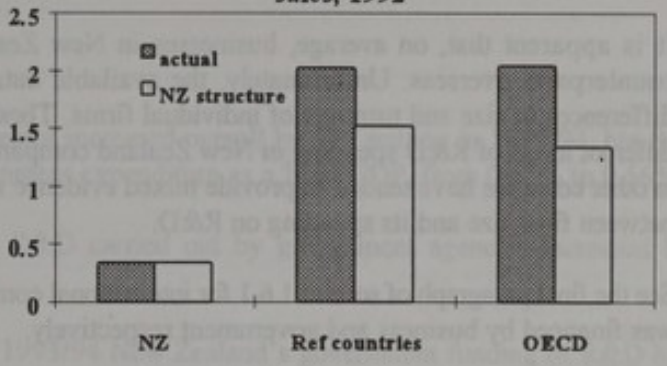
	New Zealand 1993	New Zealand 1992	Ref.* Countries 1992	OECD** (excl. NZ) 1992
Total manufacturing	0.37	0.34	2.02	2.04
Total adjusted (NZ industry structure)		0.34	1.52	1.34
Food, beverages & tobacco	0.45	0.40	0.46	0.34
Textiles, apparel & leather	0.45	0.48	0.38	0.31
Wood products & furniture	0.05	0.05	0.16	0.14
Paper, paper products & printing	0.06	0.05	0.50	0.29
Chemical products (incl. drug industry)	0.32	0.38	3.29	2.29
Non-metallic mineral products	0.27	0.17	0.78	0.75
Basic metal industries	0.20	0.10	1.44	0.91
Fabricated metal products (incl. Computer & telecommunication equipment)	0.58	0.52	3.78	3.68
Other manufacturing, nec (incl. jewellery, sporting goods)	0.20	0.16	3.67	1.63

* Australia, Denmark, Finland, Sweden

** United States, Japan, Australia, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden, United Kingdom

Food and beverage research in New Zealand is still lower than in the reference countries, but is catching up. Textiles research in New Zealand is well above the reference average, but is decreasing. R&D in the metals and metal products industries is only one-eighth of the reference countries' average level even though, of the ten industry groupings, this is the second highest contributor to total manufacturing sales in New Zealand. However, research in these industries has increased in 1993/94.

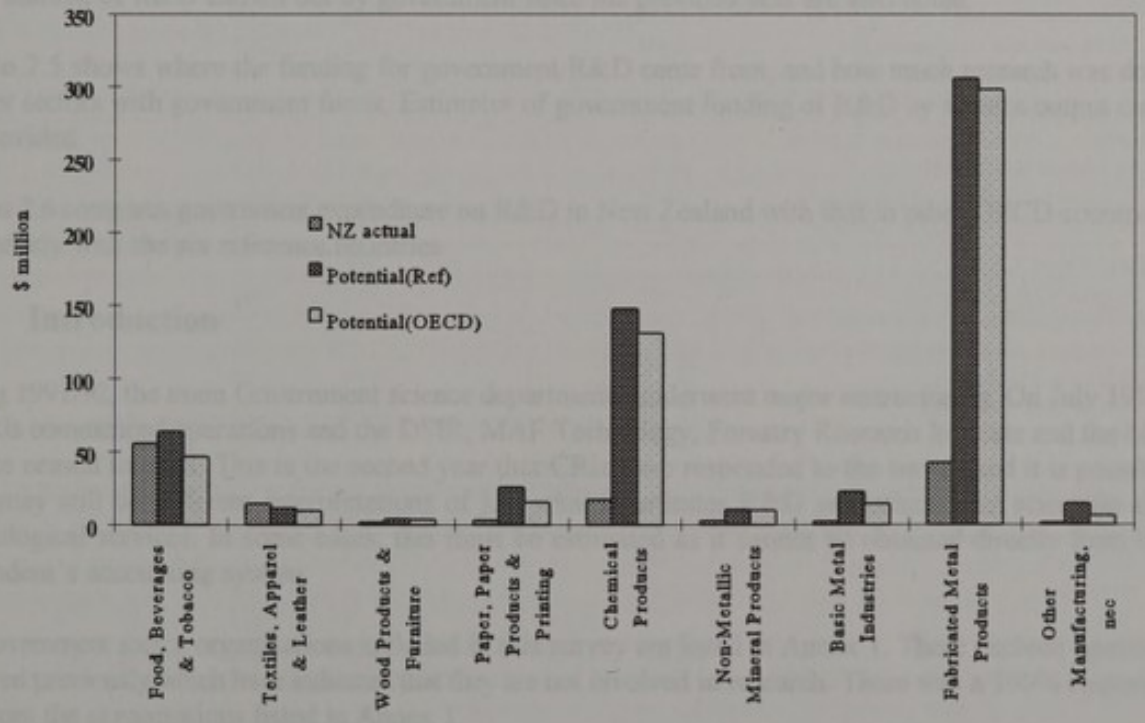
Figure 5. Manufacturing R&D as a percent of sales, 1992



If the rate at which firms invest in R&D in each of the other OECD countries were aggregated using the industry structure of New Zealand, the average rate of investment would be 1.34% of sales, and 1.52% for the reference countries, still almost four times the rate at which New Zealand firms currently invest in R&D. So even allowing for the lower R&D orientation of New Zealand's industry structure, New Zealand firms are under-investing in R&D, by OECD standards (see Figure 5).

Using the rate at which firms in the reference and other OECD countries invest in R&D in each industry, Figure 6 shows how much R&D New Zealand firms would have to invest in each industry to achieve the same percent of sales as in the reference and OECD countries.

Figure 6. New Zealand's potential R&D levels, if R&D were carried out at the same rate as other OECD countries



It is interesting to note that the average investment in R&D in other countries would decline if they had a similar industry structure to New Zealand. However, the average investment in R&D would decline the least in Australia, Denmark, Finland and Sweden because they have an industry structure much closer to that of

New Zealand. In Germany and the United States their industry structure results in almost twice as much R&D investment, quite apart from the higher levels of investment by the firms within each industry sectors.

It is apparent that, on average, businesses in New Zealand invest little in R&D compared with their counterparts overseas. Unfortunately, the available data does not permit an analysis of the effects of differences in size and turnover of individual firms. These factors could provide some explanation of the different levels of R&D spending in New Zealand compared with other countries. However, investigations in other countries have tended to provide mixed evidence as to the direction and strength of the correlation between firm size and its spending on R&D.

See the final paragraph of section 1.6.1 for international comparison of the proportion of business R&D that was financed by business and government respectively.

2 GOVERNMENT

2.1 Key results

- Research funded by the government sector increased overall by $10 million in 1993/94, but this amounted to a small decrease in government expenditure as a % of GDP, from 0.57% to 0.56%.

- Funding from the private sector for R&D carried out by government agencies increased by $8.1 million.

- Over the five years from 1989/90 to 1993/94 New Zealand's government funding of R&D has remained at around 0.56% of GDP. The average for other OECD countries increased from 0.67% to 0.68%, while for the reference countries it increased from 0.72% to 0.74%.

- Research in the processing of primary products increased by 21% as did research for the environment, exploration and assessment of the earth. Fundamental research increased by 26%.

- Research expenditures in the government sector (i.e. R&D performed rather then funded) increased overall by $25 million (8%) to $343.3 million (or 0.42% of GDP). The proportion of funds that came from FRST decreased while the proportion from 'own funds' and the private sector increased.

2.2 Outline of this section

After a brief introduction, section 2.4 shows R&D carried out by government in each science output class, and compares this with that carried out by the business sector as described in the previous section. Changes in the amount of R&D carried out by government since the previous year are also noted.

Section 2.5 shows where the funding for government R&D came from, and how much research was done in other sectors with government funds. Estimates of government funding of R&D by science output class are provided.

Section 2.6 compares government expenditure on R&D in New Zealand with that in other OECD countries, particularly with the six reference countries.

2.3 Introduction

During 1991/92, the main Government science departments underwent major restructuring. On July 1992, 10 CRIs commenced operations and the DSIR, MAF Technology, Forestry Research Institute and the Met Service ceased to exist. This is the second year that CRIs have responded to the survey and it is possible there may still be different interpretations of just what constitutes R&D as distinct from scientific and technological services. In some cases, this must be estimated as it cannot be obtained directly from the respondent's accounting system.

The government sector organisations included in this survey are listed in Annex 1. These exclude agencies surveyed previously which have indicated that they are not involved in research. There was a 100% response rate from the organisations listed in Annex 1.

As noted previously (see section 1) the science output classes are used in setting Government priorities and funding levels. Various groupings of these output classes have been used. This section describes the outputs according to the sub-groups for primary production, primary product processing, etc. The grouping by the 15 areas of science used in the 1995 priority setting are shown in Figure 2 in the Executive Summary.

Table 10. R&D carried out in the government and business sectors, by output area, 1993/94

Output areas	Govern-ment ($000)	Group Total	Group %	Group % of group	Business ($000)	Group Total	Group %	Group % of group
Primary production								
01 Sheep (meat)	839			0.6	117			0.5
01 Sheep (wool)	1,932			1.4	1,192			5.2
01 Sheep (general)	9,879			6.9	747			3.3
02 Beef Production	{5,030}			{3.5}	1,166			5.1
03 Dairy Production	{ }			{ }	3,187			13.9
04 Alternative Animal Species	5,086			3.6	613			2.7
05 Generic Animal Research	11,438			8.0	1,639			7.2
06 Forage Plants	20,815			14.6	2,836			12.4
07 Horticulture	33,742			23.6	2,133			9.3
08 Arable crops and other Plants	15,794			11.1	1,901			8.3
09 Plantation Forestry	19,654			13.8	6,437			28.1
10 Fisheries	18,716	142,925	42	13.1	910	22,879	9	4.0
Primary product processing				100				100
11 Meat Processing	3,889			11.5	15,662			18.2
12 Dairy Processing	1,963			5.8	39,025			45.4
13 Other Food Processing	{16,411}			{48.6}	12,718			14.8
14 Fibre, Textile & Skin Processing	{ }			{ }	13,176			15.3
15 Wood & Paper Processing	11,532	33,795	10	34.1	5,448	86,028	35	6.3
Materials, engineering				100				100
16 Materials & Industrial Processing	13,486			46.2	11,761			21.6
17 Engineering	5,573			19.1	26,902			49.4
18 Electronic & Instruments	10,141	29,200	9	34.7	15,762	54,425	22	29.0
Infrastructure				100				100
19 Construction	{2,286}			{16.9}	8,266			13.1
20 Commercial & Trade	{ }			{ }	4,848			7.7
21 Energy	6,512			48.2	4,685			7.4
22 Transport Services	1,728			12.8	3,030			4.8
23 Information & Communications	2,580			19.1	42,144			66.8
24 Urban & Rural Planning	408	13,514	4	3.0	153	63,125	25	0.2
Social sciences				100				100
25 History, Society & Culture	5,697			24.9	326			9.8
26 Relationships & Wellbeing	4,434			19.3	655			19.8
27 Political & Economic Relationships	7,371			32.2	1,841			55.5
28 Education, Knowledge & Training	5,418	22,919	7	23.6	494	3,317	1	14.9
Environment				100				100
29 Environmental Protection	14,327			17.2	2,638			48.2
30 Geological Structure & Process	11,451			13.7	759			13.9
31 Land use, Flora & Fauna	20,171			24.2	682			12.5
32 Marine & Fresh Waters	23,107			27.7	1,239			22.6
33 Climate & Atmosphere	11,489			13.8	99			1.8
34 Space	{2,773}			{3.4}	n.p.			n.p.
35 Antarctica	{ }	83,317	24	{ }	n.p.	5,475	2	n.p.
Miscellaneous				100				100
36 Fundamental Knowledge	3,990			22.5	n.p.			1.7
37 Health	2,781			15.7	12,033			95.2
38 Defence	{10,958}			{61.8}	n.p.			0.4
Other	{ }	17,728	5	{ }	335	12,642	5	2.7
TOTAL	343,399	343,399	100	100	247,890	247,890	100	100

n.p.= Not published

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2.4 Government R&D (GOVERD) carried out in each science output class

Total intramural government sector R&D (GOVERD), by science output area, is shown in Table 10.

2.4.1 Primary production

As in 1992/93, the major effort in government R&D (42%) was in primary production (output classes 1 to 10). In absolute terms, it received over six times more funding in the government sector than in the business enterprise sector ($143 million versus $23 million). Government provided $5 million more research than last year and the business sector also increased its R&D in these output classes.

Of the 10 component output classes, eight are devoted to agriculture, with the remaining two devoted to forestry and fishing.

Output class 7 (new and improved horticultural crops, including vegetables and management practices) accounted for 24% of primary production R&D, followed by forage plants (15%), trees and plantations (14%), fish harvesting (13%), and arable crops (11%).

The amount of R&D carried out in each output area within primary production was quite different for government and business enterprise sectors. Horticulture was the largest area in the government sector and forestry was the largest in the business enterprise sector.

2.4.2 Primary product processing

R&D in the area of primary product processing (output classes 11 to 15) was a relatively minor component of government sector R&D (10%), but it comprised 35% of the business enterprise sector's R&D. The total government sector R&D in this area was $34 million, which is about one-third of the R&D carried out in the business enterprise sector ($86 million). This is $5.8 million more research done by Government (21%), and $8.8 million more by business (11.4%) than in 1992/93.

Virtually all the government sector R&D in primary product processing was concentrated in output classes 13 (new and improved fruit, crops and other food and beverage processes, storage techniques and products) and 15 (new and improved wood and paper processes and products). These comprised 43% and 34% of the primary product processing R&D effort, respectively.

Output class 12 (new and improved dairy processes, storage techniques and products) received only 5.8% of the government sector's R&D effort. However, it was the most heavily funded component ($39 million) of the business enterprise sector's R&D, comprising 45.4% of the total effort in the processing areas.

2.4.3 Materials, engineering, computing and communications

Although R&D in the area of materials, engineering and electronic & instruments (output classes 16 to 18) accounted for 22% of the expenditure in the business enterprise sector ($54.4 million), it was of less importance in the government sector ($29.2 million, 9% of total funding). Compared to last year's results, the Government and business figures both showed a small increase (2.8% and 3.2% respectively)

Output class 18 (new and improved computing and electronic, communication and instrumentation processes, systems and products, with the emphasis being on computer hardware) was the fourth most heavily funded class in the business enterprise sector ($15.8 million). In the government sector it was funded about $10 million. However, it must be borne in mind that information technology (IT) is becoming such a basic tool that it is harder to distinguish whether research is primarily IT-related or whether it is related to some application of IT. Taking a broader definition of IT-related research would probably result in a large addition to the government sector's expenditure.

Similar arguments apply to output class 23 (new and improved information processing software, software and services for electronic communication, media transmission and data exchange). If the two output classes (18 and 23) are taken together, it is clear that computing systems are the largest area of business enterprise sector R&D in New Zealand, with a total expenditure of $57.9 million, or 23.4% of all the business enterprise sector's R&D. The comparable value for government sector R&D in these two output classes is only about $12.7 million, or 3.7% of government sector R&D.

In the government sector, output class 16 (new and improved materials, industrial processes and products) received the largest portion of the R&D funding (46.2%). Output class 17 (new and improved engineering processes, systems, and production) received 19.1% and output class 18 received 34.7% of the funding within this group.

By contrast, output class 17 received about half of the business enterprise sector's funding R&D for this group (49.4%), while outputs 16 and 18 received 21.6% and 29.0% respectively.

2.4.4 Infrastructure and services

Infrastructure and services R&D (output classes 19 to 24) was better funded in the business enterprise sector than in the government sector, representing 25% and 4% of total funding, respectively. Compared with last year, government R&D has remained virtually unchanged, while business R&D has increased by $24.1 million or 61.8%. The major government effort in this area was in energy production, comprising 48.2% of the total, followed by information and communication (19%) and construction and commercial and trade (17%).

2.4.5 Social sciences

The government sector provided $23 million of research (up $2 million) in this area, private enterprise provided $3.3 million worth of research (55% of which was in political and economic relationships).

2.4.6 Environment, exploration and assessment of the Earth

About a quarter (24%) of the R&D funding in the government sector was in the area of environment, exploration and assessment of the earth, i.e. in output classes 29 to 35. By contrast, this kind of research comprised only 2% of the R&D of the business enterprise sector. Government research in this area has increased by $14.6 million (21%); business research in the environment has increased as well ($2.9 million or 111%).

As seen in Table 10, output classes 30, 31 and 32, which deal with geological structures, land use, flora and fauna, and marine and fresh waters, together comprised about two-thirds of the government expenditure in this group (65.6%). Output class 29, which deals with R&D in the field of environmental protection, was the next most important (17.2%) followed by output class 33 (climate and atmosphere, 13.8%).

2.4.7 Miscellaneous

Within the miscellaneous sector, the main trends to note were the increase in government input into fundamental research (25.9%) and an increase in health research (9%).

2.5 Funding of R&D expenditure in the government sector

2.5.1 Source of funds for intramural R&D

In the survey, government organisations were asked to provide information on the source(s) of the funds for the R&D they undertook. The results are summarised in Table 11. Compared with the previous year, the

proportion of funding received from FRST decreased by 2.7% while the proportion made up of "own funds" increased by 1.9%. The proportion received from the private sector increased by 2.9%.

The bulk of funding (61%) came from FRST, which allocates funds from PGSF. This increased in value by $10.5 million since 1992/93.

The second largest portion of funds for R&D in government are from other New Zealand Central Government agencies, representing 15.1%.

A further 7.4% of funding came from "own funds", and 13.3% from private sector enterprises.

Table 11. Source of funds for R&D carried out in the government sector

Source of Funds	1993/94		1992/93	
	($000)	%	($000)	%
Own Funds	25,552	7.4	17,418	5.5
Foundation of Research Science and Technology	210,211	61.2	203,554	64.0
Other NZ Central Government Agencies	51,813	15.1	53,834	16.9
NZ Local Government	2,381	0.7	2,720	0.9
Tertiary Education Sector	136	0.04	205	0.10
Business Sector NZ Enterprises	45,498	13.3	33,404	10.5
Funds from Abroad	4,112	1.2	4,478	1.4
Other Sources of Funds	3,696	1.1	2,408	0.8
Total	343,339	100.0	318,021	100.0

Although the business sector reported that it spent $19.7 million for R&D carried out by the government sector, the government sector in turn reported $45.5 million sourced from the business sector. There are several likely reasons for the $25.8 million discrepancy:

- CRIs may include some service work in their reported data;
- Small CRI clients may not be on the R&D population base for the survey; and
- The TBG scheme (technology for business growth) may be counted as research by CRIs but not by their business partners.

2.5.2 Extramural R&D, by sector of R&D provider

Government agencies funded R&D carried out by other organisations in the government, business and university sectors, as shown in Table 12. By far the majority of extramural R&D research (77.7%) was carried out by Central Government agencies, including CRIs.

Table 12. Extramural R&D funded by the government sector, 1993/94

R&D Provider	($000)	Percent
Other NZ Central Government Agency	226,700	77.7
NZ Local Government Organisations	229	0.1
Tertiary Education Sector	36,944	12.7
Business Sector NZ Enterprises	26,607	9.1
Overseas Organisations	1,197	0.4
Other Organisations	250	0.1
TOTAL	291,927	100

2.5.3 Total R&D funded by the government sector

Total funding of research by the government sector increased from $442 million in 1992/93 to $452 million in 1993/94 (see Table 18, section 4). R&D funded in each science output class can be estimated from the proportion of R&D carried out with '*own funds*' and R&D funded extramurally (assuming R&D is funded

Table 13. Estimates of government funding of R&D, 1993/94

Science output class	R&D funded ($000)
01 Sheep Production	14,982
02 Beef Production	2,632
03 Dairy Production	6,416
04 Alternative Animal Species	6,087
05 Generic Animal Research	13,410
06 Forage Plants	24,816
07 Horticulture	30,815
08 Arable crops and other Plants	13,548
09 Plantation Forestry	14,624
10 Fisheries	17,071
11 Meat Processing	4,328
12 Dairy Processing	4,397
13 Other Food Processing	12,464
14 Fibre , Textile & Skin Processing	3,588
15 Wood & Paper Processing	10,309
16 Materials & Industrial Processing	16,398
17 Engineering	6,742
18 Electronic & Instruments	12,144
19 Construction	4,601
20 Commercial & Trade	3,862
21 Energy	7,764
22 Transport Services	2,985
23 Information & Communications	4,244
24 Urban & Rural Planning	1,870
25 History, Society & Culture	11,803
26 Relationships & Wellbeing	8,640
27 Political & Economic Relationships	9,241
28 Education, Knowledge & Training	11,917
29 Environmental Protection	17,152
30 Geological Structure & Process	14,860
31 Land use, Flora & Fauna	17,317
32 Marine & Fresh Waters	19,633
33 Climate & Atmosphere	9,501
34 Space	485
35 Antarctica	2,394
36 Fundamental Knowledge	30,701
37 Health	46,397
38 Defence	148
Other	5,044
TOTAL	445,000

to output classes in the same proportion as the respondent's intramural R&D). Information from funders' research schedules, non-specific output funds (NSOF) to CRIs, and information from the university survey about general university funds (GUF) were added to provide the estimates in Table 13. Because of gaps in

these estimates the total does not add to $452 million, but the estimates match to within 2%.

2.6 International Comparisons

2.6.1 Government funding of R&D

New Zealand is one of the few countries where the proportion of R&D funded by government has been more than 50% since 1989. The share of total R&D expenditures funded by the New Zealand Government has decreased from 65% in 1989 to 55% in 1993. The other OECD countries have reduced their government share on average from 44% in 1989 to 42% in 1993, whereas the share of government funding in the reference countries dropped from around the same level to 38%, a figure dominated by the sharp reduction in the share of funding by government in Ireland.

Figure 7. Government funding of R&D as a percent of GDP (excluding defence)

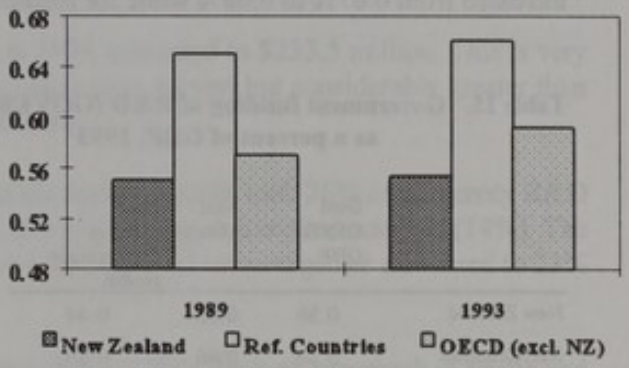


Table 14. Source of funding for R&D as a percent GDP

(1993 or latest available year as shown)

	Government	Industry	GERD/GDP
France	1.09	1.13	2.45
United states	1.04	1.56	2.66
SWEDEN(1991)	0.98	1.76	2.86
NORWAY	0.95	0.86	1.94
Iceland(1992)	0.93	0.32	1.33
Germany	0.92	1.49	2.48
FINLAND	0.88	1.26	2.22
Netherlands	0.84	0.89	1.89
AUSTRALIA (1992)	0.79	0.70	1.58
Switzerland (1992)	0.76	1.81	2.68
Austria	0.73	0.71	1.48
United Kingdom	0.71	1.14	2.19
DENMARK	0.68	0.90	1.08
Canada	0.64	0.63	1.50
Japan	0.64	2.01	2.94
Italy	0.60	0.65	1.31
NEW ZEALAND	**0.56**	**0.35**	**1.02**
Belgium (1991)	0.52	1.08	1.66
Spain (1992)	0.46	0.40	0.92
Portugal(1992)	0.37	0.13	0.63
IRELAND	0.31	0.78	1.22
Turkey	0.30	0.15	0.46
Greece	0.28	0.12	0.60

Note: OECD and reference countries data are from Table 14 (% GERD financed by government) and Table 5 (GERD as % of GDP), MSTI, No. 2 1995.

In some of the countries with a low GERD/GDP ratio, the government provides a high percentage of total R&D funding, and where the GERD/GDP ratio is high, government provides a small percentage.

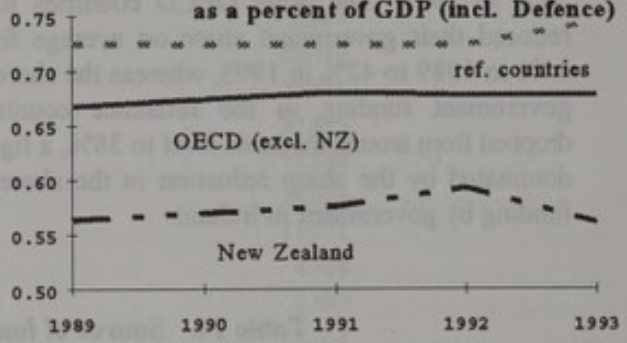
Consequently, there is some correlation between lower total spending on R&D and a higher proportion of funds being provided by government. However, a greater percent of total funding contributed by government does not also mean that the government contributes a larger proportion of GDP than in countries with a lower proportion of government funding.

In New Zealand, government funding has remained at the level of 0.56% of GDP between 1989 and 1993. On average, governments in other OECD countries, including the reference countries, have been slightly increasing the proportion of GDP spent on R&D since 1989. The average for other OECD countries increased from 0.67% to 0.68% while for reference countries the average has gone from 0.72% to 0.74%.

Table 15. Government funding of R&D (GOVERD) as a percent of GDP, 1993

	Govt GERD/ GDP	Excl. Defence	Excl. Defence Environment Health
New Zealand	0.56	0.55	0.44
Ref. Countries	0.74	0.66	0.56
OECD (excl. NZ)	0.68	0.59	0.51

Figure 8. Government funding of R&D as a percent of GDP (incl. Defence)

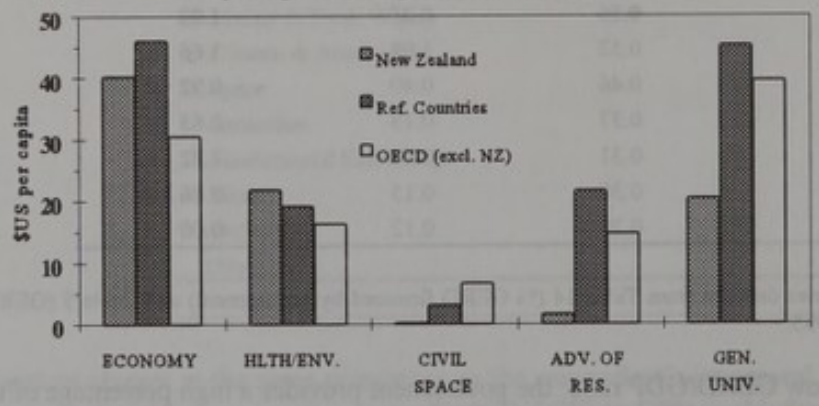


2.6.2 Government budget appropriations or outlays for R&D (GBAORD) by socio-economic objective

The New Zealand Government spends a significantly larger proportion of its R&D dollars on economic objectives and somewhat less on health & environmental protection than the average for other OECD countries. However, relative to the size of the country, New Zealand's spending is more similar to the reference countries. New Zealand contributes US$40 per person to economic objectives, more than the average of US$30 in other OECD counties but less than US$46 per person spent on economic objectives in the reference countries.

However, for per capita expenditures on health & environment objectives, New Zealand spends US$22, almost at the same level of the average US$16 for the other OECD countries, and the average of US$19 spent by the reference countries. Research spending in New Zealand towards the advancement of knowledge and general university funding is well below the level of spending in other OECD countries.

Figure 9. Government R&D expenditure per person, by socio-economic objective, 1993
(average $US, using Estimated Averages)



Note: OECD and reference countries data are from Tables 62 - 70 on GBAORD, MSTI: Main Science and Technology Indicators, No. 2 1995.

3 UNIVERSITIES

3.1 Key results

- A new survey piloted for 1993 data showed that more was being spent on R&D carried out in the university sector than previous estimates had indicated. This survey was successfully trialed and the same survey methodology was applied to obtain the 1994 data reported here.

- Total R&D carried out in the university sector in 1994 amounted to $233.5 million. This is very similar to the result obtained from the previous year's pilot survey, but considerably greater than previous estimates which were closer to $100 million.

- Research classified by field of science showed that the social sciences took 26% of university R&D expenditure, followed by medical sciences (22%), and engineering and applied sciences (14%). The natural sciences (physics, chemistry, biological and earth sciences) taken together amounted to 23% of the total.

- By science output class, the universities undertook 84% of New Zealand's research in health and fundamental knowledge outputs, and 65% of research into social science output classes. On the other hand universities only undertake 12% of the research into primary production (the government sector accounts for 76%) and 6% of primary production processing (the business sector accounts for 68%).

- Sixty-nine percent of the funding for university research came from internal sources; it is estimated that 46% came from general university funds from Government and 23% from the universities' own funds, which include student fees. The remainder of the funding came from business, government and other sources.

3.2 Outline of this section

A brief introduction provides some background to previous surveys of university R&D. This is followed by a discussion of the methodology used in conducting the surveys of 1993 and 1994 data.

Section 3.4 provides a summary of the results of the survey of 1994 R&D in universities.

3.3 Introduction

The university sector carries out research as part of its mandate with Vote Education funds, and receives funds for contract research from the Health Research Council and other Crown and private sources.

Over the last few years, a number of projects have been undertaken to gather better information on R&D expenditure in the higher education sector. Two publications in particular have analysed this information. The first of these, *A profile of Crown-funded R&D in New Zealand, 1991/92*[3], provides information for 1991 on all current university research projects, including FTE personnel engaged.

The next major study, the Bollard review[4], estimated resources used nationally for research in the non-medical university sector. It concentrated on costing that part of university research comprising public good science outputs, i.e. outside of teaching which was funded by Vote Education. The methodology is further described in the 1992/93 publication in this series[13].

This report is based on the second survey on university research developed and carried out by this Ministry

with the assistance of the New Zealand University Vice-Chancellors' Committee. The statistics collected by this joint survey cover a wider range of disciplines than the first two surveys. As recommended by the OECD, research in the social sciences and humanities were included, and all university overheads were taken into account. All research which was externally funded was also included. The data collected refer to the 1994 calendar year.

Because of the methodological differences between this survey and earlier surveys, time trend comparisons are not possible. Also, only the universities are considered here, although they are expected to count for most of the research in the higher education sector. It is recognised, however, that polytechnics are increasing the research they are doing.

3.4 The survey methodology

All heads of university departments were asked to estimate the proportion of time academic staff in their department spent on research by field of science and by socio-economic objective (science output class).

University registries supplied expenditure data for each department in three categories: salaries and wages, operating expenditure, and capital expenditure. Any research expenditure which could not be allocated by department was supplied for the university as a whole, and was added in after department data had been aggregated. The source of external funds for research was also provided.

To obtain the results shown here total teaching and research expenditures were multiplied by the departmental estimate of the proportion of time spent by academic staff on research (rather than teaching), and any "research only" expenditure added to give the total expenditure on research for each department. Each department also estimated the percentage of its research which was carried out in 9 different fields of science and aimed at each of 38 socio-economic output areas. Total departmental research expenditure was allocated to fields of science and socio-economic areas according to the percentages supplied by each department.

Data on personnel FTEs by occupation in four categories, academic staff, technicians, post-graduate students and support staff, was not collected for this report. Data collected for 1993 is shown instead.

To bring the review data into line with OECD recommendations:

- Only personal scholarship carried out specifically for a research project was to be considered an R&D activity;
- Administrative and support staff providing direct project-linked administration or clerical services within the R&D unit were included in the count of FTE personnel;
- An allowance for the stipends of post-graduate research students was included in R&D personnel costs, by university if not available by department;
- Research and equipment grants from external sources were included; and
- Overseas funds for research were included.

3.5 R&D carried out in the higher education sector (HERD)

Table 16 shows the fields of science in which the universities carried out R&D. Almost half of the total expenditure was in two fields: Medical Sciences and Social Sciences. The pattern is quite similar to that of the previous year.

Table 16. University R&D expenditure, by fields of science, 1994

Fields of science	($ 000)	%
Physical Sciences	8,900	3.8
Chemical Sciences	9,700	4.2
Biological Sciences	26,400	11.3
Earth Sciences	7,600	3.3
Engineering & Applied Sciences	31,600	13.5
Agricultural Sciences & Forestry	16,200	6.9
Medical Sciences	50,700	21.7
Social Sciences	60,900	26.1
Humanities	21,400	9.2
TOTAL	233,500	100.0

Information was provided by each university department about their external sources of funds for research. Each university provided figures for the total government operating grant and all income from other sources for teaching and research, including student fees. This was used to estimate research expenditure sourced from general university funds from the Government (GUF) versus other university income. The results are shown in Table 17.

Table 17. Source of funds for intramural university sector R&D, 1994

Source of funds	($ 000)	%
Own funds (includes students fees)	53,600	23.0
General university funds (GUF)	106,400	45.6
NZ Govt (includes FRST, HRC)	38,000	16.3
Local Government	200	0.1
NZ tertiary education sector	1,900	0.8
Private sector NZ enterprises (includes SOEs, RAs, PBs)	12,200	5.2
Funds from abroad	7,700	3.3
Private non-profit (LGB, Cancer society, etc)	13,500	5.8
TOTAL	233,500	100.0

GUF	=	General University Funds
FRST	=	Foundation for Research, Science and Technology
HRC	=	Health Research Council
SOE	=	State Owned Enterprises
RA	=	Research Association
PB	=	Producer Board
LGB	=	Lottery Grants Board

Compared with the previous year, the total figure obtained for the university sector R&D from the 1994 survey changed very little. Of $233.5 million in total, almost 70% of these funds are from the universities' own funds and general university funds.

The proportion of the universities' own funds increased by 3%. The proportion of general university funds (GUF) for research dropped from 52% of the total to 46%. This is in line with the decrease in funding per funded EFTS (equivalent full time student) and increases in revenues from student fees.

4 ALL SECTORS

4.1 Key results

- When the three sectors of R&D provider data are added together, the result is an estimate of the total R&D carried out in New Zealand. In 1993/94 the total R&D undertaken in New Zealand was $824.8 million, up just over 9% from $754.5 million in 1992/93.

- The real growth rate of New Zealand's total expenditure on R&D since 1989 has now risen to the same level as that of the reference countries and exceeds the rate of growth in the OECD. This means that New Zealand is now starting to catch up with the OECD average R&D expenditures.

- The total R&D being funded from outside each of the sectors (excluding GUF) has risen 23.3% from $105.6 million to $130.2 million (from 14% of total R&D to almost 16% of total R&D). This indicates a greater interaction between sectors in the funding of R&D in New Zealand.

- The estimated funding of R&D by the business sector has increased substantially from $245.4 million to $293 million (including the funding of research overseas), or from 0.29% of GDP to 0.35% of GDP.

- Although government sector funding of R&D has increased from $442.9 million to $452.0 million, as a percent of GDP this has dropped marginally from 0.57% to 0.56%.

- Total research funds going overseas from all sectors was $15.5 million, down from $19.5 million in 1992/93, while at the same time overseas funding of research in New Zealand has increased from $19.5 million to $20.1 million.

4.2 Outline of this section

After a brief introduction, the information provided by survey respondents in each sector on the research performed and their source of funds is combined to give a matrix of R&D funded and R&D performed across all the sectors. The R&D funded and the R&D performed by each sector are also shown as a percent of GDP and, where available, comparisons are given between New Zealand and the OECD reference countries.

Section 4.4 also compares the funding of R&D by the 38 science output classes by each of the three sectors. The contribution of each sector to the seven sub-groups of these output classes is also shown.

Section 4.5 compares the business and government sectors in terms of the type of R&D expenditure (universities did not provide this information). Section 4.6 provides a number of international comparisons of the aggregate R&D expenditures in New Zealand with the OECD and the OECD reference countries.

4.3 Introduction

From the information provided by respondents it is possible to determine what R&D they performed from their own funds and what was performed from funds being received from the other sectors. Within the government sectors there was a further distinction made between FRST, GUF and other government. Also, private non-profit organisations (PNPs), and overseas were included separately.

As mentioned previously, the provider data is used to construct this matrix because it is expected to be more reliable.

4.4 Source of R&D funds, sector of performance and output class, from provider data, all sectors

Data from R&D providers in each sectoral survey is summarised in Table 18. Each column represents the total R&D provided by that sector. Reading across the rows it is possible to estimate the total R&D funded by each sector. This will differ from the estimates obtained by using each sector's provider and funder data in isolation, as was done in the earlier sections.

Table 18. Gross expenditure on R&D carried out in, or funded by NZ, 1993/94

Source of funds	Sector of Performance ($000)							
	Done by Business	Done by Government	Done by University	Total Done in NZ (GERD)	% of GDP NZ	% of GDP 6 ref.	Done by Overseas	Done in NZ or funded by NZ
Funded by Business	221,490	45,498	12,215	279,202	0.35	1.09	14,283	293,485
Government	4,930	79,746	28,680	345,603			1,197	346,800
FRST	12,560	210,211	9,483					
General University Funds			106,417	106,417				106,417
Total Funded by Government (includes GUF)	17,480	289,957	144,580	452,020	0.56	0.74		
University(own funds)		136	55,510	55,646				56,646
PNP	570	3,696	13,536	17,802				17,802
Overseas Funds	8,350	4,112	7,659	20,120				20,120
Total other funds	8,920	7,940	76,710	93,570	0.12	0.12		
Total	247,890	343,400	233,500	824,790	1.02	1.95	15,480	840,270
% GDP	0.31	0.42	0.29	1.02				
OECD 6 reference countries	1.21	0.32	0.41	1.95				
% of GERD	30	42	28	100				
OECD 6 reference countries	61.8	16.3	21.1					

Total rounded to nearest 10,000. PNP: Private Non-Profit. MSTI: Main Science and Technology Indicators, No. 2, 1995

Thus, from this table it is estimated that the business enterprise sector spent $279 million on R&D carried out in New Zealand, the government sector spent $452 million (including GUF), and the universities spent $56 million of their own funds. Of the total of $825 million spent on research carried out in New Zealand, $20.1 million was paid for with funds from overseas and a further $ 17.8 million with private non-profit funds. A further $15.5 million was spent on research carried out overseas.

Table 19. Intramural R&D, all sectors, by output class, 1993/94

($000)

Output areas	Business	Government	Universities	TOTAL	%
01 Sheep (meat)	117	839		956	
01 Sheep (wool)	1,192	1,932		3,124	
01 Sheep (general)	747	9,879	3,307	13,933	
02 Beef Production	{4,353}	{5,030}	1,092	{13,034}	
03 Dairy Production	{ }	{ }	2,560	{ }	
04 Alternative Animal Species	613	5,086	1,484	7,183	
05 Generic Animal Research	1,639	11,438	1,971	15,049	
06 Forage Plants	2,836	20,815	2,816	26,467	
07 Horticulture	2,133	33,742	3,185	39,060	
08 Arable Crops and other Plants	1,901	15,794	1,303	18,998	
09 Plantation Forestry	6,437	19,654	2,889	28,980	
10 Fisheries	910	18,716	1,613	21,239	
% of total, primary production R&D	12	76	12	188,022	23
11 Meat Processing	15,662	3,889	917	20,467	
12 Dairy Processing	39,025	1,963	1,362	42,351	
13 Other Food Processing	12,718	14,593	2,065	29,376	
14 Fibre , Textile & Skin Processing	13,176	n.p.	n.p.	15,833	
15 Wood & Paper Processing	5,448	11,532	1,166	18,145	
% of total, primary products processing R&D	68	26	6	126,172	15
16 Materials & Industrial Processing	11,761	13,486	2,820	28,067	
17 Engineering	26,902	5,573	6,739	39,214	
18 Electronic & Instruments	15,762	10,141	6,797	32,701	
% of total, materials, engineering R&D	54	29	16	99,982	12
19 Construction	8,266	{2,286}	2,260	{23,585}	
20 Commercial & Trade	4,848	{ }	5925	{ }	
21 Energy	4,685	6,512	3,101	14,298	
22 Transport Services	3,030	1,728	863	5,620	
23 Information & Communications	42,144	2,580	4,315	49,038	
24 Urban & Rural Planning	153	408	1,986	2,547	
% of total, infrastructure R&D	66	14	19	95,089	12
25 History, Society & Culture	326	5,697	13,584	19,607	
26 Relationships & Wellbeing	655	4,434	7,823	12,912	
27 Political & Economic Relationships	1,841	7,371	10,284	19,497	
28 Education, Knowledge & Training	494	5,418	17,844	23,755	
% of total, social sciences R&D	4	30	65	75,771	9
29 Environmental Protection	2,638	14,327	4,262	21,227	
30 Geological Structure & Process	759	11,451	3,465	15,675	
31 Land use, Flora & Fauna	682	20,171	3,392	24,245	
32 Marine & Fresh Waters	1,239	23,107	3,195	27,541	
33 Climate & Atmosphere	99	11,489	2,064	13,652	
34 Space	n.p.	{2,773}	186	{4,324}	
35 Antarctica	n.p.	{ }	1365	{ }	
% of total, environment & resources R&D	5	78	17	106,721	13
36 Fundamental Knowledge	n.p.	3,990	50,261	54,469	
37 Health	12,033	2,781	52,351	67,165	
38 Defence	n.p.	{10,958}	{46}	{11,395}	
Other	n.p.	{ }	{ }	{ }	
% of total, fundamental, health & defence R&D	9	13	78	133,029	16
TOTAL	247,890	343,399	233,499	824,788	100

{ } 2 cells combined for confidentiality
{ }

n.p. = Not published for reasons for confidentiality

4.5 Type of R&D expenditure, all sectors

Government agencies were asked to indicate how they spent their funds on R&D. The results are contrasted with those from business enterprise in Table 20.

Wages and salaries consumed 47.4% of the $341 million allocated to R&D in the government sector, compared with 51.7% in the business sector. Other current expenditure accounted for 40.8% in the government sector and 33.5% in business. Capital expenditure was 11.3%, compared with 14.8% in the business sector. In these three areas, the proportion of expenditure allocated by universities was 55%, 36% and 9%, respectively.

Table 20. Type of R&D expenditure, all sectors, 1993/94

Type of Expenditure	Sector					
	Business ($ million)	Percent	Government ($ million)	Percent	University ($ million)	Percent
Wages & salaries	128.1	51.7	162.7	47.4	128.9	55
Redundancies	0.2	0.1	1.8	0.5	n.a.	
Other current	83.1	33.5	140.3	40.9	84.2	36
Capital - land & buildings	7.0	2.8	15.6	4.5	n.a.	
Capital - plant, machinery, etc.	29.6	12.0	23.0	6.7	20.3	9
TOTAL	247.9	100.0	343.4	100.0	233.5	100

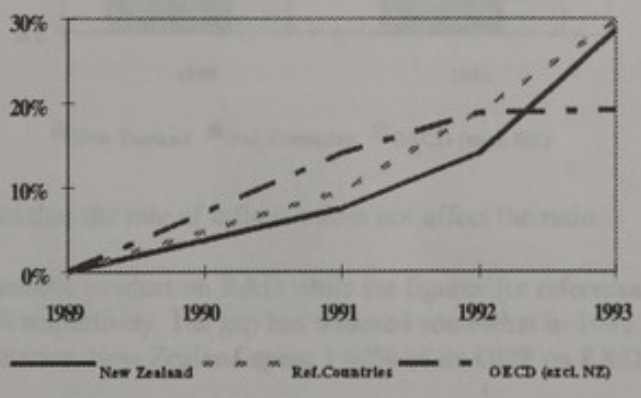
n.a. = not available separately (included in following row)

4.6 International comparisons

4.6.1 Nominal expenditure on R&D

R&D expenditures in New Zealand have grown at an average rate of 4.5% pa between 1989 and 1993 in New Zealand dollar terms, while OECD countries and reference countries have maintained their growth rate at 7.7% and 8.2% respectively in nominal currencies in the same period. Using PPPs (purchasing power parities) to convert national currencies to a common base in US$, the average growth rates in the OECD countries and reference countries were 4.5% and 6.7% respectively. The growth rate of New Zealand's expenditures on R&D, after conversions, was 6.5%. This indicates that New Zealand's R&D spending has increased more than the OECD average over this period, and just slightly less than that of the reference countries. The low growth rate in nominal currency terms (4.5%) is misleading, and is due to New Zealand's relatively low rate of inflation compared with the OECD over this period.

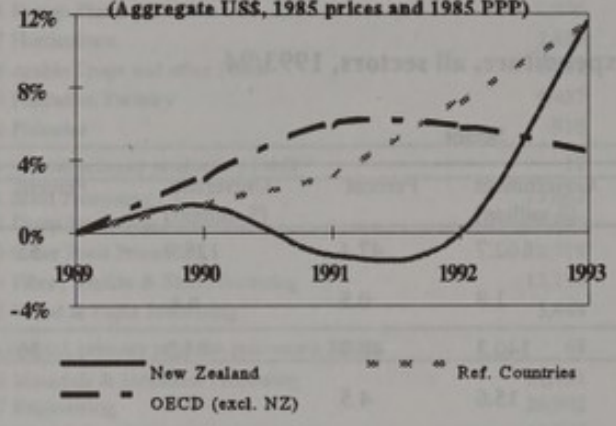
Figure 10. Nominal growth of R&D expenditure (aggregate US$)



In terms of US$, New Zealand R&D expenditures increased by 28.7% between 1989 and 1993. During this period R&D expenditures increased by 29.7% in the reference countries, while the average increase for all OECD countries (excluding New Zealand) was 19.2%.

4.6.2 Real expenditure on R&D

Figure 11. Real growth of R&D expenditure
(Aggregate US$, 1985 prices and 1985 PPP)



An increase in spending on R&D does not translate into more R&D unless the increase in funding is greater than the increase in costs. As a proxy for the changes in cost, constant 1985 prices are used to estimate real expenditures on R&D. Real expenditures in New Zealand have increased from US$372 million in 1989 to US$416 million in 1993.

Spending on R&D in New Zealand has increased in real terms by 11.6% between 1989 and 1993, while in the reference countries and other OECD countries it has increased 11.2% and 4.3% respectively in the same period. There has been an increase in real spending in New Zealand, and a flattening off of the real growth rate in the rest of the OECD.

Putting this in context, New Zealand's real growth in per capita expenditure on R&D was 7% from 1989 to 1993. During the same period, the reference countries growth rate per capita was 5 percentage points higher than New Zealand, at 12%. The OECD countries' was 4%. Although it has a higher rate of growth compared with OECD countries, New Zealand's position for gross expenditure on R&D per capita population is still behind most OECD countries. The real value is less than half the average of the other OECD countries.

Figure 12. Nominal and real compound annual growth rates of GERD, 1989-1993
(aggregate US$ in 1985 prices, and 1985 PPP)

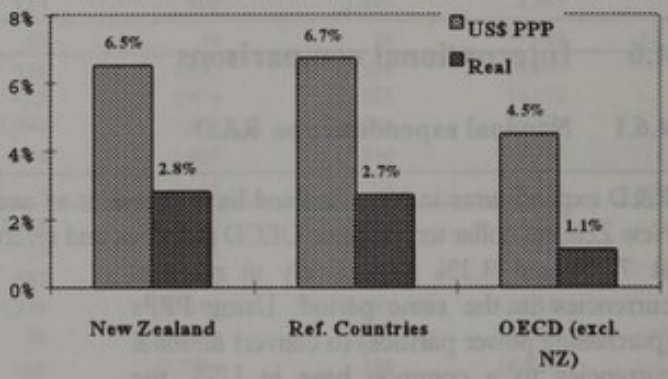


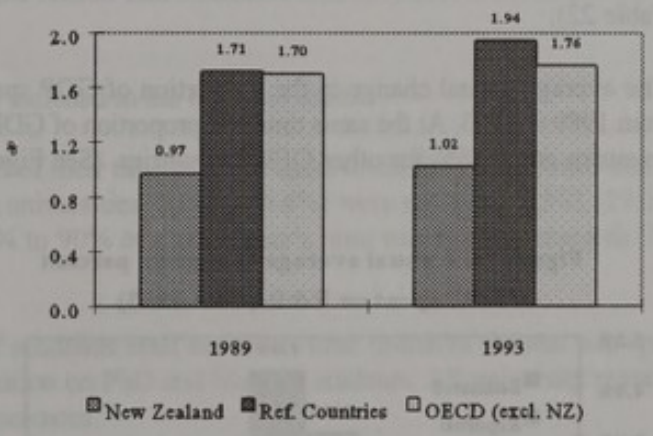
Table 21. Gross expenditure on R&D per capita population (nominal US$)

Country	Year	Nominal GERD per capita
United States	1993	645
Switzerland	1992	617
Japan (adjusted)	1993	554
SWEDEN	1993	549
France	1993	458
Germany	1993	458
UK	1993	371
NORWAY	1993	370
FINLAND	1993	346
DENMARK	1993	344
Netherlands	1993	332
Canada	1993	291
Austria	1993	290
Belgium	1991	285
AUSTRALIA	1992	267
Iceland	1992	247
Italy	1993	235
IRELAND	1993	169
NEW ZEALAND	**1993**	**157**
Spain	1993	117
Portugal	1992	71
Greece	1993	53
Turkey	1993	25

4.6.3 Spending on R&D as a percent of gross domestic product

One of the statistics frequently used in international comparisons is gross expenditure on R&D as a percentage of gross domestic product (GERD/GDP). Because this is a ratio, this statistic is unaffected by the size of the country. Therefore, averaging these across all the OECD countries gives a country average that is not dominated by the larger countries. In other words, each country is treated as one observation rather than representing a larger or smaller proportion of the overall average. These statistics also avoid the problems associated with having to deflate dollars by price increases to get real comparisons over time. A price increase affecting the GDP figure is assumed to also affect the GERD figure, so that the rate of inflation does not affect the ratio.

Figure 13. Percent of GDP spent on R&D



In 1989, New Zealand spent 0.97% of its gross domestic product on R&D while the figures for reference countries and OECD countries were 1.71% and 1.70% respectively. The gap has widened somewhat in 1993, especially between New Zealand and the reference countries. New Zealand spent 1.02% of its GDP on R&D in 1993 (see Figure 13).

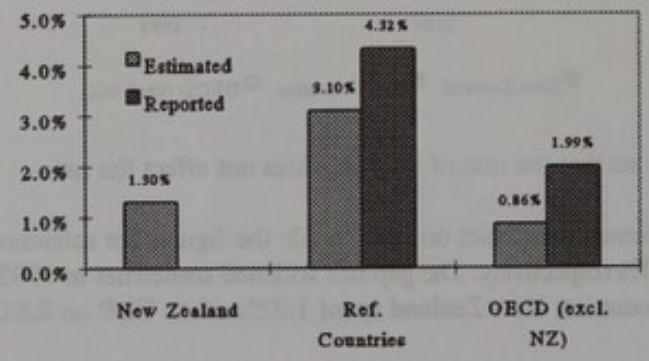
Table 22. Rank order of countries by percent of GDP spent on R&D

1989 GERD/GDP		1993 GERD/GDP	
Japan	2.98	SWEDEN	3.26
SWEDEN	2.94	Japan	2.94
Germany	2.87	Switzerland(1992)	2.68
Switzerland	2.86	United States	2.66
United States	2.76	Germany	2.48
France	2.33	France	2.45
United Kingdom	2.20	FINLAND	2.22
Netherlands	2.12	United Kingdom	2.19
NORWAY	1.86	NORWAY	1.94
FINLAND	1.83	Netherlands	1.89
Belgium	1.70	DENMARK	1.80
DENMARK	1.55	Belgium(1991)	1.66
Austria	1.37	AUSTRALIA(1992)	1.58
Canada	1.37	Austria	1.52
AUSTRALIA(1988)	1.26	Canada	1.50
Italy	1.24	Iceland(1992)	1.33
Iceland	1.02	Italy	1.31
NEW ZEALAND	**0.97**	IRELAND	1.22
IRELAND	0.84	**NEW ZEALAND**	**1.02**
Spain	0.75	Spain	0.88
Greece	0.47	Portugal(1992)	0.63
Portugal(1988)	0.43	Greece	0.60
Turkey(1990)	0.32	Turkey	0.46

In 1989 New Zealand's spending on R&D as a percentage of GDP placed it 18th amongst OECD countries. By 1993, New Zealand has dropped to 19th place, just above Spain, Portugal, Greece and Turkey. So, despite the improving indicators, New Zealand remains well below the level of the reference countries (see Table 22).

The average annual change in the proportion of GDP spent on R&D in New Zealand was 1.3% per year from 1989 to 1993. At the same time, the proportion of GDP spent on R&D increased by 3.1% for reference countries and 0.86% for other OECD countries. (See Figure 14.)

Figure 14. Annual average change in percent of GDP spent on R&D (1989-1993)



Note: Estimated - includes estimated figures for 1993 if not reported based on average growth rate for countries that did report 1993 data.
Reported - includes only the latest reported information.

5 PERSONNEL

5.1 Key results

- In 1993/94 the R&D full-time equivalents (FTEs) of all personnel engaged in research (researchers, technicians and support staff) in the business sector numbered 2,780, or 26% of the total R&D staff FTEs in New Zealand. This included 709 R&D FTEs who were engaged in research associations and producer boards. The business sector actually employed 3,854 R&D staff, who therefore spent an average of 72% of their time on R&D.

- A total of 3,975 R&D FTEs were employed in CRIs and government organisations, or 38% of the total. These FTEs came from 4,608 actual staff members who were therefore employed in R&D about 82% of the time.

- There were 3,735 R&D FTEs in the university sector (1993 data, including post-graduate students), or 36% of the total. Total R&D staff were 12,176, who therefore worked on average 31% of their time on R&D (including teachers who are engaged in research only part of their time and others who work full-time in research).

5.2 R&D personnel

5.2.1 Occupations

Business enterprises and government agencies were asked to provide information on the total number of R&D personnel, as well as breakdowns by gender and occupation in the 1993/94 survey. The university data on personnel was not covered in the survey and the data given here is based on the university survey in 1993. Head-counts of personnel working on R&D as at 30 June, 1994 are given in the column headed "R&D Staff" in the Table 23. The portion of their time in full time equivalents spent working on R&D, during the year ended 30 June 1994, is given headed "R&D FTE". R&D FTE gives a much better estimate of the R&D effort than a head-count of personnel. This is the reason that statistical data is collected in R&D FTE for the OECD.

Research associations and producer boards are included in the business sector.

The total number of staff spending at least part of their time in R&D came to 20,638. These staff carried out a total of 10,490 FTE in R&D. Excluding universities, 5,960 (70.4%) were male and 2,503 (29.6%) were female. Again excluding universities, 70% to 90% of a researcher's time was spent in research. The highest figure (92%) came from CRIs.

In universities, R&D effort accounted for 27% of academic staff member's time (much of the rest was spent on teaching). Universities also provided information on PhD and Masters students. All university research includes research in the humanities and social sciences.

Women make up 24.2% of R&D staff in the business sector (while doing 25% of the research), 33.4% in CRIs (undertaking 31.4% of the research), and 38.4% in other Government departments (doing 36.8% of the research). These figures are quite similar to previous years.

Women, excluding those employed in universities, account for 16.9% of researchers (while doing 17.1% of the research), 31.7% of technicians, and 56.8% of support staff. The highest proportion of women researchers are found in other Government departments with 38%. The lowest proportion of women engaged in R&D is in business and the CRIs with 15% and 14% respectively. The highest proportion of women

technicians are found in CRIs (37%) and the lowest in other Government departments (18%). The highest proportion of women support staff are found in other Government departments; the lowest proportion in the business sector.

Table 23. Full-time equivalent personnel engaged in R&D, all sectors, by occupation, 1993/94

Occupation	Gender	Business Enterprise		CRI's		Other Government		Universities *		Total all sectors **	
		R&D Staff	R&D FTE	R&D Staff	R&D FTE	R&D Staff	R&D FTE	R&D Staff	R&D FTE	R&D Staff	R&D FTE
Researchers	M	1,771	1,267	1,290	1,173	210	193			3,271	2,633
	F	313	241	224	189	130	112			667	542
	Total	2,084	1,507	1,514	1,362	340	305	4,322	1,173	8,260	4,347
PhD and Masters Students								5,780	1,852	5,780	1,852
Technicians	M	871	635	977	847	149	140			1,997	1,623
	F	314	260	582	460	31	29			927	749
	Total	1,185	895	1,559	1,307	180	169	1,260	497	4,184	2,869
Support Staff	M	281	182	373	310	37	34			691	526
	F	305	195	519	417	86	72			910	685
	Total	586	377	892	728	123	106	815	213	2,416	1,424
All	M	2,924	2,084	2,640	2,330	396	366			5,960	4,780
	F	931	696	1,325	1,066	247	213			2,503	1,975
	Total	3,854	2,780	3,965	3,396	643	579	12,176	3,735	20,638	10,490
Total Government						4,608	3,975				

* University data are estimates from 1992/93 data
** Gender sub-totals do not include university FTE

Using the "all sector" figures (measured in terms of FTEs actually spent in research), there are 0.46 technical staff for each researcher. This may be compared to an Australia figure of 0.4 for the business sector[14]. In CRIs, the figure is 0.96 technicians per researcher, in business the figure is 0.59, in other Government departments 0.52, and in universities the figure is 0.16.

5.2.2 Qualifications

Business enterprises and government agencies were asked to provide information on the highest qualifications of their R&D personnel, as well as breakdowns by gender. Figures are shown in Table 24. There was no data from universities. The information shows:

- The highest proportion of PhDs among R&D staff occurs in CRIs (21%). The lowest proportion occurs in business (7%);
- Forty-two percent of staff in the business sector have some kind of Bachelor's degree; the equivalent figure for CRIs is 29% and 49% in other Government departments. Thus, in these three groups combined, Bachelor degrees are the most common qualification among R&D staff (at 37%);
- People holding technical qualifications represented 13% of R&D personnel (ranging from 8 to 18% over the sectors). People holding trade qualifications represented 8.6% of R&D staff;

- R&D staff with "other post-secondary" qualifications represented 4%, those with "secondary" qualifications 15% (ranging from 12% to 19% over the sectors) and "other" came to 5% of R&D personnel; and
- Excluding universities, women made up 13% of PhDs and 27% of bachelors' degrees (while making up 30% of all staff).

Table 24. Personnel engaged in R&D, all sectors, by qualifications, 1993/94

Qualification	Gender	Business		CRI's		Other Government		Total (Business+Govt)	
		R&D Staff	R&D FTE	R&D Staff	R&D FTE	R&D Staff	R&D FTE	R&D Staff	R&D FTE
PhD	M	240	200	768	683	72	68	1,080	951
	F	45	35	95	74	20	17	160	126
	Total	285	234	863	757	92	85	1,240	1,076
Degree	M	1,303	948	762	693	185	167	2,250	1,808
	F	323	260	376	313	148	131	847	704
	Total	1,627	1,208	1,138	1,006	333	298	3,098	2,512
Technical	M	557	409	268	256	39	36	864	701
	F	144	115	99	88	11	10	254	213
	Total	701	523	367	344	50	46	1,118	913
Trade	M	295	193	68	60	43	42	406	295
	F	35	27	34	29	3	2	72	58
	Total	331	220	102	89	46	44	479	353
Other post-secondary	M	101	56	167	132	4	4	272	192
	F	50	28	137	105	13	12	200	145
	Total	151	84	304	237	17	16	472	337
Secondary	M	305	210	368	293	41	38	714	540
	F	273	192	363	274	41	31	677	497
	Total	577	402	731	566	82	69	1,390	1,037
Other/none	M	124	72	239	213	12	12	375	297
	F	61	36	221	186	11	11	293	233
	Total	186	108	460	399	23	23	669	530
All	M	2,926	2,086	2,640	2,329	396	366	5,962	4,781
	F	932	694	1,325	1,069	247	213	2,504	1,976
	Total	3,858	2,780	3,965	3,398	643	579	8,466	6,757

No qualifications data available for universities.
Totals may be rounded.

5.3 International comparisons

In 1993, there were 10,490 R&D personnel (FTE) in New Zealand: 3,975 in the Government, 3,735 in universities, and 2,780 in the private sector. Of these, 6,199 were research scientists and engineers, 2,869 were technicians, and 1,424 were other support personnel.

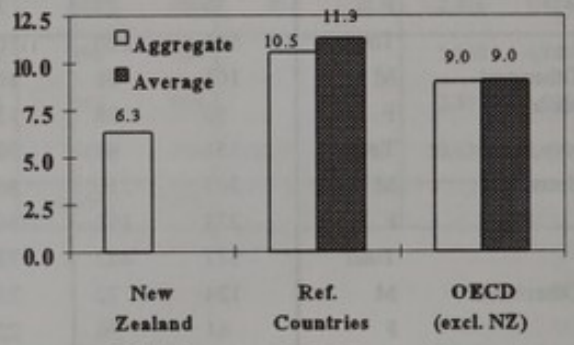
Table 25. Research personnel and research scientists and engineers

	Research Personnel		RSE	
	1989	1993	1989	1993
New Zealand	9,148	10,490	4,818	6,199
Ref. Countries	138,743	151,900	69,289	85,925
OECD (excl. NZ)	2,419,052	2,627,945	2,141,288	2,491,145

An appropriate comparison method is to look at scientific and technical personnel as a proportion of total labour force. (The labour force includes all those full- and part-time employed and unemployed who are actively seeking employment.) In New Zealand, for every 1,000 people in the labour force there were 6.31 R&D personnel, of which 3.73 were research scientists and engineers. This compares with 9.0 R&D personnel per 1000 labour force across the rest of the OECD countries, and 10.5 in the reference countries. There were 5.07 research scientists and engineers per 1000 labour force in the OECD countries, and 6.03 in the reference countries.

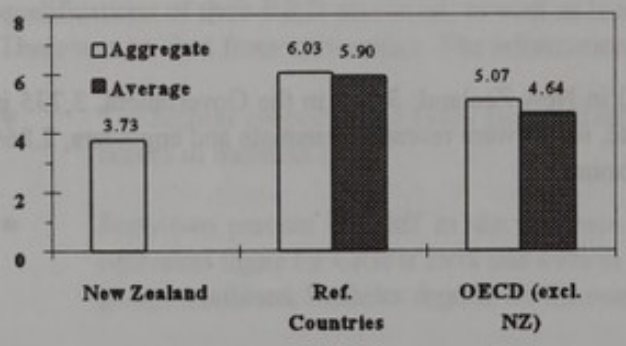
In New Zealand, the proportion of the labour force engaged in R&D, or who are research scientists or engineers, is less than the proportion in any of the reference countries and less than all the other OECD countries, except Italy, Spain, Portugal, Greece and Turkey.

Figure 15. R&D personnel per thousand labour force, 1993
(Aggregate & Country Average)



Because there is a strong international market for scientific and technical personnel, New Zealand is compared with the "aggregate" for other countries, i.e. the proportion of scientific persons in the total labour force in all the other countries. These figures are dominated by the larger countries, but this is appropriate because these larger countries represent the largest markets. The "country average" figures are also shown, i.e. the unweighted average of the proportion of scientific personnel to labour force in each country.

Figure 16. Research scientists and engineers per thousand labour force, 1993
(Aggregate & Country average)



New Zealand spends less of its GDP on R&D than most of the other OECD countries, and it has fewer research scientists and engineers (RSE) per 1,000 population. But this does not mean that New Zealand's spending per RSE is about average. In fact, the OECD countries spend on average US$132,966 per RSE, the reference countries spend somewhat less at US$112,697 per RSE, whereas New Zealand spends only an average of US$88,093 per RSE. This is not due to a higher ratio of non-graduate research personnel to graduate RSEs in New Zealand. RSEs make up 59% of research personnel in New Zealand compared with 56.9% in the reference countries and 52.5% in all the OECD countries, excluding New Zealand.

6 TECHNOLOGICAL BALANCE OF PAYMENTS

6.1 Business and government sectors

Government and business sector payments and receipts abroad for technical know-how are shown in Table 26.

In 1993/94, the business sector received a net amount of $19.3 million, a slight decrease from the figures in 1992/93. Current government figures have increased by $0.9 million, to $3.5 million. The total net receipts have increased from $22.2 million in 1992/93 to $22.8 million in 1993/94.

The national balance of payments for international transactions relating to trade in technical know-how for the business enterprise and government sectors was a surplus of $22.8 million (compared to $22.2 million for the previous year).

Technical know-how includes patents, licences and technical and engineering services that increase the existing technical knowledge in a business. For a full definition refer to the Introduction.

Table 26. Technological balance of payments ($ million)

	1992/93		1993/94	
	Sales-purchases	Net receipts	Sales-purchases	Net receipts
Business	34.3-14.7	19.6	32.1-12.8	19.3
Government	3.0-0.4	2.6	4.0-0.5	3.5
Total net receipts		22.2		22.8

ANNEX 1

Government sector organisations undertaking and funding R&D

A. Government sector organisations undertaking R&D

Accident Rehabilitation and Compensation Insurance Corporation
Carter Observatory Board
City Forests Ltd
Department of Conservation
Department of Internal Affairs
Department of Social Welfare
Economic Development Office Western BOP Ltd
Horticulture & Food Research Institute of NZ Ltd
Industrial Research Ltd
Institute of Environmental Science & Research Ltd
Institute of Geological & Nuclear Sciences Ltd
Institute of Social Research & Development Ltd
Landcare Research NZ Ltd
Land Transport Safety Authority
Law Commission
MAF Fisheries
Maori Language Commission
Ministry of Education
Ministry of Health
Ministry of Youth Affairs
Museum of New Zealand Te Papa Tongarewa
National Institute of Water & Atmospheric Research Ltd
NZ Council for Educational Research
NZ Defence Force
NZ Forest Research Institute Ltd
NZ Institute for Crop & Food Research Ltd
NZ Pastoral Agriculture Institute Ltd
NZ Qualifications Authority
NZ Tourism Board
Office of the Commissioner for Children
Southpower Ltd
Watercare Services Ltd
WEL Technology Ltd

B. Government sector organisations funding R&D

Alcohol Advisory Council of New Zealand
Bay of Plenty Regional Council
City Forests Ltd
Earthquake Commission
Foundation for Research Science and Technology
Health Research Council of NZ
MAF Policy
Marlborough District Council
Ministry of Forestry
NZ Lottery Grants Board
NZ Racing Industry Board
Otago Regional Council
Selwyn Plantation Board Ltd
The Agricultural & Marketing Research & Development Trust
Transit NZ

ANNEX 2

Science output classes

Agriculture, horticulture, forestry and fisheries
New and improved
1 Sheep and sheep production systems
2 Beef animals and beef production systems
3 Dairy animals and dairy production systems
4 Other animal species, animal products and primary production systems
5 Generic animal and animal production information bases, systems and products
6 Forage plants and forage management practices
7 Horticultural crops (including vegetables) and management practices
8 Arable crops, ornamental, amenity, shelter, conservation and other plants and management practices
9 Trees and plantation management systems
10 Fish harvesting and production systems for marine and freshwater fisheries

Secondary industries
New and improved
11 Meat processes, storage techniques and products
12 Dairy processes, storage techniques and products
13 Fruit, crops and other food and beverage processes, storage techniques and products
14 Fibres and skin processes and products
15 Wood and paper processes and products
16 Materials, industrial processes and products (includes mineral processing)
17 Engineering processes, systems and products (including transport engineering)
18 Computing and electronic, communication and instrumentation processes, systems and products (hardware).
19 Construction processes, systems and products (including roading construction)

Commercial and trade services
New and improved
20 Information bases, processes and systems for commercial and trade services

Energy
New and improved
21 Information bases for prospecting, production and use of all energy sources

Transport
New and improved
22 Information bases, processes and systems for transport

Information processing and communications services
New and improved
23 Information processing software, software and services for electronic communication, media transmission and data interchange

Urban and rural planning
New and improved
24 Urban and rural planning information bases, processes and systems

Social development and services

Information bases on

25 New Zealand history, society, culture and Te Ao Maori

26 Social and personal development, relationships and wellbeing

27 Political, economic and international relationships

28 Knowledge, education and training

Environment

New and improved

29 Protection and management technologies for the environment

Exploration and assessment of the earth

Information bases on

30 Geological structures and resources, and solid earth processes (including mineral prospecting - see output 16 for mineral processing)

31 The properties, distribution, and potential uses of types of land and land based flora and flora

32 Marine and fresh waters, their substrate, flora and fauna

33 Climate and the atmosphere

34 Properties, uses and technologies for space

35 The natural environment of Antarctica

General advancement of knowledge

Information bases on

36 Fundamental information in the natural sciences, engineering, social sciences and humanities (where no end use has been identified)

Health

New and improved

37 Information bases, systems and products in health

Defence

New and improved

38 Information bases, systems and technologies for defence

S&T Education and Services

39 Further education/training of those already active in the science community

40 Provision of scientific and technological services, e.g. museums, zoological and botanical gardens; publishing and primary measurement standards.

ANNEX 3 **New Zealand Standard Industrial Classification**

(Grouped for the purposes of R&D statistics)

Industry Groups	Component Industries	NZSIC codes
Agriculture	Agriculture, Forestry, Fishing	11,12,13
Mining	Mining and Quarrying	2
Basic Metals	Ferrous Metals	371
	Non-ferrous Metals	372
	Fabricated Metal Products	381
Chemical Group	Chemicals (industrial and other chemicals)	351, 352 except 3522
	Drugs	3522
	Petroleum Refining	353, 354
Chemical-linked	Food, Drink and Tobacco	31
	Textiles, Footwear and Leather	32
	Rubber and Plastic Products	355, 356
Electrical Group	Electrical Machinery	383 except 3832
	Electronic Equipment and Components	3832
Machinery	Instruments	385
	Office and Computing Machinery	3825
	Machinery n.e.c.	382 except 3825
Other Manufacturing	Stone, Clay, Glass	36
	Paper and Printing	34
	Wood, Cork and Furniture	33
	Other Manufacturing	39
Transport Equipment	Motor Vehicles	3843
	Ships	3841
	Other Transport	3842,3844,3849
Infrastructure Services	Utilities (electricity, gas and water)	4
	Construction	5
	Wholesalers (industrial machinery, electrical and professional equipment)	61
	Transport, Storage	71
	Communication	72
Financial, Software Services	Business and Financial Services (trading banks)	8 except 8323,8324
	Computer Bureaux and Consultancy, Software Development	8323
Engineering, scientific services	Community, Social and Personal Services including Research and Scientific Institutes, Charities, Local Authorities	9
	Engineering, Architectural and Technical Services	8324

n.e.c. = not elsewhere classified

Note: Research Associations and Producer Boards have been allocated an industry code which matches the industry which they serve, where this is known.

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"New Zealand Research and Experimental Development Statistics: Business Enterprise Sector, 1989/90", Ministry of Research, Science and Technology, Wellington 1991. *Publication No.1.*

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