Public Investment in Agricultural Research in New Zealand: 1990-2005

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For the last decade and a half agricultural research in New Zealand has been dominated by Crown Research Institutes. The four key institutes AgResearch, HortResearch, Crop Research and Landcare research took over the responsibilities formerly carried out by the Department of Agriculture and the Department of Scientific and Industrial Research. The major reform of the public research system in New Zealand was part of wider reform of the old civil service structure of science in favour of a corporate structure of research institutes which bidded for funds from a newly created agency called the Foundation for Research, Science and Technology. At the same time the Government changed many of the existing priorities for public investment in research with more emphasis on private investment, complementary funding, and new opportunities. These rules tended to reduce the funds made available to the agricultural institutes as they were among those mostly heavily dependent on public investment. In the 15 years since the reforms took place these institutes have lost about 3 percentage points of the total sums, public and private, available for all research, and have lost about 9 percentage points of the public funds available. They have made up the latter losses by more contracting and partnerships with the private sector. In 2005, we report that the agricultural research interests have coordinated a combined approach to Government to review the system of priorities and to help raise the total level of investment in agricultural research.

1. Introduction

As a country, New Zealand has a strong export oriented agricultural sector. While only 5 per cent of GDP is generated in the farm sector, farm-based exports form 55 per cent of total merchandise exports. Productivity growth in the agricultural sector is also one of the highest in the country. Forbes and Johnson (2004) have shown that total factor productivity in the sector grew at the rate of 2.47 per cent per year from 1972 to 2003. Productivity per unit of labour has grown at 3.03 per cent per year as the labour force has not expanded over this period and productivity per capital unit has grown at 1.44 per cent per year as the amount of real capital employed per labour unit has nearly doubled. These productivity increases are significantly related to organisational and technological improvements in agricultural production systems over this period. In a country like New Zealand these changes must be underpinned by a sound and productive research and development (R&D) sector. Harrington (2005) claims 'The relatively high productivity growth in the primary sector has been driven by research and development (coming up with new ideas), innovation (practical application of those new ideas) and economies of scale'. Past research investment is clearly important but productivity has also been strongly influenced by changing

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patterns of production, particularly in response to the removal of government induced distortions.

In this paper, we first discuss the evolution of the institutional structure of the R&D sector over the last two decades and how this has affected the agricultural research sector. This involves a discussion of what was called the 'New Zealand Science Model' a development of the *New Public Management* and *Public Choice theory (*Boston et al 1996). We then discuss developments in the agricultural research sector and how these have interacted with Government priorities for research and the funding available. Finally we consider leading issues that have arisen over 15 years of science reform and the current position of the protagonists involved.

1.1 The Importance of Agricultural Research in New Zealand

Despite significant spending on environmental research and via the New Economy Research Fund, New Zealand still spends a high proportion of its public R&D investment on agricultural research. Investment in different sectors varies according to the institutional type of the providers, government, business or university. Government investment has been most important for primary production and processing, business investment for manufacturing and construction and communications, university investment for the social sciences and fundamental research, and government for environmental research. This can be seen in Table 1 which shows data for 1997-98. This data has not been assembled in this form in more recent years.

Overall, one third of all spending was in the agricultural research area alone, though the respective providers vary considerably in this specialisation. The three types of institution have roughly equal shares of the overall spending in 1997-98.

Table 1: Spending on Research by Output Area Classes 1997-98

(%)

	'Business'	Universities	Government	Total
Primary production/processing	37.6	6.7	55.9	33.2
Manufacturing	50.7	19.8	29.4	6.7
Construction/transport/energy	50.1	26.3	23.5	4.0
Social sciences	2.0	83.1	14.8	12.2
Environment	2.6	24.3	73.1	12.9
Information/communications	67.5	21.1	11.3	11.4
Fund'l, Health, Defence	10.5	82.4	7.1	18.5
Tourism/commercial	0.8	2.4	0.1	1.1
Total 1997-98	28.2	36.4	35.3	100

Source: Table on p.8, MoRST 1999. 'Business' is the MoRST descriptor.

The main Government providers of R&D are the Crown Research Institutes (CRIs). These institutes were formed from former government departments in the early 1990s. The CRIs count as Government providers and draw on both private sector and public funds. In terms of total revenue generated (Table 2), the four agriculturally oriented CRIs have about the same level of R&D expenditure compared with the five non-agricultural CRIs. Further, the agricultural institutes (AgResearch, HortResearch,

Crop and Food Research, Landcare Research) increased revenue at a slower rate than the non-agricultural institutes (Industrial research, Forest Research[4], Environmental Science, and Geological and Nuclear Sciences) - by 49% in the period 1993-2004 compared with 68% for the non agricultural institutes. On this evidence the agricultural sector is only maintaining its share of R&D funds in the period since the departmental reforms.

The Chairman of AgResearch, R.Christie, points out in an address to the 2005 Grasslands Conference that agribusiness still constitutes 65 per cent of the country's merchandise exports, that almost half of exports come from the agricultural sector, that over the last 20 years the agricultural sector has been growing at almost twice the rate of the economy as a whole, and that whereas GDP grew by 39 per cent over the last 20 years, agricultural GDP grew by 72 per cent. He pleads for these facts to be taken into account in setting national priorities. 'There is more excitement in this country about the economic potential of a new way to jump off a bridge than there is about a scientific advance that has the potential to wipe out possums – or to double the number of lambs we produce in a season' Christie, 2005).

Table 2: Nominal Share of CRI Income Generated in Agricultural CRIs

$m

Year	Agricultural CRIs*	Non-Agricultural CRIs**
1993	185.5	153.2
1994	190.9	161.3
1995	192.8	171.8
1996	196.4	192.1
1997	202.0	191.3
1998	211.0	197.0
1999	213.5	207.0
2000	235.6	224.1
2001	254.5	234.3
2002	265.0	246.7
2003	266.2	256.5
2004	277.2	257.2
Growth factor	149.43	167.95
% 1993-2004	+49%	+68%

* AgResearch, HortResearch, Crop & Food Research, Landcare Research.
** Environmental Science & Research, Geological &Nuclear Sciences, Industrial Research, Forest Research, National Institute of Water and Atmosphere

Source: Annual Reports held at CCMAU.

Christie therefore envisages a future where pastoral agricultural research makes a greater claim on the available resources for R&D, and its export performance and productivity gains are recognised. He sees it as being in the national interest to promote better R&D in animals and pastures, to promote innovative science and technology generally, and to make the best use of limited resources, while at the same time maintaining environmental sustainability.

[4] Now "Scion".

1.2 Changes in the Organisation of Research

The structure of public science in New Zealand was reformed in the early 1990s to move from a corporate state model to a company-based private model of organisation. At the same time, the public funding systems were changed from the existing departmental vote allocations for science work to a bidding system administered by a special agency – The Foundation for Research, Science and Technology (FRST). The departmental advice units on science were abolished and a new agency created to coordinate science policy – The Ministry of Research, Science and Technology (MoRST).

The goal of the reforms was to seek greater efficiencies in the allocation of public funds to R&D endeavour. There was a perception among officials that public science tended to 'crowd out' private endeavour and that departmental organisations were cumbersome, self-interested and depleted effort. Indeed, in this period, public choice economics was influential and experimentation with the institutions of the state was very permissive. This was especially true of the science reorganisation (Boston *et al* 1996). The result of these forces was a movement toward specialist private delivery organisations funded from a competitive funding base. After the reforms, MoRST and FRST were to be subject to the New Public Management model with emphasis on the separation of funder, purchaser, and provider roles (op cit, p.26).

Prior to 1990, public science administration was dominated by the Department of Agriculture and the Department of Scientific and Industrial Research[5]. These departments operated under the Vote system receiving annual appropriations from central government. They employed staff, ran research campuses and determined their own scientific objectives. There was broad agreement on areas of specialisation though some duplication did occur. Central oversight was weak although there were a number of advisory bodies in place in the 1960s and 1970s. The National Research Advisory Council (NRAC) operated from 1963 to 1986 and proffered advice to central government and was succeeded by the Science and Technology Advisory Committee until 1992. In addition, the Department of Agriculture administered an extension service for farmers and horticulturalists which provided advice on a free basis. These structures had a number of similarities to the structures in Australian states and had also borrowed from USA extension models. Outside the departmental system were a number of industry research associations for dairy products (DRI), wool research (WRONZ), meat research (MRINZ), and fertiliser research which were partially funded by government but owned and controlled by the respective industry organisations.

Reorganisation of the departments took the form of establishing 10 new research institutes registered as private companies but under Crown ownership. These were based on subject matter titles eg Agricultural Research, Crop and Food, Horticulture, Forestry, Water and Atmospherics, Industrial Research, Land Care Research, Environmental Science, and Geological and Nuclear Science. An Institute of Social

[5] The 10 research institutes, formed on 1st July 1992, replaced science units in DSIR, MAF, the NZ Meteorological Service, Forest Research Institute and the Communicable Diseases Centre of the Department of Health.

Science was mooted but later dropped. Each institute had its own board of directors, appointed by government, and manages its own assets. Ownership remained with the government, represented by two shareholding ministers, the Minister for Crown Research Institutes and the Minister of Finance.

The Departmental appropriations were passed to MoRST and FRST to administer. As far as FRST is concerned, 'The Foundation's main roles are to invest public funds in research and development, provide independent policy advice on science and technology to government and encourage technological innovation' (NZ Yearbook 1993 p.291). The Public Good Research Fund (PGSF) was established to receive bids from government departments, Crown funded agencies, research associations, universities, private companies and individuals, non-profit private trusts, incorporated societies and state owned enterprises that conduct public good research. The agencies and organisations competed to win contracts to undertake agreed research programmes, which reflect national science priorities (more on these below). The Foundation was required to work alongside the private sector to increase their involvement in research and development. The Technology for Business Growth Programme (TBG), for example, invested in research and technological development business projects conducted jointly between business and research institutions. There was also a Research Associate programme, funded by the Foundation, to encourage young scientists to further their work in specific areas of priority research either in a research institution or in industry.

Thus a state model of public research, common to other countries in the British Commonwealth, was converted to a company-based private model of organisation in line with the precepts of *Public Choice* and the *New Public Management*. The new organisation split agriculture research between several crown research institutes and probably left its particular aims and objectives as unfocussed as they were before. The extension service was sold to private enterprise and disappeared off the books. We discuss below the various attempts to give focus to the needs of different industry sectors and how the quest for outcomes has probably not improved.

2.0 The New Zealand Science model

Boston *et al* (1996) point out that the NZ government reforms of the 1980s showed a general preference for:

- private over public organisations (especially for commercial functions);
- non-departmental organisations over ministerial departments (especially for policy implementation rather than advice);
- small scale over large scale organisations;
- single-purpose over multi-purpose organisations;
- pluriform over uniform administrative structures;
- divided over inclusive responsibility (ie the separation of policy and operations, the separation of funder, purchaser and provider, the separation of operations and regulation, the separation of provision and review/audit, the separation of commercial and non-commercial, and the separation of responsibilities for monitoring the Crown's ownership interests and its purchase interests);
- multi-source over single-source supply;

- like with like (primarily on the basis of purpose or the kind of service);
- short hierarchies;
- straight-line accountabilities (ie the avoidance of multiple principals); and
- decentralised administration for the delivery of services.

They point out that the formal institutional separation of policy and operations (and, where relevant, the separation of funder, purchaser and provider roles) has been implemented to a greater extent in areas like defence, environmental administration, health care, housing, justice, and scientific research, than in areas like labour, police, and social welfare. The strictest application of the functional model was in the area of scientific research. In this area there was a formal split between the roles of funder, purchaser and provider; the Ministry of Research, Science and Technology was essentially a single-purpose policy ministry; while the Foundation for Research Science and Technology was to purchase scientific research via a competitive bidding process from a series of CRIs, tertiary institutions and private providers, and monitor the performance of providers. The monitoring of the Crown's ownership interest in the CRIs was to be carried out by the Crown Company Monitoring Advisory Unit (CCMAU). Although the Ministry was the government's chief advisor on science policy, FRST was also funded to provide policy advice, thus emerging with multiple advisory, purchasing, and monitoring roles (Boston et al, p.83). NRAC and the Advisory Committee disappeared.

In such a reorganisation, there was clearly a loss of institutional memory in the old government departments and a loss of jobs in that quarter. Scientists were less discomforted by the administrative changes as far as job security was concerned but subsequently faced increased insecurity of tenure as the bidding rounds changed priorities and moved away from some traditional sacred cows. Job security was maintained in the extension service by offering employment in the privatised company though many chose not to take advantage of it. As far as setting priorities is concerned, a single agency was an advantage and a single funding agency was in position to organise a more coherent framework for the selection of projects and programmes. As will be seen later, defining a science programme has its own difficulties and the best organisational structure for this process may not yet have been found. Work on it continues.

2.1 Operating the System

The Ministry of Research, Science and Technology is the chief scientific advisor to the government of the day. It does not have an operational role. The Foundation of Research, Science and Technology administers the research funds although it also has a small policy role. MoRST is required to provide a Statement of Intent under its legislation setting out what the Minister sees as the general direction of science funding for the forthcoming period. FRST then administers a bidding round where all the providers submit their research plans in advance and decisions are reached through a series of referees and advisory committees. The priorities for upcoming research are established by MoRST and the government in a general form but the administrative details fall on FRST.

Thus FRST administers the public good science fund (PGSF) system which pooled the available government funds for research and development (R&D) from a number of government departments[6]. The newly formed crown research institutes (CRIs), other providers, and later the universities, were able to draw on these funds provided they met the administrative criteria for public good research.

FRST took over a research priority system that had been devised by the DSIR. The procedure had been developed by defining a research agenda broken down by what were called 'output areas'. Within output areas further rules gave guidance to final investment according to a Science and Technology Expert Panel (STEP) report to MoRST (MoRST 1992a, p.78). There were 40 output areas originally although these were later compressed to 19 main categories (see Appendix 1).

In the final report of the Panel, they raised concerns about the balance of research funding between research directly impacting on economic performance, and research underpinning areas on which economic activity depends indirectly (infrastructure research, and the social and natural sciences) (MoRST 1992b, p.11). The report noted that 68 per cent of PGSF funding in 1991-92 was allocated to the directly 'wealth creating' classes 1 to 19 (of the first list of output classes) (Appendix 1). They stated that this class of outputs was already well funded, but output classes 20 to 35 were more difficult to assess because the benefits they create are less direct and can be longer term. The report recommended a shift in emphasis from both the natural sciences and the production groups to what they called the infrastructural group (output areas 20 to 28). The implication was that 'underpinning' research is more of a public good than 'wealth creating' research goods.

The Panel report recommended a productive partnership between the public and private sector to ensure successful commercialisation of PGSF research results. It stated that PGSF research is more likely to be successfully adopted if the research is planned with strong user involvement and is likely to have the greatest chance of producing benefits to New Zealand where users have well-established market linkages and were performing their own research. The implication was that greater co-operation and co-ordination between sectors would compensate for the low level of private sector sponsorship of research (BERL 1995, p.46).

The report recommended that the PGSF should complement successful private research activities where funds are used to promote strategic and generic research and where there is a demonstrated need for such research. Such complementarity should not displace private research funding, the report states, or support appropriable research. The Panel therefore recommended that using the PGSF to complement private funding 'should be conditional on a continuation or enhancement of funding from the private sector'. A practical problem was the state could complement private sector activity without specifying whether business was a big spender in that output area or not. Re-allocating investment away from one set of output areas (see Table 1) created the risk that the gap would not be filled by private enterprise. In addition, the

[6] This administrative arrangement had first been suggested by the 1988 Science and Technology Committee (STAC), though it was not adopted until 1991 (Jardine 1989, p.11).

high so-called private investment in some sectors was due to the fact that the industry research associations were arbitrarily classified as 'business' rather than government even though they were all established with DSIR seed money! The key challenge was whether public investment could be used to trigger further private investment in a complementary way, as well as to create conditions where the up-take of the results of all science investment was enhanced.

In the MoRST instructions to FRST dated July 1997 these objectives do not appear to have changed (MoRST 1997a). The Minister noted that the organisational gains made have resulted in a strong focus on small-scale purchasing of outputs, over relatively short time frames, and within a rather rigid framework of rules and procedures. FRST needed to develop a strategic, far-sighted, and pro-active strategy for focusing on the achievement of outcomes. 'It will be crucial to foster interactive relationships..... in publicly funded organisations and in the private sector that together underpin a vibrant and thriving knowledge-based society'. With respect to encouragement of the private sector, 'funding allocations should be managed in a way .....that does not diminish the incentives for, or displace investment by other funders .....'

2.2 Assessing the Reforms

In terms of the objectives of Government Ministers before 1990 to encourage greater private participation in the R&D market, MoRST statistics show that there has been a steady increase from around 28 per cent to 36 percent in the amount of R&D performed in the private sector (Table 3). A greater share of the research resources is also being channelled through the universities in the period from 1990-91 to 2003-04. The government share has dropped from 44 per cent to 33 per cent over the same period. It has to be remembered that the CRIs are classified as Government providers of R&D in this survey while other research institutes (who are largely funded by industry bodies) are classified as 'business' by MoRST.

There is a lack of data on the trends in private sponsorship of research in the agricultural sector along the lines of Table 1. Table 1 does show that the agricultual/processing sector as a whole was second only to the environmental sector in being most highly dependent on government funding and support. It is therefore pertinent to trace agricultural research spending through the CRI mechanism to assess the relative share in the total system given to the agricultural sector by the public funding authorities and the private sector. It turns out (in Table 5) that the agricultural share of research resources allocated by government and derived from the private sector has declined slightly in the period from 1993-94 to 2004-05 from nearly 55 per cent to 50 per cent. As our discussion below shows, the agricultural research community has been aware of these trends and has increasingly sought to bring their share back to its former levels. Table 5 also shows a declining share of the public good funding going to the agricultural institutes which suggests that they are increasingly seeking private sector funding for all their activities.

Table 3: Research Expenditure by Major Providers
(%)

	1990-91	1991-92	1992-93	1993-94	1995-96	1997-98	1999-00	2001-02	2003-04
Business	28.3	26.8	27.1	30.1	27.0	28.2	29.7	32.1	35.6
Universities	27.8	28.6	30.8	28.3	30.7	36.4	34.2	33.3	31.0
Government	43.9	44.6	42.1	41.6	42.2	35.3	36.0	34.6	33.4
Total $m	724.6	714.5	755.3	824.8	889.3	1107.4	1091.3	1308.3*	1467.9*
% GDP	0.99	0.98	1.00	1.03	0.98	1.10	1.01	1.06	1.07

* sample total adjusted to 2000 survey basis.

Sources: MoRST 1999 Survey and Statistics New Zealand Updates.

Funding patterns are of not the only issue when assessing the reforms. The quality of the expenditure is critical and this is difficult to assess in the short run. One indicator of successful R&D expenditure is the uptake of new technologies but this is difficult to determine and further complicated by New Zealand's decision to abandon significant state funded extension activity. A related issue is that of the dispersion of scientific knowledge. The CRIs greater interest intellectual property has led to claims of 'greater interest in maximizing it value' and claims that 'in seeking extract value they have significantly slowed the dispersion and uptake if knowledge'. There is room for further research analyzing the commercial behaviour of CRIs and their impact on knowledge production and dispersion.

2.3 Agricultural Angst

In the early 1990s AgResearch was foremost in complaining that the competitive bidding process was discriminating against agricultural research endeavour. In 1997 MoRST instituted an investigation of PGSF funding mechanisms and employed reviewers to look at research fund allocations for 17 of the 19 output area classes then being employed (www.morst.govt.nz/PGSF/evaluations). The reports found that research into sheep and beef production systems and into forage and plant research were being neglected through the imposition of other priorities on FRST. In turn, the then funding decisions were starting to cause the breakdown of research teams built up over the years in some research institutes and the loss of key personnel. In response to the CRI providers, MoRST had earlier instituted another form of funding to support CRI staff capabilities and financial shortfalls – christened 'non-specific output funding' (NSOF) in 1993. In 1999-00, for example, $26.8m was allocated to non-specific output funding. This funding was determined as 10 per cent of the funds allocated the previous year from the PGSF to each institute. NSOF was for public good science and technology projects which were not subject to the Government's priorities (NZYB 2000, p.346).

Table 4 shows the allocations to the four agricultural 'output areas' after competitive bidding to the PGSF for the financial years from 1993-94 to 1999-2000. The table shows that the total PGSF fund increased by 17.6 per cent between these years and the agricultural output areas increased by 5.3 per cent in nominal dollars. As a result,

agricultural funding decreased from 46.5 per cent of total PGSF funding to 41.7 per cent. More marked was the decline in the allocation to animal industries of -3.0 per cent and the small increase in forage activities of +0.3 per cent. In real terms, the reports say, the decline for animal industries was –14.8 per cent and for forage –11.6 per cent to 1997-98. With rising wages, these are considerable falls in CRI incomes particularly for Ag Research.

Table 4: PGSF Funding by Output Areas ($k)

Output Area	93-94	94-95	95-96	96-97	97-98	98-99	99-00
1. An. Industry	37923	38444	38293	36568	36639	36719	36763
2. Dairy	7845	9766	10409	12215	13292	13678	14065
3. Forage	21433	21083	20375	20600	21034	21266	21457
4. Hort group	50045	49840	49216	50942	50700	51300	51300
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Total Agr Group	117246	118833	118293	120325	121665	122963	123585
%	46.5	46.4	45.9	44.9	42.2	-	41.7
Total PGSF	252000	256259	257452	267699	288000	na	296400

Source: www.morst.govt.nz/pgsf/evaluations.

Although there were 17 output areas reviewed covering most of the PGSF, only four of the output areas relate to agricultural research. We present a summary of the main conclusions of the four agricultural reviews undertaken and then a summary of the overall review.

Output area 1: Animal industries: Over the period under review (to 1997-98), PGSF funding for Output area 1 declined in both nominal and real terms. While overall funding for PGSF increased, output area 1 was static, as new funds were directed to areas perceived to be of higher priority. The majority of the reduction appears to have resulted in a move away from sheep and beef production research. The main providers are AgResearch, followed by WRONZ, and MIRINZ. The report notes the commodity meat trade now has a high value-added component. The improvement in the value of these exports is the result of past research and development effort. The future development of these exports is dependent on the ability to consistently produce product to specification, and the increasing emphasis on food safety and quality. These attributes will increase the requirement for appropriate research at all stages in the supply chain including production research. The main commercial funding for the set of providers comes from the producers boards and could be considered at risk. The science reforms have encouraged collaboration between researchers including applications to FRST. However, the extensive nature of the industry, and the presence of some commodity trade biases 'makes it difficult for researchers to obtain appropriate direction for research' (ibid). Farmers as a group were well aware of the benefits of PGSF funding.

Output area 2: Dairy: In the dairy report, it is noted that funding has grown strongly over the previous 5 years - 69 per cent in nominal terms and 51 per cent in real terms. The share of the PGSF fund rose from 3.1 per cent to 4.7 per cent. The report noted that there was growth in the number of programmes supported and growth in the size

of programmes. Research output was dominated by 3 providers: AgResearch, DRC and DRI. The providers derive considerable funds from outside the PGSF system. The over-all level of funding is considerably less than in output areas 1 and 3 which is surprising considering the size of the dairy industry. However, many of the programmes are generic to both animal and dairy outputs and thus support the dairy industry too. There is a high level of collaboration between AgRes and DRC. In a survey there was a high level of awareness of PGSF advantages among end-users. 'Vertical integration in the industry ensures research strategies are closely linked to commercial strategies. The report concludes that output area 2 is the only agriculturally focused output to attract a significant increase in funding level over the past five years',

Output area 3: Forage: Total funding declined by 1.9 per cent in nominal terms and 11.6 per cent in real terms to 1997-98. 'This decline is a cause for concern'. The report notes that forage production is the base that provides the competitive advantage for the single largest contributor to the NZ economy – the agricultural sector. The principal provider is AgResearch. A high level of collaboration was observed both internationally and within NZ. There was also a high level of awareness among end-users of the aims of the PGSF. 'Industry end-users included in the forage sector are two and a half times more likely to be involved in the licensing or commercialisation of products generated by PGSF research compared with other agricultural sectors' (ibid). Overall output funding declined from 8.5 per cent of PGSF funding to 7.3 per cent. The report says: 'the scientific capacity for forage research is under threat as the real level of funding has decreased over the five years'.

Output area 4: Horticulture: The full title of this report is *Horticulture, Arable and other Food and Beverage Industries.* The report notes that industry funding increased slightly over the 5 year period although there was a decrease immediately after 1993/94. A number of smaller fruit, crop, ornamentals, vegetables and the arable groups increased their private funding contributions. Government investment has been held at $51m. There was a range of collaborative networking and subcontracting. The main providers were HortResearch (56per cent) and Crop and Food (35 per cent). There was evidence of 'strong' involvement in PGSF research and also 'strong' evidence of capacity for accessing international research. The report notes that 'PGSF funding has made a 'strong' contribution to economic outcomes'. The size of individual programmes appeared to be decreasing. Total funding increased by 1.3 per cent in nominal terms but decreased by approximately15 per cent in real terms. The share of PGSF funding dropped from 19.8 per cent to 17.6 per cent. 'Prior to 1995, FRST policy was to direct funds away from research that was appropriable and this policy affected this output area. Since 1995, a change in instructions required greater account to be taken of the relevance of research and involvement of users. The industry has responded' (ibid).

The above reviews of output areas in the agricultural research sector shows that national priorities moved away from production research both on the plant and the animal area. FRST was under instruction from MoRST at all times so that is where primary responsibility lay! The reasons for the decline in meat and wool production and forage research investment appear to be:

- a common belief that agriculture is an 'old industry' and support should be going to 'new' industries;
- the move from production output areas to infrastructure areas (on the old list);
- constraints on funding available;
- the movement away from providers of appropriable research;
- a shift away from output areas where PGSF was 'too dominant':
- 'complementary' funding to the private sector;
- the 'crowding out' belief held in some circles; and
- the possible over-application of 'market failure' theory.

2.4 Change in Direction

The 1998 review identified increased emphasis on the development of a technological learning relationship as the primary means of creating better outcomes from research and the promotion of the concept of leverage of industry research funding to get better overall results. There would also need to be an increased emphasis on environmental outcomes.

The broader findings of the 1998 evaluation were:

- the need for identifying the existence of strategically significant knowledge platforms and knowledge outcomes in NZ capable of delivering high quality science and technology;
- the identification of the science and technology outputs which have significantly contributed to economic performance, environmental sustainability, and social cohesion of NZ;
- handling the increasing degree of contestability among science and technology providers, in the presence of relative stability of funding, and constraints on the entrance of new providers in the vast majority of PGSF output areas;
- taking advantage of the increased variety of competencies through employment of new staff, and the increased level of collaboration and sub-contracting among science and technology providers;
- taking advantage of the presence of symmetry of competencies in some sub-sectors; in others there was inadequate absorptive capacity among users;
- fixing some inconsistency of user support across different output areas; and insignificant support from the private sector in funding follow-up R&D projects;
- a lack of stronger links with other funding instruments such as research funded through Vote: Education and through other votes (ibid).

This evaluation was overtaken by a wide consultative initiative known as the Foresight Project. The Foresight Project was a consultative process which attempted to document a vision of a desirable future and the strategies needed to get there (MoRST website: Statement by Minister Williamson). The new framework for establishing R&D priorities was designed to ensure that Government's investment would be managed in a more enabling and less prescriptive way. The new investment framework was based 'science envelope goals' and 'target outcomes'. In summary, the science envelope goals identified were:

- An Innovation goal – accelerate knowledge creation and human capital;
- An Economic goal – creation of value in new and improved products;
- An Environmental goal – knowledge that sustains a healthy environment;
- A Social goal – knowledge of the physical determinants of wellbeing.

The science envelope goals were to provide overall direction for the public investment in RS&T. They were designed to encourage stakeholders and purchase agents to seek more effective delivery of outcomes. The target outcomes are 14 future desired states envisaged by the Foresight Project that are cross-sectoral and which provide a strategic context for the development of RS&T portfolios. The existing purchase agents (FRST, HRC, Royal Society) would continue to purchase research outputs in such a way that they are structured and grouped so that they make a coherent contribution to the science envelope goals. 'Negotiations and relationship building are critical to a stable long-term purchasing environment, but contestability and fostering a diversity of ideas and approaches will remain important aspects of the purchasing strategy' (ibid,p.14). FRST with its responsibility for investments under several 'output classes' will be expected to organise contracts with providers under each of these out put classes to create portfolios of RS&T contracts that make contributions towards target outcomes

This seems to be an exercise of organisational rearrangement rather than one of fundamental change in priorities. FRST did not have to respond greatly to the Foresight Project and the consequent reorganisation of the goals and output areas. The Treasury outputs remained the same and the votes for outputs thus defined did not vary much from year to year. Despite the initial stability, MoRST have, since 1999, been feeling their way toward more devolution in decision making. The latest manifestation is the *Picking up the Pace* document. The portfolio approach stays the same but larger projects and longer terms of contract are to be considered by FRST in allocating research funds. FRST have delayed the beginning of the 2006 round of bidding while new directions for providers are worked out.

These paragraphs describe the overall framework for funding R&D in New Zealand in this period and where it now stands. To understand where agricultural research (AR) fits in as only part of the total investment we have to look for indirect evidence of trends in funding from the state and the private sectors and in income derived by providers for various purposes. Before 1999 we have data on the allocations of public research funds for the various output areas as they were then called, and since 1999 we have some idea of the spending of CRIs on specific subject areas and the sources of their income.

2.5 Developments in the Crown Research Institutes

The output area format was abandoned in 1999-2000 and the envelope goals were adopted for layouts, priorities and statistical layouts. Emphasis moved to the research funds or portfolios administered by FRST, and how their benefits could be maximised. This makes tracking agricultural research more difficult for us. As a replacement we explore for the 1994-2005 period the rise and fall in CRI incomes (Table 5).

Table 5: Trends in CRI Income Sources

Fisc year	AR as a % of All Income	AR PGSF as % of All PGSF	AR PGSF as % All Income
1993-94	54.7	58.9	36.9
1994-95	54.2	57.9	35.4
1995-96	52.9	57.8	34.9
1996-97	50.6	56.7	32.8
1997-98	51.4	56.3	32.5
1998-99	51.7	55.3	32.3
1999-00	50.8	54.2	31.4
2000-01	51.3	54.4	30.0
2001-02	52.1	53.8	27.8
2002-03	51.8	54.1	27.2
2003-04	50.9	52.7	25.5
2004-05	51.9	50.1	23.0

Key: See Table 2.
Source: Annual reports at CCMAU.

In the first part of the period 1993-94 to 1997-98, just discussed, agricultural research institute total income was a slowly declining proportion of all CRI income; agricultural institute drawdown on PGSF funds also fell slowly; and agricultural drawdown of PGSF funds as proportion of all income declined from 36.9 per cent in 1993-94 to 32.5 per cent in 1997-98. In Table 3 the MoRST data showed this percentage declining from 46.5 per cent to 42.2 per cent. The two sources are not exactly comparable as output areas do not coincide with institute boundaries.

In the second period, for which we lack data on output areas, the proportion of total income is fairly constant; there is a continuing trend of the share of PGSF money starting to decline, and the share of PGSF income in total CRI income falls more quickly than earlier. Thus we see the trends shown in the earlier period are continued in the later period and are starting to accelerate. There has been some reaction to these trends by the R&D providers which we discuss in Section 3.2.

In July 2005 these concerns were picked up by a working group sponsored by Dairy Insight, Dexcel and Fonterra in a document 'Dairy Industry Capability Needs Review'. The review noted that there was still no coordinated framework for research in the pasture and feed supply area, that there were still significant capability gaps in animal research, that there was a lack of strategic level leadership and coordination which would be proactive in identifying infrastructure and compliance options, and that there was no entity with the mandate and necessary resources to guide, promote, and evaluate human resource development at the farmer level, extension staff and research organisation levels). Key gaps were identified in the R&D, extension and education structure, in the information available for performance analysis, investment and costs, and in on-farm industry strategic leadership and planning. Indeed the review recommends the formation of a strategic planning unit along the lines of the Meat and Wool Economic Service.

3.0 Current Issues in Agricultural Research

3.1 Setting of Government priorities

In 2004-05 discussions between the Government and the research industry led to a new approach to allocating research funds to science providers. The aim appears to be to get away from short term contestable funding in the public choice model and move toward long term commitment of resources to individual providers to plan their own priorities. This could be interpreted as a return to the priority setting process under the DSIR and MAF where priorities were internalised within departments with the surety that the Minister of Finance would always provide the committed funds in following years. Duplication was not then seen as a problem. While Government has made several announcements in the course of 2005 setting out an outline of the new system of funding, the agricultural research community in particular has been increasingly vocal on the role it wishes to play and critical of the old contestable fund system. International interest may well lie in these developments given the past publicity for the so-called "New Zealand Science Model".

Before the Budget in May, there was newspaper discussion of the replacement of non-specific output funding (NSOF) by a capability fund (Dominion Post 11.5.05). The article noted that NSOF had been paid out to help meet operating costs, pay for non-funded research and retain staff. CRIs had complained that 2004-05 funding of NSOF of $32.376m was inadequate to retain promising scientists, but funding agencies were concerned that providing money without specifying how it should be used made accountability difficult. A scientist was quoted as saying 'the key issue is uncertainty. Once you put in a funding application you don't know for nine months whether or not you are going to be successful. That makes it difficult to plan ahead'. The Budget itself was devoid of details of the NSOF problem, but did include $17.8m in new capability funding for CRIs in addition to some other funding increases.

Minister Maharey then made a major announcement at the beginning of July. He said that it is now time for less contestability and more annual 'devolved allocations' to CRIs. The methods of allocation were still being developed. He noted that research institutes need sustainable funding to be able to maintain core competencies, finance capital works, new equipment and address the loss of researchers and inability to recruit young scientists. 'Contestability is not completely the wrong answer, because it drives innovation, but it went to extremes'. He further noted that previously the aim of science policy under successive governments had been to reduce funding of research of benefit to industry from the public purse, requiring industries and producers to contribute directly to appropriate Crown research institute research programmes. He also indicated it was time CRI boards were given more of the discretionary roles they were set up for, instead of the funding bodies making all the key decisions.

In the 2005 statement of intent, *Sustaining Strong Investment: Excellence in Knowledge and Innovation*, the Minister (Mr Maharey) announced that the government would continue to sustain strong investment in RS&T, particularly on people and resources. The new Capability Fund will *replace* the former Non-Science Outputs Fund (NSOF), to assist the CRIs to maintain core capabilities. Extra funding will be provided for the Marsden Fund, Fulbright Awards, Health research, a scheme

called Envirolink to encourage regional councils to access CRIs, research consortia, Technology New Zealand and an Investment Opportunities Fund (to encourage a more rapid response to international opportunities and also to fund relocation of exceptional scientists to New Zealand).

In the *Picking up the Pace,* government confirmed that it had moved away from the competitive bidding model for R&D funding toward more long term arrangements with the science providers. They needed to step up from simplistic public choice theory models of the 1990s. The needs of the industry were: long-term sustainable investment; a stable funding environment; support for high performers; a clear and purposeful R&D agenda; enhanced opportunities for collaboration, networking and technology transfer; and RS&T that is valued, trusted and supported by New Zealanders. One of the early indications of the approach is FRST's Outcome Based Investments (OBIs) which are focused on research sectors where the contracted research delivers benefits that are widely dispersed and not solely of value to a single individual or organization.

The intention is investment will keep pace with increasing research costs, innovative opportunities and OECD trends, accompanied by matching growth in the private sector. They proposed: development of a multi-year RS&T budget package; accelerated growth of R&D investment by private companies through leveraging public sector investment and applying other incentives; greater trust in research organisations to make decisions where they have an information advantage and can maximise the advantage of a devolved investment approach; devolve up to 60 per cent of PGSF to research organisations; ensure non devoted funds (Health, NERF, Marsden and Technology NZ) provide regular opportunities for new ideas to be funded; to define what a successful CRI looks like; and
to develop measures for financial and non-financial performance.

The aim is to provide a clear understanding of critical responsibilities of players in an RS&T system with a focus on core capabilities that deliver benefit to New Zealand so research organisations can mange better for their people and future research priorities. Alongside the multi-year budget package a one off statement will be developed on the obligations and expectations for sectors. A series of RS&T directions or roadmaps for key science areas would be developed with relevant groups of stakeholders, key users and research organisations. There would be increased emphasis on collaboration and networking (MoRST 2005).

This setting of the scene is reflected in FRST's recent statement of intent dated April 2005 (FRST 2005a). 'To support the Government's strategies and address the Minister's challenges FRST's strategy focuses on:

- investing in areas that will help achieve measurable target outcomes where RS&T can make a real difference in improving wealth and wellbeing;
- investing in a manner that encourages improved performance in achieving these outcomes including greater devolution of decision making to RS&T providers;
- evaluating and bench marking performance to support making the right investment choices to reinforce and reward good performance;
- enhancing the Foundation's role as facilitator of an integrated and responsive innovation system'.

FRST tell us that the Foundation is currently assisting MoRST as they work through the policy development process. 'Over the last couple of years we have been trying various ways to provide longer and larger investments while still ensuring that emerging research and researchers are able to succeed with proposals for investment. We have been working to identify practical implementation issues, identification of which is essential to achieve the improvements we are all looking for' (N.Allison, FRST, pers com, October 2005).

In a document about investment signals and requests for proposals on the website (FRST 2005b), the Foundation outlines how it will handle investment proposals for the round starting in July 2007. FRST notes that the Minister wishes to bring greater stability into the funding environment. This will involve reducing contestability in the system by devolving funding and detailed decision making to research organisations although some portfolios funds will be released for investment through fully contestable project rounds. FRST has received consistent feedback and support on the need for New Zealand to use its limited RS&T investment in a more focused manner where that is possible. FRST interprets this as investment that is narrower and deeper. Actions they propose to take include: reducing compliance costs through shorter concept documents; increased focus on science merit and track record through fewer proposal assessment criteria; stronger investment focus through target outcomes, themes and priority research questions; development of scientific road maps; increased focus on researcher performance and capability; restructuring of research portfolios and managers; a new condensed portfolio structure and cross portfolio alignment.

3.2 Recent responses from the agricultural research community

In the meantime, the agricultural research interests were not sitting quietly. There have been initiatives by Lincoln and Massey Universities to enhance the synergies between their research programmes. Likewise other collaborative agreements have been formed and new initiatives have been established such as the Waikato Innovation Park with strong links between Universities, CRIs and the agricultural sector. Significantly AgResearch has returned to highlighting its identity as an 'Agricultural Research' institute rather than a 'Life Sciences' institute.

One key development has been the development of a 'Strategic Framework for Dairy Farming's Future'. The purpose of the framework is to 'set the strategic direction for all on-farm research, development, extension and education' Funding to achieve the targets and objectives 'will come from a number of sources: government, industry good, Agmardt, provider investment, industry and agribusiness'. The major dairy cooperative, Fonterra, was the driver behind this initiative as part of its quest to achieve industry growth and productivity goals. Hence it needed to have a plan for increased efficiency that did not compromise economic, environmental and animal welfare imperatives.

The first version of the strategy document was adopted jointly by the Boards of Dairy Insight (the dairy industry levy collecting body) and Dexcel (the major provider of on farm dairy research and extensions) in 2004 and then endorsed by the wider industry. A second version, commissioned by Dairy 21 (a peak industry body with membership

from Fonterra, Livestock Improvement, Dairy Companies Association, Dexcel and AgResearch) has been drafted after feedback and consultation.

The industry has set a goal of boosting farm productivity by 4 per cent per year. Dairy 21 has already lobbied Government for a $60m boost to pastoral farming research. The Chairman of Fonterra states that putting resources into 'core' agriculture is a safer bet than some less-established sectors, and that the above sum is a relatively small amount of money given the potential economic benefits to the country (The Dominion Post, 28.9.05). This strategy will not have been helped by Fonterra's choice to base a major research centre in Melbourne rather than in New Zealand.

Fonterra was clearly showing considerable leadership in getting the pastoral research participants together. According to the National Business Review (16.12.05), Fonterra has been pushing its own research agenda vigorously since cutting its $159m funding package to biotec subsidiary ViaLactia, in a major restructure in 2004. The CEO stated that the company wanted a more efficient model that makes sense for all parties involved. It wanted to avoid as much duplication in the farming sector as possible and to ensure the company was not burdened with spending money on research that does not directly benefit its value-added goals. Fonterra is said to have initiated the Dairy 21 project.

Not to be outdone, AgResearch was in the news on the 1st of November 2005. The CEO announced that AgResearch needed $73 m for buildings alone. Dr West argued that the extra $60m should go straight to the Crown research institutes who will then decide what to spend it on. He also argued that farmers' contributions to research investment should rise too. 'The $10m they contribute in levies is not much when you consider farm gate returns are $6 billion'. AgResearch's strategic plan for the next 15 years was based on the country investing in its core strengths, the husbandry of plants and animals, he said. He outlined that major investments were required in an animal health laboratory in Palmerston North, a new animal animal handling facility at Grasslands, a biosecurity and infectious diseases facility near Wellington, a centre for reproduction and genomics in Dunedin and other new buildings. Dr West said it was an article of faith that more funding would come.

Taken with Government showing a willingness to increase devolved funding to the CRIs [though the increase in the 2005-06 Budget is quite small] there is a marked willingness in the agricultural research sector to expand their research activities. However there does appear to be some confusion between research project investment and capital spending. More importantly, the agricultural research lobby has increased its mass and firepower and has started to put significant research programs in front of government for public good spending. Private participation will be needed as well. It appears unlikely Government will come to the party in a big way given other pressures on government expenditure. While the Minister talks of investing 3 per cent of GDP (a trebling) in future years, marked increases in research spending by the government or the private sector are not that likely. What the Dairy 21 group might achieve is winning a greater share of the public funds in which case it will be at the expense of some other group. This then comes back to who sets the priorities for R&D spending and how national priorities are determined.

4.0 Reflections on Research Priorities for Agricultural Research

The last 15 years in New Zealand has seen a significant experiment undertaken with regard to the organisation of R&D services. In this country there has traditionally been a fairly even split of resources between the government sector, the private sector and the universities. Before the 1990 reforms, some commentators were of the view that the government sector was too dominant and had been creating a 'crowding-out' effect on the private sector. The erstwhile aim of the reforms was to increase private participation and to decrease the influence of the large government departments and the funding drain on the government. To this end, 10 research companies were set up to absorb the science roles of all government departments. To finance the new structures, the former government votes were placed in a government pool – known as the Public Good Science Fund (PGSF) – for allocation to all research providers on a bidding process.

The agricultural sector was previously serviced by the Department of Agriculture with some support in basic science from the Department of Science Industry and Research. Large research campuses were created over the years for crops, animals and horticulture and the Department of Agriculture provided a free extension service. At least one third of the total resources available were devoted to the agricultural sector. The agricultural sector in common with the environmental sector were the most highly supported by central government compared with other sectors.

Since the reforms began the allocation of resources to science has kept pace with gross domestic product. In terms of provider spending there has been an increase in the share of research being performed by the private sector and the universities and a decline in the share conducted by government agencies. In terms of overall funding, there has been a parallel increase from the private sector and a decline in the government share. These changes were predicated by the reforms in the first place and could be said to have achieved what the planners set out to do.

Agricultural research before the reforms absorbed about one third of all resources made available. Going by the spending by the agricultural crown institutes (Ag Research, Crop & Food Research, HortResearch and Landcare research.) the share of CRI resources going to agricultural research has almost been maintained (55 per cent in 1993-94 and 52 per cent in 2004-05). At the same time the share of agricultural research funded by the government has fallen from 59 per cent to 50 per cent. Thus the agricultural sector has followed the overall trend in decreased government participation and increased private sector participation.

In a mid-term review by MoRST in 1998 these trends were already evident. Data on the then 'output areas' showed that there was a serious decline in resources being devoted to forage research and to animal research. The mid-term review showed that the dairy industry had maintained and even improved its share of resources while the small crops sector had maintained its share.

There was criticism of the funding mechanism and the rules which were used to choose successful projects. These protests probably served to prevent the decline in resources going to the agricultural sector from going any further.

Concurrently with the above review, MoRST was seeking a new mandate for future planning of research in what is known as the Foresight Project. In the light of wide consultation with interested parties a new set of achievable outcomes was adopted by the government which did away with the output area approach. We maintain that the priority setting for individual projects did not change much under the new set of outcomes and we noted that Budget allocations continued largely under the old expenditure classes.

In 2005 the government issued the outlines of a new system of public good research funding which would be based on longer-term contracts with the research providers and devolving more of the individual project choice to them also. At the time of writing FRST had not published a new set of guidelines for research applicants which would indicate how the rules would then apply to the various providers. We observe that, in a curious sort of way, this development is a return to the ways of the 1970s and 1980s when the two large departments were in sole charge of spending priorities for the public good science money. Allocations of research funds are still politically contentious and there is ongoing debate concerning appropriate decision-making by central Government vis a vis research providers and industry participants. High transaction costs continue to be a burden and politicians and interest groups continue to aspire to a dynamic research system which they can influence.

This review is completed by noting resurgence in the private sector research interests in agriculture in 2005. The major participants like Ag Research, Fonterra, Dexcel and Dairy Insight have produced a series of reports on future developments, particularly for the dairy sector, which envisage both increased private spending and an increased contribution from the government. It should be noted that the clamour is not so strong on the meat and wool side, though the above protagonists see all the animal and forage industries working together for the common good and with an increased commitment from public funds.

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Appendix 1: Output Classes

1992 Science Output Classes

Agriculture, Horticulture, Forestry and Fisheries

New and improved

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

Secondary Industries

New and improved

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

Commercial and Trade Services

New and improved

20 Information bases, processes and systems for commercial and trade services

Energy

New and improved

21 Information bases for prospecting, production and use of all energy resources

Transport

New and improved

22 Information bases, processes and systems for transport

Information Processing and Communications Servicing

New and Improved

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

Urban and Rural Planning

New and improved

24 Urban and rural planning information bases, processes and systems

Social Development and Services

Information bases on

25 New Zealand history, society, culture and Te Ao Maori
26 Social and personal development, relationships and wellbeing, Political, economic and international relationships
27 Knowledge, education and training
28 Knowledge, education and training

Environment

New and improved

29 Protection and management technologies for the environment

Exploration and Assessment of the Earth

Information bases on

30 Geological structures and resources, and solid earth processes (including mineral prospecting – see output 16 for mineral processing)
31 The properties, distribution, and potential uses of types of land and land-based flora

32 Marine and fresh waters, their substrata, flora and fauna
33 Climate and the atmosphere
34 Properties, uses and technologies for space
35 The natural environment of Antarctica

General Advancement of Knowledge

Information bases on

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

Health

New and improved

37 Information bases, systems and products in health

Defence

New and improved

38 Information bases, systems and technologies for defence.

1999 Science Output Classes

1. Animal industries
2. Dairy industries
3. Forage
4. Horticultural, Arable, Food & Beverages
5. Forest products
6. Fisheries and Aquaculture
7. Manufacturing
8. Tourism, Commercial services
9. Information, Communication
10. Construction
11. Energy
12. Transport
13. Society and culture
14. Earth resources and processes
15. Land, fresh water ecology
16. Marine, climate and atmosphere
17. Antarctic, defence, other
18. Space, fundamental
19. Health

Source: MoRST 1999.

Appendix 2: Acronyms and Institutional Structure

CRI:	Crown Research Institutes
Agricultural Institutes:	AgResearch, HortResearch, Crop & Food, Landcare
Non-Agricultural Institutes:	NIWA, IRL, FRI, ESR, GNS
FRST:	The Foundation for Research Science and Technology
MoRST:	Ministry of Research Science and Technology
NRAC:	National Research Advisory Council
Industry Research Associations:	
DRI	Dairy Research Institute
WRONZ	Wool Research Organisation of New Zealand
MRINZ	Meat Research Institute of New Zealand
PGSF:	Public Good Research Fund
TBG:	Technology for Business Growth Program
CCMAU:	Crown Company Monitoring Advisory Unit
STEP:	Science and Technology Expert Panel
BERL:	Business and Economic Research Limited
STAC:	Science and Technology Committee
:	
:	
NSOF:	Non-Specific Output Funding