REPORT OF THE SCIENCE FUNDING REVIEW PANEL

TO THE HON. SIMON UPTON MINISTER OF RESEARCH, SCIENCE, AND TECHNOLOGY

30 September 1991

Report No. 4

A report on the review of the 1991/92 allocation round which was conducted by the Science Funding Review Panel at the request of the Minister of Research, Science and Technology. The report has been published by the Ministry of Research, Science and Technology on behalf of the Science Funding Review Panel and requests for copies will be co-ordinated through the Ministry.

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FOREWORD

The establishment of the Foundation for Research, Science, and Technology with responsibility for allocating the Public Good Science Fund has been a key element in the on-going reforms of science and technology in New Zealand.

The Science Funding Review Panel has had the task of conducting, within a little over a month, a review of the 1991/92 allocation round. In that time members of the Review Panel discussed the allocation round with individuals and groups widely representative of a diverse range of interests in Auckland, Hamilton, Rotorua, Palmerston North, Wellington, Christchurch, and Dunedin. Because of the short time at its disposal, the Review Panel did not promulgate requests for written submissions, but carefully considered all the submissions it received.

The Review Panel is appreciative of the co-operation of the Chairman, Board, and Staff of the Foundation and also wishes to acknowledge the executive support provided by the Ministry of Research, Science, and Technology, particularly Mike Doig and Gerald Rys. We are grateful, too, to the Royal Society of New Zealand for providing meeting and office facilities at Science House.

We have been conscious of the impact of our participation in the Review on our colleagues in our own institutions. We particularly wish to express our appreciation for the support and assistance of Katrina Taber and other staff of the Division of Sciences, University of Otago, Pat Johnstone of the Meat Industry Research Institute, and Adrienne Forbes and Judy Griffith of the Forest Research Institute.

Donald McGregor   John Butcher   Douglas Wright

Donald McGregor (Chair)	John Butcher	Douglas Wright

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RECOMMENDATIONS

The Review Panel makes the following recommendations to the Minister of Research, Science, and Technology. These recommendations encompass both structural and process issues within the Foundation for Research, Science, and Technology. In addition, recommendations are made on pertinent issues within the total framework of recent science reforms which the Review Panel considers to have an impact on the purchase of Public Good Science Outputs.

The Review Panel recommends that:

1. The Foundation Board clearly defines and separates its policy and accountability functions from the executive and operational functions of the Foundation.

2. The Foundation Board concentrates on
   - (i) broad issues of funding policy and strategies;
   - (ii) the overall purchase of science Outputs in relation to Government Outcomes and national science priorities.

3. The Foundation Board remains independent of the Ministry of Research, Science, and Technology.

4. The Foundation Board appoints a Chief Executive to be responsible and accountable to the Board for the implementation of the Board's policies and for the operation of the Foundation.

5. The Foundation Board and its Chief Executive review the level and skills of its professional staff commensurate with the Foundation's responsibility of managing a $260 million investment portfolio on behalf of the Crown.

6. The Foundation Board reviews the membership and the terms of reference of its committees and their responsibilities to
   - (i) achieve wider representation of science providers and science users;
   - (ii) distance the Foundation Board from detailed decision making;
   - (iii) align committees with vertically integrated sector- or resource-based portfolios of Outputs.

7. The Foundation Board delegates to committees the authority to make decisions on details of funding within Outputs, according to clearly enunciated guidelines laid down by the Board to ensure that each committee follows common processes and standards.

8. The Foundation committees make decisions on funding allocation at a programme level and not at individual objective levels within programmes.

9. The Foundation Board audits the decisions of the committees prior to final allocation of funds
   (i) to ensure the purchase of science Outputs is consistent with the achievement of Government Outcomes and national science priorities;
   (ii) to be aware of likely consequences of total funding decisions on providers, particularly in regard to maintenance of key skills and expertise essential to New Zealand.

10. The Foundation links its audit of science provider performance with its funding allocation function into a single annual audit and funding round.

11. The Foundation reviews the assessment process, and its pool of science referees, to ensure both a high competence of assessment and increased communication with providers during the bid assessment process.

12. The Foundation establishes procedures that ensure collaborative bids between providers are not disadvantaged.

13. The Ministry of Research, Science, and Technology responds to the need for wide consultation and transparency in establishing national science priorities and the need for a sharp strategic focus for Priority Research Themes.

14. Funding levels by Output classes be set indicatively for several years ahead so that the Foundation and science providers can plan beyond an annually changing framework.

15. The Cabinet Committee on Education, Science, and Technology, the Ministry of Research, Science, and Technology, and the Foundation use a common aggregation of Public Good Science Outputs for general portfolio management to provide
   (i) more effective linkage between Government Outcomes and Public Good Science Outputs;
   (ii) greater integration between strategic priority setting, science purchase, and science Output and review.

16. The Ministry of Research, Science, and Technology and the Foundation review the Output classification system in consultation with science providers and science users to ensure it provides a suitable framework within which the future directions of science provision in New Zealand can be both planned and implemented.

17. The Foundation Board develops clearly enunciated and well-understood policies, interpretations, and procedures of Public Good Science which reflect that
    - (i) Public Good Science encompasses scientific development and provision of services relating to research, science, or technology;
    - (ii) Public Good Science Outputs include those "that may be of benefit to New Zealand, but are unlikely to be funded, or adequately funded, from non-government sources".

18. The Foundation Board reviews its policy on technology transfer to ensure that
    - (i) funds from the Public Good Science Fund may be used for public good technology transfer;
    - (ii) technology transfer components be contestable and transparent and not be treated as overheads.

19. Regular meetings be held between the Ministry of Research, Science, and Technology, the Foundation, major science providers (Crown Research Institutes, Research Associations, Universities), stakeholders (Royal Society of New Zealand, Professional Associations), and users to foster the concept of partnership.

1. INTRODUCTION

The Minister of Research, Science, and Technology, aware of the need to ensure effective and credible allocation of the Public Good Science Fund by the Foundation for Research, Science, and Technology sought an independent review of the allocation of funds for 1991/92.

In the recent bidding round the Foundation for the first time assessed all bids, totalling 705 in number and $457 million in value, for funding from the Public Good Science Fund of $260 million allocated by Cabinet.

The results of the funding round were challenged by some of the traditional science providers. The science community have commented both favourably and unfavourably on the process and the results, expressing particular concern that funding favoured fundamental and strategic research at the expense of applied research, that technology transfer did not receive adequate consideration, that bids involving collaboration between organisations were disadvantaged, and that some adverse consequences of funding decisions were not foreseen.

Government has the expectation that recent reforms of science in New Zealand which have led to the establishment of the Cabinet Committee on Education, Science, and Technology; the Ministry of Research, Science, and Technology; the Foundation for Research, Science, and Technology; and the contestable Public Good Science Fund would provide benefits by better targeting research to meet national economic and social objectives, to improve efficiency in the use of a relatively small research and development resource, and to enhance the quality of the scientific and technological output in New Zealand.

This Report prepared by the Science Funding Review Panel comprising Professor Donald McGregor (Chairperson) (Assistant Vice Chancellor, University of Otago), Dr John Butcher (Director, Wood Technology Division, Forest Research Institute, Rotorua), and Dr Douglas Wright (Director, Meat Industry Research Institute of NZ (Inc.), Hamilton) addresses these issues, identifies problems, and makes recommendations towards improving future bidding rounds.

Because of the urgent nature of this Review, the Panel did not seek public or written submissions. Members of the Panel met with individuals and groups with interests in the allocation process and received a total of 139 oral, and in some instances written submissions (Appendix A). The Review Panel relied on "fair" and honest comment, as it had insufficient time to audit all the commentary provided during the consultation process. All of the major research and development providers in New Zealand were consulted, together with the Foundation for Research, Science, and Technology, the Ministry of Research, Science, and Technology, Treasury, and the State Services Commission. The Review Panel recognises that few "private" providers were consulted.

The full Terms of Reference for the Review are noted in Appendix B. The Purpose of the Review is quoted below.

- To examine the extent to which, and means by which, science priorities and other criteria set by the Cabinet Committee on Education, Science, and Technology have been implemented by the Foundation for Research, Science, and Technology.

- To examine the impact and effectiveness of the allocation processes adopted by the Foundation with regard to developing and maintaining scientific expertise and capability, and achieving the highest possible scientific quality and relevance within the policy constraints set by the Cabinet Committee.

- To record the results of the 1991/92 science funding round including bidding levels, the degree of competition across outputs, the success achieved by traditional and new science providers, allocation decisions by provider and by output, and the balance of allocations between fundamental, strategic, and applied research, and technology transfer.

- To compare these indicators with the results of the previous year's funding round.

- To receive and consider suggestions for improvements to the allocation process and make recommendations accordingly.

2. POLICY FRAMEWORK FOR FUNDING ALLOCATION IN 1991/92

The new system to allocate public funds for research and development is based on each provider bidding to the Foundation for dollars on a contestable basis with other providers.

The policy framework consisted of four elements:

(i) The Foundation for Research, Science and Technology Act, 1990.

(ii) A series of Cabinet minutes.

(iii) The Statement of National Science Priorities issued by the Minister of Research, Science, and Technology on 10 December 1990.

(iv) A series of decisions made by the Board of the Foundation.

Foundation Act 1990

The Act describes the purpose and function of the Foundation. It defines "Public Good Science Outputs", the setting of priorities, the Foundation structure, and its reporting responsibilities.

Cabinet Decisions

These include the creation of the contestable "Public Good Science Fund", the classification and priorities for funding research Outputs, the eligibility to bid, the guidelines on criteria for selection of proposals for annual and long-term funding, and the funding limits by both Output and provider. Government investment in research and development is expected to contribute towards achieving a set of Outcomes for economic, social, and cultural development, environmental management, and risk management.

Statement of National Science Priorities

The Public Good Science Fund is divided amongst 40 science Outputs which arose from both the Public Finance Act 1989 and the need to establish priorities for funding research and development. Science priorities are expressed in terms of proposed funding by Output (Appendix C), and by reference to Priority Research Themes (Appendix D). The Foundation is allowed discretion in the allocation of funding within Outputs. Additionally, the Cabinet drew the Foundation's attention to "themes".

Decisions made by the Foundation

The Foundation:

- designed the funding application form;
- set the closing date for applications;

- designed the process for assessing applications which included the formation of Advisory Committees and the use of referees;
- designed the documentation which was used by referees;
- issued guidelines to members of Advisory Committees;
- issued an overview and interpretation of these decisions to its Advisory Committees.

The Structures Supporting the Purchase of Public Good Science Outputs

In the 1991/92 funding round the following parties participated in the process:

- The Cabinet Committee on Education, Science, and Technology.
- The Ministry of Research, Science, and Technology.
- The Foundation for Research, Science, and Technology.

A feature of the structure is the separation of roles (Appendix E). The Cabinet Committee makes decisions on broad priorities for science following advice principally from the Ministry, which has an oversight of the whole process; the Foundation purchases research in accordance with the broad priorities set by the Cabinet Committee.

The priority setting system is evolving with time, i.e., past allocations made by the traditional science providers largely influenced the allocation of funds between the Outputs in 1991/92.

Setting priorities is ultimately a political process. Acceptance of the priorities is dependent upon adequate consultation with all those who have an interest in the results of research and development. These include science providers, users of science, and research funders. The annual priorities exercise needs to be aligned with strategies for national economic and social development and to be responsive to the national need for change.

The Foundation established a process to allocate funds according to priorities decided by the Committee on Education, Science, and Technology. This process involved:

- Establishing a timetable for the bidding round.
- Designing and printing an application form.
- Setting up a bank of referees.
- Forming four Advisory Committees to assess research bids in selected areas.
- Sending application forms to science providers and receiving bids for funding.
- Providing bids to referees and Committee members.
- Committee assessment of bids.
- Review by the Foundation Board of the allocations recommended for each bid by each Committee.
- The Board deciding upon provisional, and later final, allocations.
- Advising bidders of the result of their applications.
- Returning to the bidder part of the referees' comments.

The four Advisory Committees separately assessed bids for the Public Good Science Fund in:

- biological sciences;
- natural resource and environmental sciences;
- physical and engineering sciences;
- social sciences.

The procedure for appointing members to the Advisory Committees was unclear.

Features of these Committees were the high proportion of university staff, the low number of science users, and their science discipline rather than sector orientation. We understand the senior staff of the Ministry of Research, Science, and Technology were observers in some of the Committees' operations. Each Committee was serviced by Foundation staff with a Board member acting as chairperson.

The science providers prepared bids using a form developed by the Foundation. Information provided by the bidder included details on the bidding organisation, on scientific methods and objectives, and on costs.

The Advisory Committees provide an external source of science intelligence, with their "advisory" role paramount. The Foundation Board, in its guidelines to the Advisory Committees, identifies "the quality of application to the science Output areas" as the basis for recommending which bids should be funded. "Quality" is assumed by the Review Panel to be based on eligibility, science quality, relevance, and ability to deliver, with due consideration also being given to value for money, duplication, collaboration, joint proposals, and long-term funding.

Science providers were asked to nominate knowledgeable referees to assist the Foundation in evaluating research bids. It seems that few of these referees were used by the Foundation. Instead the Foundation used its own "bank" of referees, with up to three referees per bid. Using referees' comments as one criterion, the Advisory Committees assessed bids at an objective level into categories (varying from Committee to Committee) which ranged from no funding to funding above the 1990/91 level. The funding awarded was dependent upon this grading.

Initially it was not envisaged that the Foundation would handle 100% of the Public Good Science Fund on a contestable basis. Earlier decisions envisaged the Foundation having final authority for only a portion of the Public Good Science Fund, increasing year by year to 50%. In 1990/91 the Foundation allocated 20% of the Public Good Science Fund. The balance was allocated by Government on advice from the Ministry of Research, Science, and Technology. For the 1991/92 year the Cabinet agreed that a unified bidding and merit review process should be used for the entire Public Good Science Fund. The Foundation had authority to allocate 45% of the Fund. This comprised all funding in 28 of the 40 Output classes, and funding to non-Government department providers in the other 12 Output classes. The Foundation advised the Minister on allocations to Government departments in these 12 Output classes, with the allocations being approved by the Cabinet Committee.

The Foundation had not planned, in its formative stages, to handle such a large and complex task. It had developed systems and engaged staff for what had originally been anticipated to be a smaller and less extensive operation.

The total value of the Output classes considered by each Advisory Committee varied widely. Whereas the Biological Sciences Committee (Outputs 1–15) received requests for more than $240 million and awarded contracts for $142 million, the Social Sciences Committee (Outputs 25–28) received bids totalling $11 million and awarded contracts totalling $1.6 million. Thus, the workload was far from evenly distributed between the Committees.

Interaction between the Ministry of Research, Science, and Technology and the Foundation for Research, Science, and Technology

Science reform in New Zealand has been based on the principle of separation of three functions:

"The provision of science advice to Government."

"The allocation of funding to research programmes and projects."

"The conduct of research."

Clearly there must be dialogue and consultation between the "advisers", the "funders", and the "providers" for this process to be judged successful. The process is new, and inevitably it will present initial problems. It can be anticipated that, with experience and goodwill, a productive relationship will develop amongst those individuals and organisations involved in the decision-making and science delivery processes.

The relationships between Cabinet; the Committee on Education, Science, and Technology; the Minister of Research, Science, and Technology; the Foundation, the Ministry; and the science providers and users are described in Appendix F.

These relationships depend upon both formal and informal mechanisms. Formal mechanisms include directions on both funding allocations and priorities each year; reporting responsibilities of the Ministry, the Foundation, and providers; the bidding and contracting process; and the priority setting process. Equally important are the informal mechanisms, which include discussions between the Foundation Board and Ministry staff, monthly meetings between the Foundation managers and their counterparts in the Ministry, visits by Foundation and Ministry staff to research institutes, and ready access of science providers to Foundation and Ministry staff. The Foundation is now developing mechanisms to improve consultation.

The Ministry and the Foundation have a formal responsibility to review the operations of the Foundation Act soon after it has been operating for three years. The Ministry does not have a responsibility for monitoring the daily operation and management of the Foundation. This separation ensures the independence of the Foundation and needs to be maintained.

The Ministry is conducting reviews of science which extend beyond those areas funded from the Public Good Science Fund. This review activity was established to provide input into the priority setting exercise and to assist the Foundation in its funding allocation responsibility.

3. KEY PRINCIPLES

The Review Panel wishes to emphasise principles which should form the basis of the allocation process. It is the responsibility of the Board of the Foundation, and its Chief Executive to develop and implement details of the allocation process.

1. **Vision**

   The Ministry, the Foundation, the science providers, stakeholders, and the science users need to share a vision of the directions in which publicly funded science and technology should develop, in the short, medium, and long term, for the benefit of New Zealand.

2. **Partnership**

   The key element in the allocation process should be partnership between the Foundation and the providers of science and technological development.

3. **Consultation**

   There should be regular and continual consultation and dialogue between the Foundation and the providers on all elements and at all stages of the allocation process.

4. **Transparency**

   The allocation process must be open and obvious, and clearly understood by all.

5. **Simplicity**

   The process should be as simple and as straightforward as possible.

6. **Consistency**

   There must be consistency in the operation of the process in a given year and from year to year.

7. **Flexibility**

   There must be flexibility to cope with the diversity of science and technology, with new and unanticipated needs, and with the different constituencies of the scientific community such as the Crown Research Institutes, the Research Associations, the Universities, and private bidders.

8. **Credibility**

   Credibility of the allocation process is critical to the success of the Government science reforms. Credibility requires that the process is conducted in a professional manner by people highly regarded for their knowledge and understanding of science and technology, and committed to applying and developing science and technology for the benefit of New Zealand.

4. ANALYSIS OF 1991/92 ALLOCATION ROUND

Implementation of Science Priorities (and Other Criteria) Set by the Cabinet Committee on Education, Science, and Technology

The result of the 1991/92 funding round was the purchase of Public Good Science Outputs by the Foundation for Research, Science, and Technology with the overriding purpose of contributing to Government Outcomes. In its purchasing decisions, and within the discretionary limits granted to it, the Foundation was required to reflect the science priorities and other established funding criteria set by the Cabinet Committee on Education, Science, and Technology.

The Statement of Priorities for the 1991/92 financial year was communicated to the Foundation by the Minister of Research, Science, and Technology and specified

- indicative funding allocation by Output;
- priority research themes for selected Output classes;
- themes applying across outputs.

Decisions of the Cabinet Committee on Education, Science, and Technology that had an impact on the 1991/92 funding round were

- the classification of output research activities;
- the portion of the Public Good Science Fund allocated by the Foundation;
- eligibility to bid;
- criteria for the selection of proposals for funding;
- bidding limits;
- long-term funding;
- the funding guaranteed to traditional providers;
- funding by Output;
- contingency funding at Foundation discretion;
- the size of the Public Good Science Fund for 1991/92;
- how science priorities were to be established and expressed.

Limits of funding discretion by the Foundation were considerable, given the permissive nature of the definition of Public Good Science Outputs and the subjective nature of assessing such factors as relevance and quality. It is noted that in the Statement of Science Priorities for the 1991/92 financial year it was stated "the Foundation will be allowed discretion in the allocation of funding to Outputs so that you will be able to fully recognise the quality of research proposals in your deliberations". The criteria for the selection of proposals for funding developed by the Cabinet Committee on Education, Science, and Technology stated that "in assessing quality, considerable weight will be given to the record and quality of the researchers themselves, and of the institution". It further noted that lower cost of delivery will be favoured only in selecting proposals of similar high quality and relevance.

Limits of discretion were clearly defined for funding by Output (where an upper limit of 105%, or 100% +$200,000, of the size of the Output in the 1991/92 Statement of Priorities applied) and for funding by traditional providers (where a lower limit of 90%, or 100% -$200,000, of the 1990/91 funding applied). No further limits were imposed.

A contingency fund of 0.5% of the total pool was allowed, but to be applied "so that the guidelines of funding by Output will still be met".

The prime indicator of Science Priorities is the Indicative Funding Allocation by Output (Appendix C). These indicative allocations were applied to the Public Good Science Fund after technical adjustments for base funding in 1990/91 for Outputs 33, 35, and 40. Following preliminary allocation of funds for 1991/92, the Public Good Science Fund was increased by $3.146 million ($3.5 million, minus $231,000 committed for the Priority Research Contract Scheme and $123,000 held by the Foundation as a contingency fund).

A confusing factor was that the Indicative Funding Allocations were made to the Public Good Science Fund inclusive of the Priority Research Contracts Scheme, but were applied after exclusion of funds associated with this Scheme.

Indicative and actual allocations against Outputs are therefore best compared on the basis of the Public Good Science Fund minus the Priority Research Contracts Scheme (Table 1). The overall impact of funding allocation decisions is judged from analysis of trends in "over" or "under" funding of each Output calculated in dollar values from a base of indicative dollar allocation.

1. Biological Outputs (1–15)
   There was a strong trend of "under funding" Outputs with only two notable exceptions—Horticulture (Output 7) and Arable Crops (Output 8)—which were "over" funded by $259,000 and $196,000 respectively.

2. Physics and Engineering Outputs (16–23)
   There was a strong trend of under funding in this Output cluster with a major reallocation occurring between Materials and Industrial Processing (Output 16) which received "over" funding of $304,000 and Electronics and Instruments (Output 18) which was "under" funded by $344,000. Both were targeted for status quo funding.

3. Urban Planning and Social Sciences Outputs (24–28)
   Urban Planning was funded according to indicator allocations. Social Sciences (Outputs 25–28) were also close to target but illustrated a large increase in Output 26 at the expense of Outputs 27 and 28.

4. Environmental Science and Natural Resources (Outputs 29–33)
   There was a strong trend of "over" funding in Natural Resources Outputs—by $336,000 in Geological Processes and Structures (Output 30), $473,000 in Land Use, Flora and Fauna (Output 31), and $557,000 in Marine and Freshwater (Output 32). By extreme contrast, Environmental Protection (Output 29) which was targeted for some growth actually contracted with "under" funding of $467,000. Climate and Atmosphere (Output 33) was close to indicative target.

5. Residual Outputs (34–40)

No clear trends were apparent, but Fundamental Knowledge (Output 36) was "over" funded and S & T Education and Training (Output 39) was "under" funded.

In broad terms, Outputs targeted for growth were not funded up to indicative allocation levels, whereas those targeted for reduction or no change either received partial reduction or displayed some growth.

The Foundation operated correctly within its discretionary powers, but they were sufficient to dull or counter many of the strategic directions signalled by Government in the Statement of National Priorities.

TABLE 1 — Allocation by Output 1991/92 (excluding PRCS*)

Output No.	Description	Priority statement 1991/92 ($000)	Proposed priority shifts (%)	Actual funding 1991/92 ($000)	Actual priority shifts (%)	Actual/ proposed funding (%)	Deviation between actual & proposed funding ($000)
01	Sheep production	16,464	−2.00	16,351	−2.68	99.31	−113
02	Beef production	1,439	0.00	1,438	−0.05	99.93	−1
03	Dairy production	4,075	5 12	3,952	1.96	96.98	−123
04	Alternative animal species	5,332	2.00	5,244	0.32	98.35	−88
05	Generic animal research	12,047	2.00	11,935	1.06	99.07	−112
06	Forage plants	21,680	−3.53	21,570	−4.02	99.49	−110
07	Horticulture	30,499	−2.01	30,758	−1.18	100.85	+259
08	Arable and other plants	13,131	0 00	13,327	1.48	101.49	+196
09	Plantation forestry	11,028	0.00	10,979	−0.46	99.56	−49
10	Fisheries	1,320	2.27	1,127	−12.76	85.38	−193
11	Meat processing	2,190	10.17	2,157	8.52	98.49	−33
12	Dairy processing	2,635	9.71	2,648	10.26	100.49	+13
13	Other food processing	10,202	3.40	10,019	1.56	98.21	−183
14	Fibre, textiles, and skin processing	2,395	3.66	2,289	−0.94	95.57	−106
15	Wood and paper processing	7,215	7.40	7,171	6.74	99.39	−44
16	Materials and industrial processing	13,016	0.00	13,320	2.34	102.34	+304
17	Engineering	5,691	−2.04	5,685	−2.15	99.89	−6
18	Electronics and instruments	7,537	0.00	7,193	−4.57	95.44	−344
19	Construction	2,614	−2.03	2,649	−0.70	101.34	+35
20	Commercial and trade services	253		77		30.43	−176
21	Energy	1,972	2 11	1,904	−1.41	96.55	−68
22	Transport services	988	34.47	960	30.60	97.17	−28
23	Information and communication	997	0.00	1,029	3.25	103.21	+32
24	Urban and rural planning	636	66.29	634	65.87	99.69	−2
25	History, society, and culture	439	30.02	425	25.88	96.81	−14
26	Relationships and wellbeing	298	51.53	442	124.72	148.32	+144
27	Political and economic relationships	511	42.40	437	21.88	85.52	−74
28	Education, knowledge, and training	377	116.24	293	68.02	77.72	−84
29	Environmental protection	9,329	3.30	8,862	−1.86	94.99	−467
30	Geological structures and processes	18,594	−5.00	18,930	−3.28	101.81	+336
31	Land use, flora, and fauna	13,811	0.00	14,284	3.43	103.42	+473
32	Marine and fresh waters	15,962	−5.00	16,519	−1.68	103.49	+557
33	Climate and atmosphere	6,612	0.00	6,558	−0.82	99.18	−54
34	Space	435	0.00	496	14.04	114.02	+61
35	Antarctica	5,967	−0.57	5,941	−1.01	99.56	−26
36	Fundamental knowledge	2,664	0.00	2,785	4.53	104.58	+122
37	Health	352	0.00	350	−0.43	99.43	−2
38	Defence	28	0.00	28	0.00	100.0	0
39	S&T, education, and training	203		0		0.00	
40	S&T services	5,182	0.00	5,230	0.93	100.93	+48
	Total	256,120		255,997		99.95	

*PRCS = Priority Research Contract Scheme.

Priority Research Themes

The Themes (Appendix D), at least in some Outputs, are very broadly described to the point of covering nearly all activities which might be expected in any single Output. An example would be for Output 1 Sheep and Sheep Production Systems where the funding for the Themes was 99% of the total given to that Output (Table 2). This is hardly surprising, as the four Themes covered most of the research to be expected in this Output. *The Ministry of Research, Science, and Technology should give sharper and more strategic focus to research priorities within each Output to make the Theme system more meaningful.*

The Foundation was expected to recognise the priority of these Themes and to fund accordingly, although it was not intended that the Themes be associated with specified sums of money. The results of funding allocations to Themes are shown in Table 2.

TABLE 2 — Funding allocation to Priority Research Themes

Output No.	Description	Total funding in Output ($000)	Value of programmes associated with Themes ($000)	% Themes
01	Sheep production	16 351	16 317	99.8
03	Dairy production	3 952	1 890	47.8
07	Horticulture	30 758	22 302	72.5
09	Plantation forestry	10 979	9 085	82.7
12	Dairy processing	2 649	2 559	96.6
13	Other food processing	10 019	9 007	89.9
14	Fibre, textiles etc	2 289	1 207	52.7
19	Construction	2 649	1 147	43.3
25	NZ culture	425	183	43.1
26	Relationships	442	291	65.8
27	Political and economic	437	318	72.8
28	Education and training	293	260	88.7
33	Climate and atmospheric	6 558	5 733	87.4
40	S&T services	5 230	0	0.0
Across Output Themes				
	Various / Bovine Tb	—	4 008	—
	Various Climate change	—	8 025	—

In 13 out of 14 Outputs the value of proposals associated with Themes ranged from 43% to 99% of the total funding provided in their respective Outputs. In Output 40 Scientific and Technological Services no programmes were associated with Themes. This resulted from a Ministerial request to give priority to maintenance of primary physical standards and to delay any decisions on the Theme topic (establishing a computer-based information network) until after the Crown Research Institutes had been established. The two Priority Themes of bovine tuberculosis and climate change both received significant funding.

It is concluded from the above information that the Foundation funded Themes in a manner which was generally consistent with their importance in the Priority Statement, but detailed scrutiny of programmes would be required to confirm this conclusion.

Long-term Funding

The Cabinet Committee on Education, Science, and Technology placed limits on long-term funding commitments made in 1991/92 so as "not to pre-empt the availability of long-term funding in future years or the future allocative independence of the Foundation". Programmes funded for more than one year were not to exceed 30% of the total Public Good Science Fund, or 60% in any individual Output. Subsequently the Foundation had authority to allocate a further 20% as 2-year funding as a mechanism to ease transition during establishment of Crown Research Institutes.

The results of the decisions on long-term funding by Output, and in total, are shown in Table 3.

Table 3 — Long-term funding by Output

Output No.	Description	Total funding 1991/92 ($000)	Long-term funding 2-year ($000)	3-year ($000)	Total ($000)	% Long term
01	Sheep production	16 351	—	7 145	7 145	43.70
02	Beef production	1 438	—	—	—	0.0
03	Dairy production	3 952	—	856	856	21.66
04	Alternative animal species	5 244	156	2 818	2 974	56.71
05	Generic animal research	11 935	—	6 001	6 001	50.28
06	Forage plants	21 731	4 962	3 008	7 970	36.67
07	Horticulture	30 808	7 789	8 672	16 461	53.43
08	Arable and other plants	13 351	3 147	2 928	6 075	45.40
09	Plantation forestry	11 041	—	4 214	4 214	38.16
10	Fisheries	1 127	—	387	387	34.34
11	Meat processing	2 858	—	250	250	8.75
12	Dairy processing	2 744	—	850	850	30.98
13	Other food processing	10 209	847	3 725	5 422	53.11
14	Fibre, textiles, and skin processing	2 538	149	433	582	22.93
15	Wood and paper processing	7 501	—	2 080	2 080	27.73
16	Materials and industrial processing	13 710	2 002	3 323	5 325	38.84
17	Engineering	5 940	687	1 596	2 283	38.43
18	Electronics and instruments	7 218	1 635	1 144	2 779	38.50
19	Construction	2 649	629	324	953	35.98
20	Commercial and trade services	77	—	—	—	0.0
21	Energy	2 035	1 362	—	1 362	66.92
22	Transport services	985	—	—	—	6.0
23	Information and communication	1 029	729	—	729	70.85
24	Urban and rural planning	634	114	—	114	17.98
25	History, society, and culture	425	—	95	95	22.35
26	Relationships and wellbeing	442	52	—	52	11.76
27	Political and economic relationships	437	251	—	251	57.44
28	Education, knowledge, and training	293	214	—	214	73.08
29	Environmental protection	8 862	1 533	707	2 240	25.28
30	Geological structures and processes	18 990	9 653	2 540	12 193	64.21
31	Land use, flora, and fauna	14 284	0	6 124	6 124	42.87
32	Marine and fresh waters	16 598	6 257	2 447	8 704	52.44
33	Climate and atmosphere	8 058	837	3 341	4178	51.85
34	Space	496	—	—	—	0.0
35	Antarctica	6 310	—	—	—	0.0
36	Fundamental knowledge	2 785	2 046	—	2 046	73.46
37	Health	423	—	—	—	0.0
38	Defence	28	—	—	—	0.0
39	S&T, education, and training	0	—	—	—	0.0
40	S&T services	5 230	—	3 526	3 526	67.42
Total		260 766	45 051	68 531	113 582	43.56

In terms of individual Outputs where the limit set by the Cabinet Committee was 60% in any one Output, this limit was exceeded in:

Output	21	Energy	66.92%
Output	23	Information and communication	70.85%
Output	28	Education, knowledge, and training	73.08%
Output	30	Geological structures and processes	64.21%
Output	36	Fundamental knowledge	73.46%
Output	40	S&T services	67.42%

In the opinion of the Review Panel, long-term funding allocations of the order of 70% and above have effectively "locked in" these Output areas. Of particular concern is the fact that Outputs 23 and 40 were identified in the Statement of Priorities for zero growth from the 1990/91 base, yet programme funding decisions resulted in significant growth (from 3.25% to 4.53%) and long-term funding decisions have reinforced these deviations. Output 30 was targeted for significant reduction (–5.0%) in funding for 1991/92, but was only partially reduced (–3.28%), and long-term funding also exceeded the set limit.

Equally concerning is where significant long-term funding has been committed to Outputs and Programmes in the absence of any Research Themes. *This mitigates against the future setting of Research Themes for these Outputs.*

There is also a strong impression that research targeted at secondary industries (Outputs 11–19) received less long-term funding than that targeted at primary production and New Zealand's natural resources.

Long-term funding has also been shown by provider (Table 4). There were no guidelines for long-term funding per provider, but possibly this is an additional factor that may have to be taken into account in funding decisions, since it clearly affects long-term stability and the maintenance of scientific expertise and capability.

Developing and Maintaining Scientific Expertise and Capability

In exercising its discretionary powers at an Output level, the Foundation operated conservatively and at the expense of change, which obviously had a favourable impact on the maintenance of expertise and capability. Output 7 Horticulture, Output 30 Geological Structures and Processes, and Output 32 Marine and Fresh Waters (targeted for reduction) were collectively funded above indicative allocation by $1.152 million. Output 8 Arable and Other Plants, Output 16 Materials and Industrial Processing, and Output 31 Land Use, Flora and Fauna (targeted for status quo funding) received growth totalling $973,000. These decisions removed a total of $2.125 million from allocation to Outputs targeted for growth (from a base of 1990/91 funding) in the Priority Statement.

There were claims that decisions on funding within Outputs had adverse effects on the maintenance of scientific expertise and capability. This was caused by funding decisions at the programme, and particularly the objective, level. Under funding at a programme level was often the result of deletion of objectives which placed specific personnel in an under-funded position and this threatened retention of specific skills in some provider institutions.

Table 4 — Long-term funding by provider

	Science Provider	1991/92[1] funding ($000)	Long-term[2] funding ($000)	% long term
DSIR[3]	Geology and Geophysics	14 547	8 349	57.4
	Marine and Fresh Water	17 116	10 218	59.7
	Chemistry	8 184	3 384	41.3
	Physical Sciences	15 712	10 153	64.6
	Industrial Development	14 957	7 425	49.8
	Crop	8 405	4 983	59.3
	Grasslands	13 952	6 687	47.9
	Fruit and Trees	16 502	9 213	55.8
	Plant Protection	11 972	3 725	31.1
	Land Resources	12 584	4 092	32.5
	Social Sciences	517	517	100.0
	ALL DSIR (including Antarctic)	140 274	68 746	49.0
MOF[3] (FRI)	Forest Technology	10 669	4 561	42.7
	Wood Technology	4 865	629	13.0
	Pulp and Paper (PAPRO)	2 484	2 080	83.7
	Forest Wildlands	4 710	1 220	25.9
	ALL FRI	22 728	8 490	37.35
MAFFish		889	0	0.0
MAFTechnology		72 430	32 274	44.6
Meteorological Service		3 834	857	48.4
AEI		1 477	0	0.0
BRANZ		1 020	324	31.8
Carter Observatory		422	0	0.0
Cawthron Institute		1 084	0	0.0
CCANZ		196	0	0.0
CRANZ		463	0	0.0
CRM		98	0	0.0
DRI		2 226	850	38.2
HERA		357	0	0.0
LASRA		311	149	47.9
LIRA		322	0	0.0
MIRINZ		1 843	462	25.1
RITS		70	0	0.0
WORKSLL		1 238	0	0.0
WRONZ		1 789	433	24.2

1 Funding allocations as at 30.7.91
2 Long-term funding equals the sum of 2-year and 3-year funding
3 Divisional allocation from Departmental audit trails

Achievement of Highest Possible Quality and Relevance

Quality and relevance decisions were made by the Foundation's Advisory Committees following input from referees. This is a particularly difficult area to assess, since measurement of quality and relevance is based on subjective judgement and can be objective only after defined research programmes have been completed. In this regard, the Review Panel is concerned that

- no dialogue occurred between the Foundation and providers during the assessment period;
- few referees nominated by providers as having full appreciation of the research programmes were used by the Foundation in the refereeing process;
- bids regarded as of high quality and relevance were poorly funded because of assumed appropriability;
- there was a lack of any strategic framework within Outputs to guide decision making.

An overriding concern is the balance between quality and relevance and the extent to which decisions by the Foundation should be guided by the definition of Public Good Science in terms of the concept of benefit to New Zealand.

Relevance is an important criterion which relates to the provision of science Outputs that contribute to Government Outcomes, which in essence may be collectively defined as being to the benefit of New Zealand and should not be over-shadowed by concepts of quality alone.

A further impact of the interpretation of the Public Good definition appeared to be that some research likely to be of benefit to New Zealand had its quality and relevance ratings overridden by judgements of appropriability (i.e., where those benefiting directly were considered to be able to pay for the research). The Review Panel accepts the complexities of this issue, but notes that the Foundation is essentially managing a $260 million investment portfolio and purchasing science Outputs to contribute to Government Outcomes. *Investment decisions constrained by strict adherence to one interpretation of Public Good may well not provide the full potential benefits that research and development can make to New Zealand's economic and social goals.*

1991/92 Bidding Levels and Competition Across Outputs

Bidding levels by main provider or groupings of providers are shown in Table 5. Over-bidding on a 1990/91 base ranged from 147% to 183% amongst main providers, but the private sector provided bids valued at $32.9 million, compared with an allocation of only $1.5 million in 1990/91 (a 2138% increase). The total Public Good Science fund was over-bid by 181%.

This level of over-bidding caused problems for the Foundation in having to assess bids for close to double the value of available funds, especially as the Foundation was having to assess the total science pool for the first time. However, it must be noted that over-bidding is a normal consequence of running a contestable process.

A total of 705 bids, with 5000–6000 objectives, had to be evaluated, and the Foundation must be congratulated on being able to process all bids in the short time available. The Review Panel considers the volume of bids and the time constraints for assessment had an impact on the *quality of the overall assessment. Providers must take a degree of responsibility for this situation, since the level of bidding was quite unrealistic and most would not have had the resources available for science provision had all bids been successful.*

TABLE 5 — Bidding levels by major providers

Provider	1990/91	1991/92 No. of bids	Amount bid for ($000)	Amount allocated ($000)
DSIR	137 694	239	251 911	140 274
MAFTech	74 562	85	110 169	72 430
MOF (FRI)	21 702	37	34 931	22 728
MET	3 698	10	5 751	3 834
MAFFish	928	3	1 823	889
Research Associations etc.	12 494	71	19 688	12 916
Private sector*	1 541	260	32 951	2 926
TOTAL	252 620	705	457 224	255 997
Priority Research Contract Scheme	5 000	—	—	4 769
Grand total	257 620			260 766

* Including universities funded under former Social Science Research Fund.

The problem was even greater in individual outputs (Table 6), with many bids exceeding the available funding by more than 200% and some by 400-600% and beyond.

Success Achieved by Traditional and New Science Bidders and Allocation Decisions by Provider

In broad terms, most major providers (DSIR, MOF, Met Service) had increased funding, but MAFFish and MAFTech received 95.8% and 97.1% funding based on 1990/91 levels. However, within DSIR some Divisions, notably Land Resources and Social Sciences, also appeared to have suffered funding losses.

Research Associations showed a wide range of success in bidding from a low of 89.9% for the Agricultural Engineering Institute to a high of 176% for the Cawthron Institute.

Actual success is difficult to assess, since information available does not show where funds allocated to one provider are to be transferred to another provider as a result of successful joint bidding.

Private bidders may be regarded as true new science bidders, and although the level of funding is still comparatively small ($2.9 million, or about 1% of the total pool) they increased their market share by 90%.

TABLE 6 — Bidding by Output 1991/92 (excluding PRCS)

Output No.	Description	Requested Funding	Available Funding*	Requested / available (%)
01	Sheep production	26 152	16 240	161
02	Beef production	2 785	1 419	196
03	Dairy production	5 790	4 019	144
04	Alternative animal species	9 261	5 259	176
05	Generic animal research	17 463	11 882	147
06	Forage plants	38 628	21 384	181
07	Horticulture	58 008	30 082	193
08	Arable and other plants	28 387	12 952	219
09	Plantation forestry	16 987	10 877	156
10	Fisheries	2 450	1 302	188
11	Meat processing	4 058	2 160	188
12	Dairy processing	5 745	2 600	221
13	Other food processing	20 909	10 063	208
14	Fibre, textiles, and skin processing	3 176	2 362	134
15	Wood and paper processing	9503	7117	134
16	Materials and industrial processing	19821	12838	154
17	Engineering	9981	5613	178
18	Electronics and instruments	10614	7434	143
19	Construction	5632	2578	218
20	Commercial and trade services	1505	250	602
21	Energy	7799	1945	401
22	Transport services	2158	975	221
23	Information and communication	3014	983	307
24	Urban and rural planning	1641	627	262
25	History, society, and culture)			
26	Relationships and wellbeing)	11014	1602	1830
27	Political and economic relationships)			
28	Education, knowledge, and training)			
29	Environmental protection	19364	9201	210
30	Geological structures and processes	29928	18340	163
31	Land use, flora, and fauna	25347	13622	186
32	Marine and fresh waters	22386	15744	142
33	Climate and atmosphere	10620	6521	163
34	Space	613	429	143
35	Antarctica	8877	5886	151
36	Fundamental knowledge	5087	2628	194
37	Health	2001	347	577
38	Defence	133	28	475
39	S&T, education, and training	1425	200	713
40	S&T services	9425	5111	184
Total		**457680**	**252620**	**181**

* According to priorities statement and after technical adjustments.

Balance of Allocations Between Fundamental, Strategic and Applied Research, and Technology Transfer

The Ministry of Research, Science, and Technology has provided the following five-stage categorisation of research and development activity for New Zealand.

Fundamental Research

Experimental or theoretical activities undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Sometimes referred to as pure or basic research.

Strategic Research
Research activities conducted to support long-term "national needs" and directed into specific broad areas in expectation of useful discoveries, or providing the broad knowledge base necessary for solution of recognised practical problems.

Applied Research
Research activities to acquire new knowledge which is directed primarily towards a specific and pre-determined objective or application, and including possible uses for the findings of fundamental research.

Experimental Development
Systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

Technology Transfer
Activities directed at encouraging the exploitation of knowledge by a specified recipient in a different place to its origin through a range of media and means, including concepts, processes and products, with the aim of its application to social, environmental, and economic areas.

Statistics are not available to quantify allocations to these categories of research and technology transfer. However, in wide consultation with science providers who were able to comment at the programme and objective level, the general experience was that

- funding decisions had favoured the fundamental and strategic end of the research spectrum, with applied research, experimental development, and technology transfer being progressively under-funded;
- some new programmes were not funded because of "no proven track record"; this had a particular effect on young scientists, but it also affected established scientists attempting to move into new areas of science activity outside of their established areas of science endeavour;
- applied research was not favoured, particularly if it appeared "near market", in which case it was deemed appropriable, although in many instances likely beneficiaries may have been in no position to fund the research themselves;
- technology transfer generally was not funded unless included as an overhead which led, in some instances, to the results of several years' research not being communicated to potential users;
- overall, the decisions of the funding round were regarded as being conservative, which may be translated as helping to maintain existing scientific skills and expertise, but at the same time could be interpreted as inhibiting New Zealand science from becoming truly innovative.

5. COMMENTARY

In the widespread consultations of the Review Panel a number of issues and concerns were raised consistently and repeatedly by different groups and individuals. In the time available, the Review Panel was not able to verify the accuracy of all of the comments made to it, or to quantify the extent to which they may apply. The Review Panel reports comments as views widely held in the science community.

Comments made to the Review Panel included

- A process for developing and evaluating fundamental and strategic science may not be as appropriate for assessment of applied science, experimental development, and technology transfer. The application of a uniform process, primarily developed for assessment of fundamental science, could have contributed to a skewing of allocations to fundamental and strategic science and away from applied science, as may have the heavy use of university referees and the predominance of university members on Advisory Committees.

- The Review Panel encountered a number of criticisms of the application forms, including insufficient space being provided for a description of the science to be carried out. The Panel was aware when conducting its Review that the Foundation was at the same time reviewing its application form.

- There was criticism of the refereeing and assessment process from almost all the providers whom the Review Panel interviewed. Criticisms included the standard of refereeing, the competency of referees in making judgements outside their fields of interest or expertise, the methods of selection of referees, allegations of conflict of interest with referees reviewing applications in Outputs in which they were also bidders. The Review Panel heard of a case in which a referee was asked to assess a programme in which he was a participant.

- Returning to applicants the summary page of the referees' reports did not add to the credibility of the refereeing and assessment process. Applicants commented on wide discrepancies between reports of different referees and lack of consistency between the referees' reports and allocations of funds. Return of hand-written referees' reports led, in some cases, to identification of referees, who were supposedly protected by confidentiality.

- It was felt by some that referees competent to judge quality of science may not be so well qualified to comment on resource implications, including human resources, or the relevance of a programme to national needs and priorities.

- Some referees reported difficulties in properly reviewing and assessing applications due to lack of sufficient information, and of being faced with requests to referee a large number of applications within a period of a few days.

- A number of criticisms of the Advisory Committees of the Foundation were similar to those of refereeing, e.g., competency to make judgements outside their fields of expertise, inconsistency between Committees in their operation. There was ignorance as to how the Advisory Committees' membership was decided, and how the Committees reached their decisions.

- Some providers reported that funding was cut for the final year of long-term programmes, with a consequent waste of earlier investment in programmes.

- The Review Panel heard of a number of instances where key objectives were not funded, whereas subsidiary objectives which depended upon the key objective did receive funding. Many of these cases were sorted out by discussion with the Foundation following notification of indicative funding decisions.

- There was almost universal agreement among providers that assessment should be made at the level of programmes and not objectives. From the Foundation's perspective, concentration on objectives was forced upon them by over-bidding and the need to normalise bids against previous funding through audit trails.

- There were very widely expressed views that the assessment process should be more consultative and transparent, with more dialogue between the Foundation and applicants, especially at programme manager level; the Panel noted that this opportunity was precluded by some research providers.

- The allocation process did not identify early enough the effects that failure to receive funding would have on particular stations or units. Part of the blame for this rests with provider organisations for not providing appropriate information.

- Many of the providers spoke of the high transaction costs of the bidding process, and the expense in terms of time and resources of preparing applications. It was estimated in one submission that the effort in preparing and submitting bids by DSIR and MAFTech taken together represented 100 person-years of work. Comment was also made on the wide variance between time for bid preparation and time for bid assessment; the ratio has been variously estimated between 100:1 and 50:1.

- A number of those with whom the Review Panel spoke believed that the process worked against collaborative proposals within and between organisations.

- A major concern was that the process was essentially conservative, operating in favour of established applicants and programmes and safe science. The Foundation has a responsibility to maintain skill bases and programmes that are of long-term benefit to New Zealand. It is equally important that there be some risk-taking and that less-established scientists with novel, innovative, even unconventional, programmes are nurtured and supported.

6. ISSUES

Introduction

The Science and Technology Review — A New Deal (1988) noted that:

> "the allocative issue is the key issue in the restructuring of government support for S&T. The success or failure of the restructuring will be directly dependent on how the allocative process is structured and operates".

Recommendations of the Science and Technology Advisory Committee, fundamental to the allocation of funds for research and development activities, were translated into legislation in the Foundation for Research, Science, and Technology Act 1990.

Key elements were:

(a) purchases by the Foundation of science and technology Outputs according to national priorities;

(b) definition of Public Good science and technology;

(c) contestability as a governing principle in the allocation of funds.

National Priorities

The Ministry of Research, Science, and Technology uses the Output classification to recommend to the Cabinet Committee on Education, Science, and Technology levels of funding by Output category in order to express national science priorities. An important element of this process is the requirement for the Ministry to engage in extensive consultation with the community and science sector, prior to recommending science funding priorities.

The Review Panel, in its discussions with science providers, was struck by the widespread ignorance of this process. Few with whom the Panel met had any knowledge or understanding of how the Ministry arrived at its recommended funding levels by Output (i.e., national science priorities). Some had vague recollections about having been consulted about the classification framework. The overriding feeling, though, was that the classification framework and the funding levels per Output were imposed from above by the Ministry, a process over which scientists had little influence. This is worrying, not only in itself, but also as a symptom of a developing alienation between scientists and the Ministry. There is a feeling amongst scientists that the Ministry does not understand science or listen to scientists. Not infrequently, the Review Panel heard comment that "there are too few scientists in the Ministry", with the Chief Scientist being identified as a notable exception. It is the Panel's view that this judgement is too harsh. Many in the Ministry have had extensive training and experience as practical scientists. It is also true that the Ministry has been industrious in sending out questionnaires or undertaking reviews and inviting responses on a variety of matters related to science policy and planning, and that Ministry staff have visited institutions up and down the country. Nevertheless, these perceptions represent a problem which the Ministry may wish to reflect on. The problem is one of values, culture, and language of communication. The Ministry talks process rather than science, and the Ministry's values and culture relate to those of the machinery of Government (or so it is seen). The values of scientists are commitment to the discovery of new knowledge, and their culture and language are those of their fields and disciplines. *There needs to be common ground, shared values and goals, if the Ministry and scientists are to work in partnership for the benefit of New Zealand.*

Output Classification

The concept of Output classes arose from both the Public Finance Act 1989 and the need to establish priorities for funding research and development. Priorities established by the Cabinet Committee on Education, Science, and Technology are communicated to the Foundation as indicative funding levels per science Output. Originally 19 categories were defined for 1990/91, and these were expanded to 40 for 1991/92. The classification also assists in meeting a number of requirements, including those of the Ministry of Research, Science, and Technology for a system that is compatible with its audit and review functions, and those of the Foundation for Research, Science, and Technology for allocation and tracking of the Public Good Science Fund.

The classification is purported to assist with achievement of Government socio-economic Outcomes for Public Good Science, although there is no clear linkage between the Outcome statement for science and technology and the Output classification. The system is related to the OECD classification system for science and technology and the Frascati manual. It has been extensively adapted, enlarged, and subdivided to reflect both past and present patterns of funding and the organisation of New Zealand science and technology. Nevertheless, the present pattern of science Outputs seems to have been determined largely by previous funding allocations to Government science departments.

While it is recognised that a classification system is needed for financial and priority-setting purposes, comments were received expressing concern about the current system as a suitable framework to plot and manage future directions for research and development in New Zealand.

The Review Panel repeatedly heard of the need for a statement of national science policy to bridge the gap between the statement of the Government's socio-economic Outcomes for science and how these Outcomes are to be achieved through the purchase of Public Good Science Outputs. There is an urgent need for a longer-term vision of the direction(s) in which science and technology should be heading for the benefit of New Zealand. Public Good Science should be purchased with reference to that vision.

Thus, funding by Output classes should be set by reference to where New Zealand science and technology should be heading, rather than where it has been. *Funding levels by Output classes should be set indicatively for several years ahead so that the Foundation and science providers can plan beyond an annually changing framework.*

While some with whom the Review Panel spoke made no criticism of the Output classification, there were others who considered there were too many Outputs. The number of Outputs was seen as being restrictive, creating inflexibility, and impeding change. The Review Panel considers the need for change in Output classification might be approached incrementally to minimise both the cost and disruption to the science community. It is important to note that the number and categorisation of Outputs must be sufficient to provide a balance between the power of the Cabinet Committee on Education, Science, and Technology to set strategic directions for science that can then be actioned, and the power of discretion of the Foundation in purchasing science Outputs. The number must also be meaningful in terms of being capable of expressing the vision the Government has for science and technology.

The key requirement is to adopt a flexible approach to the Output classification. For example, in setting the strategic research directions for New Zealand, it may be appropriate for the Cabinet Committee to consider allocating funds to aggregated Outputs in the first instance (e.g., Primary Production, Primary Products and Processing, Industrial Development, Natural Resources, Science Infrastructure, etc.) and then make funding allocations to the specific Outputs within each grouping. This approach would create a good linkage with Government Outcomes for science and also with the Foundation's bid assessment and allocative process which presently comprises Advisory Committees responsible for advising allocations of funds across defined aggregations of Outputs. At present, the Foundation's Advisory Committees are discipline-based, but the Outputs for which they are responsible are aggregated in a manner which is not dissimilar to the sector-based groupings which the Review Panel is advocating.

The Review Panel considers that if the Cabinet Committee, the Ministry, and the Foundation use a common aggregation of Outputs for general portfolio management, this would result in a

- more effective linkage between Government Outcomes and Public Good Science Outputs;
- greater integration between strategic priority setting, science purchase, and science audit and review.

Public Good Science Outputs

A primary function of the Foundation is "to allocate funds for the production of Public Good Science Outputs".

"Public Good Science Outputs" are interpreted in Section 2 of the Foundation for Research, Science and Technology Act 1990 to mean Science Outputs, which:

"(a) are likely to increase knowledge or understanding of the physical, biological, or social environment; or

(b) are likely to develop, maintain, or increase research skills or scientific expertise that are or is of particular importance to New Zealand; or

(c) may be of benefit to New Zealand, but are unlikely to be funded, or adequately funded, from non-government sources."

The Act specifies that science Outputs means goods and services (including information) that relate to research, science, or technology, and that "research" includes scientific development and services.

A key issue confronting the Panel was a lack of clarity, bordering on confusion, as to what is Public Good Science and what is not. This is not new. The Science and Technology Advisory Committee Review (1988) commented on the confusion "which continues to bedevil much of the debate regarding the funding of S & T activity in New Zealand. The confusions are:

- between science as an element of our culture and S &T as tools for economic growth;
- between the role of S & T as a contributor to economic growth and the issue of who should fund that contribution".

The major problem is the last — what should and should not be funded from the Public Good Science Fund? The issue came up at almost every interview and discussion that the Review Panel had. Many of those with whom the Panel spoke interpreted the result of the allocation round as indicating that the Foundation took a narrow view which favoured funding of fundamental and strategic science at the expense of applied science, experimental development, and technology transfer.

There is a concern that favouring the fundamental end of the research spectrum may not be conducive to science making a rapid contribution to the achievement of Government Outcomes.

A widely accepted strategy for New Zealand, as emphasised by the Porter Project, is to add value to primary products and move progressively along the value chain away from commodity products and increasingly towards the production of diversified added-value products. To achieve this, effort must be directed towards innovation and developments in processing and new products, and to the effective and efficient transfer of new technologies into New Zealand industries. Although industries may be regarded as having the responsibility to fund research from which they can be direct beneficiaries, many cannot currently afford speculative research. Additionally, many companies are technology averse and have yet to accept the need to invest to provide the benefits that can accrue from research and development. Thus, there is a need in the short term for the Government to promote the development of knowledge-based and technology-based industry in New Zealand. Once achieved, we expect that companies will more commonly accept their responsibilities to fund more speculative, market-driven research and development.

The Review Panel considers that a greater degree of pragmatism must be introduced to the Foundation's funding decisions when applying the Public Good Science Output definition "that may be of benefit to New Zealand, but are unlikely to be funded, or adequately funded, from non-government sources". The Foundation's interpretation of Public Good Science Outputs is considered to be appropriate for research targeted at New Zealand's national resources, but appears to be somewhat conservative towards funding research and development targeted at the productive and industrial sectors, given the present economic circumstances.

The formation of Crown Research Institutes has resulted from decisions of Cabinet that the Crown wishes to own research companies that focus on "strategic" research (research with an ultimate use or user in mind) rather than on "fundamental" research (often, but not always, research for its own sake). It should be of great concern for Government to ensure that the Foundation interprets Public Good Science in a manner that does not inhibit funding of strategic (and applied) research that is likely to have a direct impact on the achievement of Government Outcomes.

In February 1991 the Foundation issued a paper entitled "Guidelines for Public Good Criteria for Research". While the Review Panel is in agreement with the general thrust of the paper in that there is a continuous gradation from public good to fully "appropriable" research, the paper could be seen as a restrictive interpretation of the Foundation Act.

Therefore, the Review Panel regards it as essential that the Foundation promulgates clearly enunciated and well-understood policies, interpretations, and procedures developed from the definition of Public Good Science embodied in the Foundation Act. In particular two provisions of the Act need to be stressed:

1. Public Good Science encompasses scientific development and provision of services relating to research, science, or technology;
2. Public Good Science outputs include those "that may be of benefit to New Zealand, but are unlikely to be funded, or adequately funded, from non-government sources".

Technology Transfer

The Review Panel heard much from the Foundation, from applicants, and from users about difficulties regarding funding of technology transfer.

The Foundation's policy is that technology transfer should not usually be funded as a separate entity because this creates a division between scientific research and its application. The Foundation prefers to fund technology transfer as an overhead as part of a research programme and generally would not fund technology transfer as separate objectives.

The Review Panel agrees that in assessing all applications the question must be asked "How are the results of the research programmes to be transferred eventually to users for the benefit of New Zealand?" If a satisfactory answer is not obtained to that question there would seem to be no justification for Public Good funding.

Just as important is the issue of Public Good funding of programmes where the objectives are primarily technology transfer. This issue was addressed in some detail in the Report of the Ministerial Science Task Group (1991), which recommended that "Funds from the Public Good Science Fund be used for public good technology transfer programmes which need not contain a research component and may be proposed by all those organisations eligible to bid to the Fund". The Science Task Group also stated that the use of public funds for technology transfer should be contestable and transparent and that it was inappropriate to treat technology transfer as an overhead on research programmes as accountability is not clear. The Panel endorses these views.

In concluding this section, it is appropriate to quote the Science and Technology Advisory Committee Review (1988), which formed the basis of public science reforms.

> "Except to a limited extent, government has no interest in funding research for its own sake. Rather, its interest lies in the benefit which will flow from that research. Thus, for example, if government funding supports continuing research into our geological environment, this will be because of a judgement that the better understanding which should result will produce benefits for society, not simply because of a scientific judgement that the research represents 'good science'."

These views have been translated into the Foundation Act. *It is a primary responsibility of the Board of the Foundation to see that the provisions of the Act form the basis of its procedures for its allocation of funds.*

Contestability

Over-bidding is an essential element of a contestable system. Unless bids exceed the funds available within an Output, the Foundation is unable to make choices between bids. The Review Panel was told by providers that over-bidding was encouraged by the Foundation so that it could make choices. However, the Foundation was unprepared for the level of over-bidding in many Outputs. Providers must take a degree of responsibility for this, since the level of bidding by some providers was quite unrealistic. Many of the providers lacked the resources for the science for which they bid. Had they been 100% successful they may have had difficulty in attracting suitable graduates and other appropriately qualified staff.

A contestable system presupposes a mobile reserve pool of scientists and technologists with a diverse range of skills, expertise, and experience. This is inherently unlikely given the marketability of graduates and the opportunity costs to scientists of gambling on the possibility of a job emerging from the uncertainties of a bidding round.

The Public Good Science Pool is contestable within the constraints imposed by funding limits per Output. These limits are set according to national priorities. They would need to be set years in advance if appropriate signals are to be sent to students and tertiary institutions about future prospects and needs for graduates.

The Review Panel noted that the Foundation is funding a small number of post-doctoral positions in areas of high priority. The Foundation may need to be more active in supporting graduate students, and particularly post-doctoral fellows in areas of national priority, not only to cope with expansion but also to provide for the wave of retirements which could soon have a serious impact on national capabilities for provision of science and technology.

There is concern in the science community about the impact of the tertiary funding policies, announced in the 1991 Budget, on the output of graduates in science and technology. These policies, unless modified, could provide strong disincentives for study and postgraduate research in science and technology, and could erode national capabilities and threaten achievement of Government socio-economic outcomes.

Collaboration

One of the key recommendations of the Science and Technology Advisory Committee was that the allocative process should encourage collaboration between providers in different organisations. It was therefore disturbing to hear reports that collaboration was frequently a casualty of the 1991/92 allocation round when programmes received less funding than that bid for. The Review Panel heard of examples where objectives involving collaboration were not funded, while other objectives within a programme were funded.

A common occurrence was that one provider proposed a collaborative research programme requesting total funding, with the intention of subsequent transfer of the required portion of funds to the collaborator after allocations had been made. In the frequent event of the programme being insufficiently funded, no transfer of funds to the collaborator was made, since to do so would have jeopardised the viability of the main collaborator.

In other instances, collaborative components between different programmes (objectives) received different judgements from Advisory Committees, leading to one component being funded and one not funded. This situation was exacerbated when collaborative components fell into Outputs assessed by different Advisory Committees.

The Review Panel considers that the Foundation's funding strategy should accord a high priority to encouraging collaboration between providers, and procedures must be put in place to ensure that collaborative bids are assessed in their totality and not by their individual components.

Funding by Objectives

A requirement of applications is that they have clearly stated objectives. This is necessary and desirable for a variety of reasons, including assurance that programmes will be well managed and to facilitate audit of the output from programmes.

Bidders did not generally anticipate that decisions on funding might be made by objectives. From the Foundation's perspective, concentration on objectives was forced upon them by over-bidding and the need to normalise bids against previous funding through audit trails.

Concern was frequently expressed to the Review Panel that the Foundation, by concentrating on the funding of objectives within programmes, was encroaching on the management of the provision of science which is the role of providers. This was seen to have the potential for conflict *between science providers and the Foundation, especially with the formation of Crown Research Institutes.*

There is a logic in the Foundation's views that assessment of objectives is an integral part of assessment of the quality and relevance of programmes. It is also true that there was great diversity in the size and complexity of programmes, and an objective in a large programme may be equivalent to an entire smaller programme. The Panel acknowledges and endorses the need for flexibility in assessment processes.

Nevertheless, the Review Panel is concerned by the implications and consequences of funding decisions being made at the level of objectives rather than programmes. Three major concerns are:

- It could lead to funding of inputs rather than the purchase of Outputs.
- Concentration on objectives could restrict the Foundation's overview of programmes and, more importantly, Outputs as a whole, and the allocation of funding according to a strategy and a vision of where science and technology should be heading.
- There is a risk that, by making funding decisions at the level of objectives, the Foundation could become a manager of science as well as a funder, cutting out management in provider organisations.

The Review Panel firmly believes that decisions on the allocation of funding should be made in relation to programmes as a whole, and not at the level of objectives.

The Allocation Process

The Panel encountered consistent and wide-ranging criticism of the allocation process. It needs to be stated that by no means all of the criticism was directed at the Foundation where a small band of hard-working people had to cope with a process that was almost too big for them to handle within the time and resources available to them.

It needs to be stated clearly too that the Panel heard little criticism of the philosophy underlying the principles of the funding system. It is clear that the science reforms are widely accepted by the science community. No one the Panel encountered wanted to scrap the system. What is needed, and urgently, is improvement to the process through which funding is allocated. Our meetings with members of the Board and staff of the Foundation indicated that they were aware of many of the problems and were working hard to remedy them. Many of the steps that have been taken already are welcomed by the science community.

Audit and Funding Round

The Review Panel considers that the Foundation should link its audit of science provider performance and its allocative functions into a single annual audit and funding round. The same people within the Foundation should be responsible for both the audit and allocative processes for particular programmes, Outputs, and groups of Outputs. This would close the feed-back loop between the audit and allocation functions of the Foundation into a continuous annual cycle.

An essential feature of the audit and allocative round is that it should be consultative and involve frequent and regular dialogue between the Foundation and science providers, spread over the whole year.

The Review Panel considers it should flesh out the process it is recommending. At the same time it does not wish to be overly prescriptive. Details of the round and its timing will require careful consideration by the Foundation, and appropriate consultation with science providers and the Ministry of Research, Science, and Technology. A suggested timetable and outline of the Review Panel's proposals for the audit and funding round are given in Appendix G.

The Foundation Board

The function of the Board of the Foundation, and its members, is to implement the provisions of the Foundation Act, including the statement of science priorities conveyed annually in writing by the Minister, and to be accountable to the Minister for their implementation, through its allocation of the Public Good Science Fund.

The Foundation Board must share a vision of the direction in which science and technology should be heading for the benefit of New Zealand, communicated to it by the Minister and the Cabinet Committee on Education, Science, and Technology. The Board's primary role is to implement a funding strategy which translates that vision into reality through the Foundation's allocation of the Public Good Science Fund.

The Review Panel considers that the Board should concentrate on broad issues of funding policy and strategy, and delegate to committees and its Chief Executive Officer authority to implement the Board's policies. *The Board should develop an overview on the overall purchase of Public Good Science Outputs in relation to Government Outcomes, national science priorities, and its own funding strategies.*

The Chairman of the Board presently acts as a part-time executive Chairman to whom the General Manager is accountable for overall management and day-to-day operation of the Foundation and its employees and consultants. The Board's Chairman considers his role as an executive Chairman to have been appropriate during the development phase of the Foundation, but recognises that this may need reviewing.

The Review Panel considers that the Chairman and members of the Foundation Board should not be involved in the executive operation of the Foundation.

The Board must, and must be seen to, stand back from the actual operations of the Foundation. The Review Panel is concerned by the level and degree of involvement of Board members in executive functions of the Foundation. *Having Board members involved in executive and operational decisions, and being accountable to the Board for them, seriously confuses the Board's role with that of management.*

The Foundation Act states that "The Foundation shall consist of not fewer than 5 nor more than 9 members" who shall be "qualified for appointment, having regard to the functions and powers of the Foundation". The members "shall be appointed by the Governor-General on the recommendation of the Minister".

For the Foundation Board to share the Government's vision for science and technology, it must have a more balanced membership. The Board needs a better balance between people with knowledge and experience in science and technology, and users from industry and business. *Most of all, the Board must have the ability to think strategically about the use of the $260 million Fund.*

In terms of Board membership, the Review Panel endorses the present separation of the principal policy advice and purchasing systems and agrees that no officer of the Ministry of Research, Science, and Technology be a member of the Foundation Board or its committees.

The Chairman and members of the Foundation Board have had heavy responsibilities in implementing the recommendations of the Science and Technology Advisory Committee Report and the inaugural allocative processes of the Foundation. The Review Panel considers that it may now be appropriate to consider beginning a planned rotation of Board membership and to bring to the Board new members and a fresh vision.

Chief Executive of the Foundation

The Review Panel recommends that the Board appoint a Chief Executive Officer to be responsible and accountable to the Foundation Board for implementation of the Board's policies and the operation of the Foundation.

Committees of the Foundation Board

The Foundation Board established four specialist Advisory Committees to cover the areas of biological sciences, natural resource and environmental sciences, physical and engineering sciences, and social sciences. The Board has recently agreed to split the work of the original biological sciences committee into two, with one committee covering animal production and processing, including forage plants and systems (Outputs 1–6, 10–12, 14) and the second committee being responsible for horticulture, forestry, and arable crop production (Outputs 7–9, 13, 15).

Each Advisory Committee is chaired by a member of the Board and reports to the Board through the Committee chairperson. The membership of the four Advisory Committees with responsibility for the Public Good Science Fund for the 1991/92 allocation round included in total 14 university scientists, 6 government scientists, 2 research association scientists, and 5 others (plus the Chairman of the Foundation Board, who is an ex officio member of all Advisory Committees).

The guidelines for the Advisory Committees agreed to by the Foundation Board state that "Members are selected (by the Board) on the basis of experience and expertise in decision-making and do not represent interest groups".

The functions of the Advisory Committees are:

> "To advise the Board and staff on the quality of applications in the Output areas they examine, and recommend priority lists on this basis."
>
> "From time to time the Committees' advice may also be sought on issues such as national science and technology priorities and policies, and in the monitoring and performance evaluation process."

The Review Panel considers that the Board should delegate to committees authority to make decisions on funding within Outputs, according to strategies and guidelines developed by the Board.

It is also considered that there should continue to be a small number, say three to five, committees of the Foundation Board, each responsible for an appropriate portfolio of vertically integrated, sector-based groups of Outputs. The workload and responsibilities of committees should be reasonably balanced and approximately equal, with each committee having responsibility for allocating approximately one-third to one-fifth of the Public Good Science Fund (say between $50 and $90 million annually).

The committees should both be named and have a membership which is sector- rather than scientific-discipline-based, according to the Outputs for which particular committees have responsibility. Membership of the committees should be balanced and include users from industry and/or environmental management, as well as scientists and technologists. The Foundation Board should appoint the members of the committees and develop clear and transparent policies for appointment procedures, terms of reference, and membership for the committees.

Although it might be appropriate for a member of the Foundation Board to be present at meetings of committees, possibly as an observer, the Review Panel is firmly of the view that Board members should not chair Foundation committees. The Chief Executive Officer of the Foundation should have an important role in linking the Board and its committees and communicating Board policy to committees. The Foundation may wish to consider whether it would be appropriate for the Foundation's Chief Executive to chair at least some of its committees. It is important that there is consistency between committees in their operation, and that there is a direct link and open channels of communication between committees. It is also important that the procedures of the committees are well understood by providers and users.

Foundation Executive and Support Staff

The Foundation appears to be under-resourced in terms of executive and support staff needed for handling, with the high degree of professionalism required, allocation of an annual appropriation of $260 million.

About 15 staff in total, plus an executive Chairman, is a very lean establishment for such a complex and responsible task, even given our recommendation for the Foundation to pull back to less detail from assessment at the science objective level.

The Review Panel considers that there is a need for the Foundation to add to its core staff a small number of people with considerable reputation and experience in both science and financial management. These senior executive staff would add credibility to the Foundation and would provide a reservoir of scientific and financial intelligence and experience. They would be of an appropriate stature for interaction, at a senior level, between the Foundation and management in provider organisations such as Crown Research Institutes and Research Associations.

Partnership

It needs to be stressed that partnership must be the essence of relationships between the Ministry, the Foundation, science providers, stakeholders (such as the Royal Society), and users. Communication between the partners must be direct, continuous, and transparent. As Dr Bruce Smith said at the Sci-Tech 2000 Conference (1991) "You've got to have the Foundation and the Ministry singing the same tune or you're in trouble". This applies equally to the providers and users and will become even more critical with the formation of Crown Research Institutes and entry of the universities to the Foundation.

There can be no substitute for frequent and informal dialogue between partners. There is a need to continually work to improve channels of communication and regularly review their effectiveness. The Review Panel believes that communication between users, stakeholders, science providers, the Foundation, and the Ministry needs to be improved.

The Review Panel suggests that there be regular meetings, perhaps twice a year, of the chief executives of the Ministry and the Foundation, representatives of the chief executives of the major science providers (Crown Research Institutes, Research Associations, Universities), stakeholders, and users. The Chief Executive of the Ministry would be responsible for convening these meetings on behalf of the Minister of Research, Science and Technology. The Minister, when present, would chair the meetings. In his absence they would be chaired by the Chief Executive of the Ministry, on behalf of the Minister.

7. CONCLUSION

"The allocative issue is the key issue in the restructuring of government support for science and technology. The success or failure of the restructuring will be directly dependent on how the allocative process is structured and operates" (Science and Technology Advisory Committee Review, 1988).

The Foundation Board has had responsibility for developing and implementing an allocative process with the freedom conferred by the Foundation Act and the constraints imposed by the Cabinet Committee on Education, Science, and Technology and conveyed by the Minister of Research, Science, and Technology.

The implications of expansion of the Foundation's activity to include responsibility for making decisions and recommendations on the allocation of 100% of the Public Good Science Fund for 1991/92 had not been fully anticipated by the Foundation Board. The Foundation's structures and procedures had originally been developed for what had been envisaged to be a much smaller operation.

The Foundation staff deserve to be congratulated for their dedication in coping with the severe pressures of the 1991/92 allocation round.

Our Review has drawn attention to weaknesses in the allocation process that urgently need addressing. The Foundation is aware already of many of the comments and criticisms that were reported to the Review Panel. They are symptoms that point to the need for the Foundation Board to reassess and to re-think the bases of its allocative process and its own part in the allocative procedures.

The fundamental role of the Foundation Board is to develop a funding strategy for implementing the Government's vision of the direction in which science and technology should head for the benefit of New Zealand.

8. REFERENCES

Crown Research Institutes: Research companies for New Zealand. Report of the Ministerial Science Task Group, Wellington, 1991.

Science and Technology Review: A New Deal. Science and Technology Advisory Committee, Wellington, 1988.

Smith, B.L.R.: Verbatim transcript. Sci-Tech 2000: Strategies for Science and Technology. New Zealand Technology Advancement Trust, Wellington, 19-20 June 1991.

APPENDIX A

CONSULTATION AND SUBMISSIONS

Submissions were provided by members of the following organisations.

- Department of Scientific and Industrial Research at Lincoln, Wellington, Palmerston North, and Auckland.
- MAF Technology, Ministry of Agriculture and Fisheries at head office, Invermay, Lincoln, Wallaceville, Palmerston North, and Ruakura.
- Ministry of Research, Science, and Technology
- Foundation for Research, Science, and Technology
- Ministry of Forestry at head office and Rotorua
- Combined Producer Boards Research and Development Committee
- Research Associations
- Crown Research Institutes Interim Steering Committee
- University of Waikato
- University of Otago
- Massey University
- University of Auckland
- Vice Chancellors Committee
- State Services Commission
- Treasury
- Royal Society of New Zealand
- NZ Association of Scientists
- Dairying Research Corporation
- Health Research Council
- Allison Consultants
- Zenith Technology Ltd

APPENDIX B

ANNEX A: PROPOSED TERMS OF REFERENCE FOR REVIEW OF PUBLIC GOOD SCIENCE FUNDING IN 1991/92

Purpose of Review

1. To examine the extent to which and means by which science priorities and other criteria set by which the Cabinet Committee for Education, Science and Technology (EST) have been implemented by the Foundation for Research, Science and Technology.

2. To examine the impact and effectiveness of the allocation processes adopted by the Foundation with regard to developing and maintaining scientific expertise and capability, and achieving the highest possible scientific quality and relevance within the policy constraints set by EST.

3. To record the results of the 1991/92 science funding round including bidding levels, the degree of competition across outputs, the success achieved by traditional and new science providers, allocation decisions by provider and by output, and the balance of allocations between fundamental, strategic and applied research, and technology transfer.

4. To compare these indicators with the results of the previous year's funding round.

5. To receive and consider suggestions for improvements to the allocation process and make recommendations accordingly.

Reporting

7. The results of the review are to a be reported to the Cabinet EST Committee, through the Minister of Research, Science and Technology. The Minister will discuss the findings of the report with the Foundation.

Composition of the Review Team and the Conduct of the Review

8. The review panel will be appointed by the Minister of Research, Science and Technology. The review panel will have power to coopt additional members on such terms and conditions as it thinks fit, provided that such cooptions are made in consultation with the Minister.

9. The Review Panel is required to consult widely with organisations carrying out public good science, and with organisations representative of scientists and technologists including the Royal Society, in carrying out each review.

Executive Support

10. Executive support for the review panel, including background investigation, the organisation of meetings, note taking and drafting of reports; will be provided by the Ministry of Research, Science and Technology.

Timing

11. A report will be delivered to the Minister of Research, Science and Technology no later than 30 September 1991.

Publication of the Review Report

12. The annual review report will be published, through the Ministry of Research, Science and Technology, as soon as possible after the Minister's recommendations as a result of the review have been considered by the Cabinet EST Committee and discussed with the Foundation.

APPENDIX C

INDICATIVE FUNDING ALLOCATION BY OUTPUT IN PUBLIC GOOD SCIENCE POOL

Output No.	Description	1990/91 Funding	1990/91 % of total	Proposed % of total for 1991/92
01	Sheep production	16 571	6.49	6.36
02	Beef production	1 419	0.56	0.56
03	Dairy production	3 914	1.53	1.61
04	Alternative animal species	5 156	2.02	2.06
05	Generic animal research	11 649	4.56	4.65
06	Forage plants	22 329	8.74	8.44
07	Horticulture	30 890	12.09	11.85
08	Arable and other plants	13 005	5.09	5.09
09	Plantation forestry	10 977	4.30	4.30
10	Fisheries	1 414	0.55	0.56
11	Meat processing	2 215	0.87	0.95
12	Dairy processing	2 558	1.00	1.09
13	Other food processing	10 039	3.93	4.06
14	Fibre, textiles, and skin processing	2 525	0.99	1.02
15	Wood and paper processing	7 004	2.74	2.93
16	Materials and industrial processing	13 027	5.10	5.10
17	Engineering	5 842	2.29	2.24
18	Electronics and instruments	7 509	2.94	2.94
19	Construction	2 672	1.05	1.03
20	Commercial and trade services	0	0.00	0.10
21	Energy	2 008	0.79	0.80
22	Transport services	725	0.28	0.38
23	Information and communication	983	0.38	0.38
24	Urban and rural planning	377	0.15	0.25
25	History, society, and culture	333	0.13	0.17
26	Relationships and wellbeing	194	0.08	0.12
27	Political and economic relationships	365	0.14	0.20
28	Education, knowledge, and training	172	0.07	0.15
29	Environmental protection	8 921	3.49	3.61
30	Geological structures and processes	19 305	7.56	7.18
31	Land use, flora, and fauna	13 622	5.33	5.33
32	Marine and fresh waters	16 572	6.49	6.16
33	Climate and atmosphere	5 804	2.27	2.27
34	Space	429	0.17	0.17
35	Antarctica	6 237	2.44	2.43
36	Fundamental knowledge	2 628	1.03	1.03
37	Health	429	0.17	0.17
38	Defence	28	0.01	0.01
39	S&T, education, and training	0	0.00	0.08
40	S&T services	5 568	2.18	2.18
Total		255 414	100	100

APPENDIX D

PRIORITY RESEARCH THEMES FOR PUBLIC GOOD SCIENCE FOR SELECTED OUTPUT CLASSES

Output Class 1 — Sheep and Sheep Production Systems

1. The physiological and genetic bases for, and manipulation of, wool fibre production; including the impacts of sheep nutrition.
2. The physiological and genetic bases for pest and disease prediction, prevention, resistance and management in sheep; emphasising genetic, biological and integrated control solutions, and aspects that may impact on New Zealand's overseas earnings.
3. The physiological and genetic bases for, and manipulation of, lamb growth; emphasising aspects that enhance New Zealand's overseas earnings through meeting the needs of the processing sector and enhancing characteristics demanded by consumers.
4. Sheep reproduction and methods of manipulation that enhance the rate of genetic gain of animal productivity related traits.

Output Class 3 — Dairy and Dairy Production Systems

1. The physiological and genetic bases for, and manipulation of, synthesis of milk constituents and their properties; including the impacts of dairy cattle nutrition.
2. The physiological and genetic bases for pest and disease prediction, prevention, resistance and management in dairy animals; emphasising genetic, biological and integrated control solutions, and aspects that may impact on New Zealand's overseas earnings.
3. Dairy cattle reproduction and methods of manipulation that enhance the rate of genetic gain of animal productivity related traits.

Output Class 7 — Horticultural Crops and Management Practices

1. Product differentiation by development of fruit and vegetable products through genetic means, emphasising the needs of the fresh market and processing sectors, and enhancing quality characteristics demanded by customers.
2. The physiological and genetic bases for pre-harvest pest and disease prediction, prevention, resistance and management; emphasising genetic, biological and integrated control solutions, and aspects that may impact on New Zealand's overseas earnings.
3. Product diversification by the introduction, evaluation, production and market assessment of new and novel crops.

Output Class 9 — Trees and Plantation Management Systems

1. The physiological and genetic bases for pest and disease prediction, prevention, resistance and management in plantation forestry; emphasising genetic, biological and integrated control solutions.

2. The impacts of plantation forestry on the on-site and off-site physical environment, including harvesting and sustainable land use.
3. The physiological and genetic bases for enhancement of desirable tree and wood product characteristics, including propagation and early tree growth.
4. The introduction and assessment of alternative tree species to *Pinus radiata* and special purpose species to meet aesthetic and market needs.
5. The understanding of the human and social factors that impact on the recruitment and retention of people into forestry, including the skill base and training requirements.

Output Class 12 — Dairy Processing, Storage Techniques, and Products

1. The properties of dairy milk components, their interactions in food systems and potential therapeutic effects.
2. The impacts on dairy products of existing and new dairy technologies and processes.
3. Dairy products in human health and nutrition, including food safety.
4. Management and monitoring of environmental effects on dairy products (e.g. microbial and chemical contamination) particularly those that may impact on New Zealand's overseas earnings; and management of the impacts of dairy processing on the environment.

Output Class 13 — Fruit, Crops, and Other Food and Beverage Processing, Storage Techniques, and Products

1. Pre- and post-harvest physiological and genetic factors, and their manipulation, influencing ripening, senescence and quality of fresh fruit in storage and under transportation.
2. Post-harvest disinfestation systems that are of quarantine importance for the horticultural exports; and that enhance the image of New Zealand products.
3. Seafood storage, handling, transport and processing that enhance fish species and products relevant to New Zealand.
4. Processes that add value to unprocessed exports through transformation into high quality food ingredients, emphasising modern biological and microbiological techniques.
5. Horticultural and food products in human health and nutrition, including food safety; with specific emphasis on major export products.

Output Class 14 — Fibre, Skin, and Textile Processing and Products

1. The development of environmentally friendly and consumer acceptable materials and technologies in the fibre, skin, and textile industries; with emphasis on bio-technological alternatives.
2. Processes and end uses that add value to unprocessed exports in the fibre, skin and textile industry.
3. The physiological and genetic bases for, and manipulation of, skin and skin product quality including the impact of on-farm management practices.

Output Class 19 — Building and Construction Processes, Systems, and Products

1. Minimising the lifetime cost of building and construction in New Zealand.
2. Low energy architecture.
3. Ways to improve indoor environments in which we live and work to aid the health and efficiency of the people who use the buildings.
4. Improving building safety for occupants.
5. The factors that the building and construction industry must take account of in building for the changing population mix and distribution in New Zealand.

Output Class 25 — New Zealand History, Society, Culture, and Te Ao Maori

1. Iwi development, on Maori social, cultural, political and economic issues.

Output Class 26 — Social and Personal Development, Relationships, and Wellbeing

1. The inter-relationship between economic and social policy, with a specific focus on the impact of Government policy on individual family and group well-being in New Zealand.

Output Class 27 — Political and Economic Relationships

1. New Zealand labour force dynamics and workplace culture in their national and international context, with specific attention to structural adjustment, employment generation, immigration, quality of working life and equity of employment opportunity.
2. New Zealand trade and investment patterns, market problems and opportunities within the framework of a rapidly-changing regional and global economy.

Output Class 28 — Education, Knowledge, and Training

1. Research on the process of skills formation in New Zealand (including analysis of the barriers and opportunities to developing a highly skilled workforce) in the context of continuing economic change. This includes equity issues in education and employment.

Output Class 33 — Climate and the Atmosphere

1. Studies of stratospheric ozone and other stratospheric gases aimed at understanding the chemistry determining ozone concentrations in the atmosphere, and ultraviolet measurement and analysis, including detailed spectral measurements.
2. Studies of tropospheric gases, including isotope studies and measurement of greenhouse gases, aimed at understanding the chemistry of the troposphere.
3. Climate dynamics and paleoclimate studies aimed at describing and understanding past and present New Zealand climates and to predict future variations in atmospheric circulation.

4. Climate monitoring and climate databases, in particular the production of high quality climate records.
5. Trace gas budgets for radiatively active molecules and aerosol, including their sources and sinks in terrestrial and aquatic ecosystems and soils.
6. Investigating interactions between the atmosphere and land surfaces, including the biosphere, with an emphasis on the impacts on the atmosphere.

Output Class 40 — Scientific and Technological Services

1. The establishment for the scientific community of an integrated, nation-wide, electronically-based information network with appropriate flexibility for on-going international connections, to foster the growth of the country's scientific infrastructure.

THEMES APPLYING ACROSS OUTPUTS

1. Climate Change

(a) Fundamental Climate Knowledge

(i) Improving understanding of physical and chemical processes and constituents in the atmosphere and oceans, including long term research, monitoring and modelling of atmospheric and climatic variables; (Output 33, although some work on oceans may fall within Output 32).

(ii) Investigating interactions between the atmosphere and land surfaces including the biosphere; (various Outputs).

(iii) Collection and use of instrumental, historical, and proxy data in the New Zealand, South Pacific and Antarctic Region to assess climate variability; (Output 33).

(iv) Collaboration in developing and validating computer models for predicting regional scale changes; (Output 33).

(v) Trace gas budgets for radiatively active molecules and aerosols, including their sources and sinks in terrestrial and aquatic ecosystems and soil; (various Outputs)

This work is a priority nationally, regionally, and globally, and priority should be given to those programmes which are part of larger efforts directed at increasing fundamental knowledge of climate change parameters, both locally and internationally. Fundamental climate knowledge is the basis for all climate change research.

(b) Adaptation to Climate Change

(i) Impact studies, including sensitivity and adaptive responses of natural and managed ecosystems and responses by the agricultural, horticultural and forestry sectors; (various sector-specific Outputs).

(ii) Assessment and mitigation of climatically influenced hazards; (various sector-specific Outputs).

Adaptation and impact studies are listed as a second priority because it is necessary to understand the likely nature of climate change, based on a better understanding of climate process and the impacts of rising levels of greenhouse gases to define adaptation and impact studies. Preference should be given to funding of broad, co-ordinated programmes aimed at increasing knowledge of the local situation.

2. Control of Possums and the Threat of Bovine Tb

(a) The epidemiology of Tb in farmed and feral animal species

(b) The ecology of possums and other feral animals which may be vectors for Tb

(c) The impact of possums on the natural environment

(d) Development of systems for controlling the possum population in New Zealand emphasising biological control solutions.

(Not in order of priority)

APPENDIX E

STRUCTURES

The Cabinet Committee on Education, Science, and Technology

The functions of the Cabinet Committee include

- evaluates science and technology policies and oversees the consolidation of the new science structures;
- reviews advice from the Ministry of Research, Science, and Technology and the Foundation for Research, Science, and Technology on science policy and research priorities;
- establishes priorities for science funding;
- recommends the total Government funding for science.

The Ministry of Research, Science, and Technology

The functions of the Ministry include:

- Advice to the Minister on national science and technology policy and on the implementation of Government science and technology policy, including national priorities and levels of Output funding, advice on total Government investment in research, science, and technology, and advice on funding to be allocated by the Foundation.
- Arrange and publish the results of science audits and science reviews.
- Provide the Foundation with its Government research funds.
- Maintain a national research and development database.

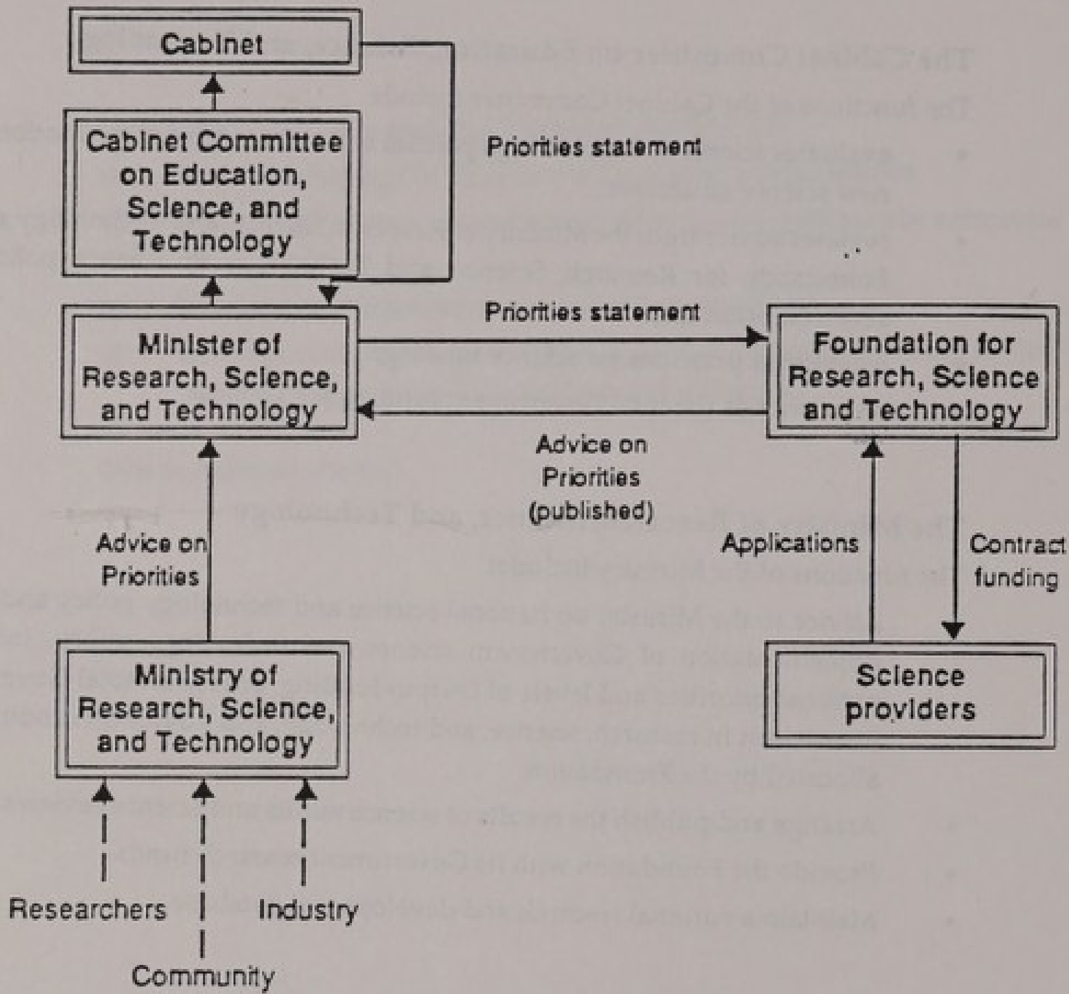
The Foundation for Research, Science, and Technology

The Foundation

- Invites proposals for the provision of public good science outputs.
- Considers and selects proposals from the bids and allocates funds for the production of public good science outputs.
- Provides independent policy advice to the Minister.

APPENDIX F

RELATIONSHIPS BETWEEN ORGANISATIONS



APPENDIX G

SUGGESTED TIMETABLE AND OUTLINE OF THE AUDIT AND FUNDING ROUND

April–May

Audit by providers (e.g., Crown Research Institutes, Research Associations, universities, private bidders) of their science and technology provision, by Output category and programme within Output, and achievement in relation to attainment of Government Outcomes.

Summaries of the retrospective audits and prospective strategic plans prepared by providers, by Output and programme, would be forwarded to the Foundation.

June–August

The Foundation assesses the audits and strategic plans, by Output and in relation to attainment of Government Outcomes. Through doing so the Foundation draws up an overview of Outputs. This will involve the Foundation in visiting providers and interviewing scientists and science managers about their programmes and capabilities. It will also require the Foundation to seek expert advice and peer review of science and technology provision by Output and programme. In practice, this would include external assessment of the internal audits and strategic plans of science providers.

Not all programmes might be reviewed each year. Programmes which have been allocated funding for three years might be audited in their second year and programmes which have been allocated funding for five years might be audited in their fourth year.

The audits and reviews would be collated and prepared for submission to the committees and the Board of the Foundation by the Foundation's executive.

September

The Foundation Board considers the audits and reviews in relation to overall science provision within Outputs and achievement of Government Outcomes. In the light of the reviews the Board sets out a five-year rolling strategy for funding.

The Foundation advises

(a) the Ministry of Research, Science and Technology of its funding strategy, including any recommendations of the Foundationon on national priorities;

(b) science providers of its funding strategy for the next five years, revised annually. The advice to providers would be in the form of a public document.

October

The Ministry of Research, Science, and Technology advises the Minister of science priorities and funding for the next financial year, and four subsequent years. The Minister notifies the Foundation of preliminary indicative funding by Output for the next financial year and changes which could be anticipated in the four subsequent years.

November–December

The Foundation invites and receives bids from providers.

Applicants should emphasize clearly any variations from their strategic plans submitted in April–May and how they may relate to the Foundation's funding strategy published in September

The Foundation will selectively seek peer assessment of quality and relevance of programmes. Programmes that were assessed by the Foundation in June–August will not normally be reassessed, unless there have been significant changes.

January-February

The Foundation completes data entry and analysis of bids.

Applications selected for refereeing are sent to referees chosen for their ability to evaluate the quality and relevance of the applications. Referees will be invited to comment on resources and funding, maintenance of national capabilities, and research skills, to the extent that they are qualified to do so.

Applicants would be invited to nominate suitable referees and also to name people, institutions or countries from whom or which they would not want reports solicited. Brief reasons should be given for nominations and vetos.

Referees should prepare their reports in the knowledge that they would be made available to applicants and also to other referees. However, referees would be permitted to provide the Foundation with a separate confidential report, should they consider that necessary and appropriate.

Applicants, and other referees of an application, would be sent referees' reports and be given a brief period in which to respond to the Foundation on the reports.

February–March	The Foundation's executive staff, assisted, if necessary, by staff seconded from provider organisations (e.g., Crown Research Institutes) would analyse and collate applications for submission to committees. The advice would include reference to provider audits and strategic plans, the Foundation's assessment, referees' reports, resources (including human resources) and funding, and would incorporate reference to national priorities, scientific merit and collaboration, and the Foundation's funding strategy.
March–April	Committees, organised by Outputs and appropriate grouping of Outputs would consider applications and make recommendations and decisions. The committees will have responsibility for taking an overview of the Outputs and groups of Outputs for which they are responsible, in accordance with the Foundation's funding strategy. The committees would make recommendations and decisions according to the authority delegated to the committees by the Board of the Foundation.
May	The Foundation Board considers the recommendations and decisions of its committees and confirms them, or refers them back for further consideration. The Foundation Board should focus on funding recommendations by Outputs as a whole, and the overall purchase of Public Good Science Outputs, rather than reconsider individual programmes. The Board should consider and review decisions of its committees in relation to Government Outcomes, national science priorities, and its own funding strategy. The Foundation informs science providers of indicative decisions. There may be further discussion between the Foundation and providers on details of funding.
June–July	The Foundation prepares contracts for dispatch when the Budget is approved.