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Utilizing Science and Technology Indicators for Socio-economic Planning in Sri Lanka

Prepared by
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Project Report of a Training Program with the Australian Expert Group in Industry Studies on

Science and Technology Indicator Systems

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Foreword

This report has been prepared by Ms P.R.M.P. Dilrushki from The National Science Foundation of Sri Lanka (NSFSL). Her work has been a core part of an integrated research and policy training program designed by the Australian Expert Group in Industry Studies (AEGIS) at the University of Western Sydney in collaboration with the University of Wollongong. The program was designed to enhance the skills and technical capacity within the NSFSL for managing and integrating S&T indicators in a national system of socio-economic indicators.

Ms Dilrushki was based at the AEGIS Research Centre in Sydney from November 2003 to February 2004. Through these three months she was guided through a data collection and analysis program drawing on Australian, Sri Lankan and international data sets. The major objective was not so much to make the international comparisons but rather to confront the different issues that such comparisons throw-up. Such issues included finding the most useful data sets, organising data in order to make appropriate observations and to identify options for the more effective management of a national S&T indicator system.

Through these tasks Ms Dilrushki has proved very adept and skilful in achieving the objectives. Her report provides a review of the various steps she undertook in collecting and arranging international data. The content, however, is only one of the project outputs. Her skills and enthusiasm for making use of data are part of an ongoing process that should bring benefit to others at NSFSL. I am sure she will build on her experiences in Australia and continue to contribute to the on-going development of the S&T management system in Sri Lanka. We have been pleased to have Ms Dilrukshi as part of our AEGIS team in Australia and look forward to continued collaboration into the future.

Professor
Tim Turpin
Deputy Director
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February 10th. 2004

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1. General Introduction

Most countries make considerable investments in research with the intention of developing national science capability, improving technology capacity technologies, and enhancing economic performance. Therefore, it is important to know the outcomes and impact of these investments in order to guide decisions about future investments. Science indicators can provide a national management tool to monitor national investment in science and assess future investment in technology and knowledge. They are also a valuable tool for identifying and monitoring progress towards achievements in priority areas for investment.

Science indicators can be used to review the R&D activities in organizations and measure quality for setting performance benchmarks for organisations, institutions and fields of activity. Apart from that they can be used for important policy issues as well as making policy that address some outcomes indicated by the indicators themselves. The type of indicator that should be used in decision-making depends on the policy initiative. Science indicators can be used to analyze performance in research, innovation, education and training in a country at a macro level as well as at a micro level.

In the context of integration of science indicators at an international level, the OECD plays a central role in collecting internationally comparable science and technology data. The Frascati Manual prepared by the OECD gives necessary definitions on S&T indicators (OECD, 1991).

The growth of multinational enterprises and the globalization of trade make the understanding of relative S&T performance essential (Holbrook, 1992). The S&T information can be used to provide an overview of the relative competitiveness of various nations and as a potential site for the R&D operations. Multinational cooperation can use the information required for decisions about expansion or cooperation takeovers. The trade in the high technology product and services, and intellectual property has long provided a measure for governments of the success or failure of their policies to encourage private sector technology development (Holbrook, 1992). Today, technology policy and economic policy are intertwined. The ability to apply technology to pursue national economic objectives makes the understanding of technological importance an absolutely necessity for decision makers. To measure the outcome of science and technology and (although a more difficult task) impact; various diagnostic tools can be used.

The expenditure on R&D activities and the numbers of persons involved can be used to measure inputs to R&D activity. The number of publications, number of patents, number of training courses, symposia, and number of post graduates can be used as output indicators to measure the R&D activity.

The expenditure on R&D per unit of the gross output of country can be used as an indication of S&T performance of a country or organization. The number of personnel involved in the research activity per capita of population also provide an indicator of the R&D performance of a country.

Patent data have long been used as a measure of innovative activity and technology development and particularly for international comparisons of technology growth. The number of patent applications lodged or patent granted can provide a proxy measure for the output of inventive activity. They can be also used to monitor technological activity and internationalization. However, when comparing these data across different countries there is a need to take into account precautions such as:

- patents legislations and domestic patenting activity differ from country to country;
- patent cost in a single country may vary with consequent significant effects on observed trends;
- all the patents do not necessarily have the same commercial value;
- not all inventions are not patented; and
- the prosperity of patents varies between industries and across different economic conditions.

Other than that the nature of the industry in different countries also should be taken into consideration when drawing comparisons between countries. Countries based on high technological industries tend to yield more patents than the manufacturing based industrial countries.

The international classification provides a system of classification (IPC) based on technology subject areas. However the patents are not taken as actual reflection of innovation.

The number of publications is also a useful criterion for measuring achievements in R&D activity. Analyzing research literature (bibliometric studies) such as counts of articles in scientific journals, symposia, books and chapters. The number of publications simply reports the quantity of the research outcome. The number of times the published article referred or cited by other authors can be used, to measure with due caution the impact and the quality of that research work. When comparing the publication outputs across countries, the country population also should be taken into account.

The R&D activity of a country depends on the R&D investment tradition and access to resources. A careful examination of all of the S&T data available that definitive conclusion on S&T policy should be drawn. It is important that these analysis rest on hard, quantitative data.

Measuring the impact of research activities and outcomes is extremely difficult as they are interconnected with other factors. Nevertheless, they can be interrelated with economic indicators and may give some indication of the impact. Therefore it is important for NSF to develop a national S&T indicator strategy in collaboration with other relevant agencies.

In Sri Lanka, decisions for funding research are mainly done in the traditional way. That is, by calling for grant applications and assessing project proposals and reputation of researchers or the institution rather than looking specifically at the priority areas of the country. Therefore special attention should be made to improve this process and measure the quality, out comes and impact of the research work carried out in the country at present and whether such research serves to answer questions of national importance. The purpose of this report is briefly to explore the research and development work carried out in Sri Lanka using the country's health sector as a case study. Australia is used here as a comparator country with a reputation for well-developed R&D activity to identify any shortcomings of the research and development indicator systems in Sri Lanka and to reveal potential options for improving that system. The comparison between these two very different economies offers an opportunity to raises S&T data collection and management systems options for implementation within the Sri Lanka NSF and their integration with national economic indicators more generally.

2. The Science and Technology Research and Development in Sri Lanka

2.1 General overview

Sri Lanka is a developing country in Asia with a total population of 19 million. It was one of the first developing nations to provide universal health and education coverage and promote gender equality and social mobilization. As a result it has achieved health and education outcome more consistent with those of high-income countries (World Bank, 2003). Sri Lanka per capita GDP is presently US$ 900 and is the highest in South Asia. The educational achievement includes primary education completion rates around 100 percent. Sri Lanka literacy rates both adults and child, are on par with the more developing countries of the world (World Bank, 2000). The literacy rate is 92%- the highest in South Asia and second highest in Asia.

On the economic front Sri Lanka began it economic transformation in 1977 to market economy based on liberalized trade, foreign exchange and investment arrangement. Since then the gross domestic production per year increased in steady rate of 4-6% except in year 2001 with negative growth recorded first time. This was prompted by the effect of the global economic downtown as well as domestic factors including drought, terrorist attack on Sri Lankan main airport and stalled economic reform. A gradual recovery has begun and currently economy is growing at an annual rate of more than 5%. (World Bank, 2003). Creating the conditions for accelerating economic growth with macroeconomic stability is top priority in Sri Lanka. Improving access to quality education and basic health service is central to the poverty reduction strategy in the country and involvement of the private sector in this venture is considered as a necessary part in the plan.

In par with the open economy embankment in 1977, Sri Lankan agricultural based economy has shifted toward industrial based economy. The dynamic industries now are food processing, textile apparel, food and beverage, telecommunication and insurance. The textile, apparel, and leather product sector is the largest industrial sector and accounted for 42 percent of industrial output (Central Bank Sri Lanka 2002).

2.2 Research and Development activities in Sri Lanka

Sri Lanka has an ancient history of well-developed irrigation engineering techniques; civil engineering and well-organized hospital based health care system that goes beyond 400 AD. However, with the foreign invasion and change of political system, the recent history of research activity in Sri Lanka begun in 1822 with the establishment of the Botanic Garden in Peradeniya, Kandy.

One of the key element of the country's policy in science is it's policy on Science research. More specifically on orientation of research activities on the basis of improvement of the quality of living of people, and achievement of the national objectives. Hence, the scientific progress and its achievements should discreetly monitored. However, at present with the increase of cost on research activities, combined with the dwindle of resources, high cost on national security etc. has compelled decision makers to tighten the grip on the research expenditure and curtailing much needed scientific activities in the country. This resulted the difficulties in keeping up with the minimal standard in the scientific activities and causing most of the eminent scientists in the country to leave the country in search of better prospects for their research activities.

The general reluctance to increase the financial support for the research activities in the country is often linked with the lack of visibility in the immediate benefit to the country development. Therefore it is vital to recognize the priority areas and scientific goals in the research activities to achieve the better target in the area of research in the country. Traditionally funds allocation for research in Sri Lanka was not determined by the expected return in research or the pre-determined societal need. If resources for research are to be used effectively and efficiently, consistent with resource priorities, mechanisms are needed to ensure the coordination and monitoring of resource flows over time.

Measuring the flows of resources will also help to monitor shift in the allocation of research and development funding towards most important areas and determinants. This will also help to identify the neglected areas that do not attract sufficient funding, and avoid the unnecessary duplication of research efforts. Further more these data can be used for advocacy purpose, for instance to indicate the inadequate allocation of resources by government or organizations for research activities. Therefore, in regard to this context several attempts had made to evaluate the research activities in the country. Main purpose of this was to overcome the depletion of fund toward R&D and make some recommendations and in formations to the policy planners and financial advisors to recognize the importance or the key research areas in the country and devoting funds toward the R&D in the country.

The Natural Resource, Energy and Science Authority of Sri Lanka (presently NSF) under took task of analysing national science indicators during the period of 1990-1992. Three successive studies were conducted to measure the productivity of Sri Lankan research in the field of Science and Technology. The results of these studies were used in the policy planning in the organization toward funding for the research in the country. Further studies carried out by the National science foundation of Sri Lanka published handbooks on science indicators in Sri Lanka with some comparative indicators of some developing countries within a period of 1989-1996. These reports gave some insight in to the R&D activities in the country. A follow up study is under way at present to measure the output of the research activities in the country during the period of year 2000-2003.

The Central Bank of Sri Lanka has been conducting national surveys on a regular basis regarding the economic indicators in the country. However, no attempt was made so far to do a broad survey on evaluation of R&D in the country and find association with the out come of the research activity with the economic indicators in the country.

The present study on R&D activity in Sri Lanka is carried out as a preliminary study to investigate the current research activities in Sri Lanka in comparison to Australia. The research activities in the medical sector in the country is selected as a case study for comparison as basis and the goal of the medical sector is common to all countries. Thus this report discusses R&D activities in Sri Lanka with special emphasis on research activities in health sector in the country.

2.3 Research in Health Sector in Sri Lanka

In term of health achievement Sri Lanka outperformed all the other low income and middle income developing countries. Despite continuing poverty it is more akin to those of some members of the OECD than its neighbors (World Bank, 2003). Between 1977 and 2001 Sri Lanka reduced the infant mortality rate from 48-17 deaths per 1,000 live births and average life expectancy at birth climbed from 67 to 73 years. From 1980 to 1996, the maternal mortality rate dropped form 90 to 60 deaths per 100,000 live births while fertility rate declined from 3.5 births per women to near replacement level of 2.1 births.

In late 1980, as a part of a free state medical system, government agencies operated western style medical and Ayurvedic (traditional medicine) clinics and research institutions. The health research sectors is involved more in the areas of infectious diseases and are in cooperation with United Nations agencies in program to eradicate vector born diseases like Malaria which is one of the main health problem in the country. Compare to other Asian countries Sri Lanka had little exposure to the acquired Immuno Deficiency Syndrome (AIDS) and some researchers are involved in research work related to communicable diseases as well. However, a little importance was given by the government to the research sector in the country compared to the health education and welfare system in the country. Therefore, more attention for the research and development activities is needed today to achieve better standard in comparison to other countries and also to achieve its goals. Thus, the evaluation of current research and development has become vital in the country to recognize more productive utilizations of R&D expenditure in the prioritized areas in the country economy.

2.4 Research and Development Expenditure in Sri Lanka

According to the data collected from a survey conducted by the National Science Foundation of Sri Lanka (NSFSL) the total R&D expenditure was Rs. 1,492,610 (US$ 149.26 m) in the year 2000 and 1,409,600 (US$140.96 m) in year 1996. The ratio of GERD/GDP showed that there was a reduction (0.07) in the total funds allocated for the R&D in year 2000 (GERD/GDP=0.11) compared to the year 1996 (GERD/GDP=0.18). However, the funds that were allocated for the improvement in the infrastructure of the universities (buildings and equipments) was not added to the R&D expenditure as those funds were intended primarily for the improvement in teaching and training in universities though they were indirectly associated with the development of the research infrastructure. If these figures were added to the total expenditure the GERD/GDP ratio would became 0.2% in year 2000.

Table 2.1: R&D expenditure by source of funds (in Rs.) in Sri Lanka (All S&T sector)

Source	Year			
	1996		2000	
	Expenditure	%	Expenditure	%
Higher Education sector	981,082	69.6%	334,654	22.4%
Government			761,717	51.0%
Private business	21,144	1.5%	139,690	9.4%
Privet non profit			70	0.0%
Foreign source	324,208	23.0%	81,557	5.5%
Other	83,166	5.9%	164,088	11.0%
Generated funds			10,834	0.7%
Total	1,409,600	100	1,492,610	100.0

Source : National Science Foundation Sri Lanka

The total funds for the R&D in the country came from the higher education sector, Government, business sector, private non profit (PNP) agencies and the foreign sources.

The funds from non-government agencies directed largely for the research under social science and humanity and were not fully recorded. Thus, some parts of the foreign funds were not included into the total R&D expenditure present in this report.

According to the funding sources the government carried the major part of the R&D expenditure in the country (51% in 1996 and 73 % in 2000). Funds for the higher education was from the government and therefore it can also added to the government account devoted to R&D expenditure (Figure 2. 1).

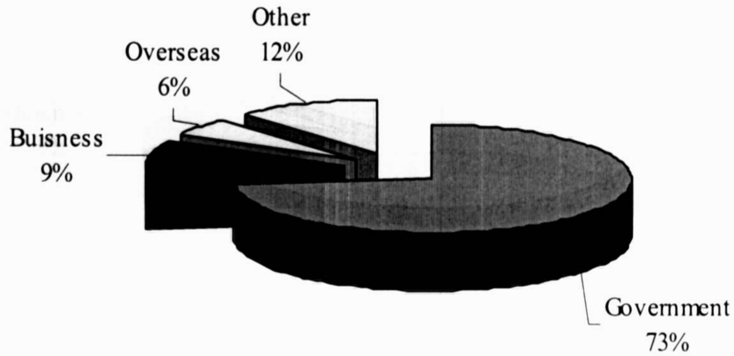

Figure 2.1: R&D expenditure in Sri Lanka from different source in year 2000

Table 2.2: R&D expenditure by type of research (in Rs. Million) in year 2000 in Sri Lanka (All S&T sector)

Type of research	1996		2000	
Basic research	446.3	32%	237.3	15.9%
Strategic basic research			126.3	8.5%
Applied research	867.3	61%	743.9	49.8%
Experimental development	96.0	7%	385.3	25.8%
Total	1409.6	100	1492.8	100%

Source: National Science Foundation Sri Lanka

According to the nature of research major portion of the research carried out in Sri Lanka fallen under applied research and basic research. According to the data available it is difficult to identify the actual expenditure on strategic basic research carried out in the year 1996. Thus, all related studies were given under basic research in that year (Table 2.2). According to the data a large number of research carried out in Sri Lanka fallen under applied research category. However there was a tendency towards more experimental research in year 2000 (26 %) compare to that of year 1996 (7%). The above changes in the activities can be a reflection of economic policies of the country towards industrializations. It can see that industrial sector is getting involved more in the R&D activity in the country and are more interested in experimental research work than basic research. This was reflected in the trend of research funding by the private sector from 1996 to 2000 (Table 2.1). The amount of funding by the private sector increased 8% from 1996 to 2000. Accordingly, the R&D expenditure on Engineering &Technology research and Natural Science research has increased and this may due to the influence of the private sector, as they are more interested in industrial based research that fallen into Engineering & Technology and Natural Science sectors.

2.4 R&D Expenditure by discipline

Table 2.3: R&D expenditure by disciplines (in Rs. Million) in year 1996 and 2000 (In all S&T sector)

Discipline	Total Expenditure Rs. Million			
	1996		2000	
Natural Science	318,300	22.6%	441,929	29.6%
Agriculture	669,200	47.4%	396,916	26.6%
Engineering &Technology	164,300	11.6%	255,895	17.1%
Medical Science	136,600	9.7%	159,752	10.7%
Social Science	121,200	8.6%	205,098	13.7%
Humanities			14,069	0.9%
Others			18,951	1.3%
Total	1,409,600	100.0%	1,492,610	100%

Source: National Science Foundation Sri Lanka

The R&D expenditure on different disciplines has shown changes from 1996 to 2000. In 1996, 47% of R&D funds were directed towards the Agricultural sector and this was reduced to 27% in the year 2000. Accordingly funds for the Natural Science, Engineering and Medical Science sectors increased in year 2000 (Figure 2.2). However, the increase in the expenditure of medical science research (10% in 1996 to 11% in 2000) was slight compared to the increase in engineering and technology sector, which, was 5% increase from 1996 to 2000 (12% to 17%).

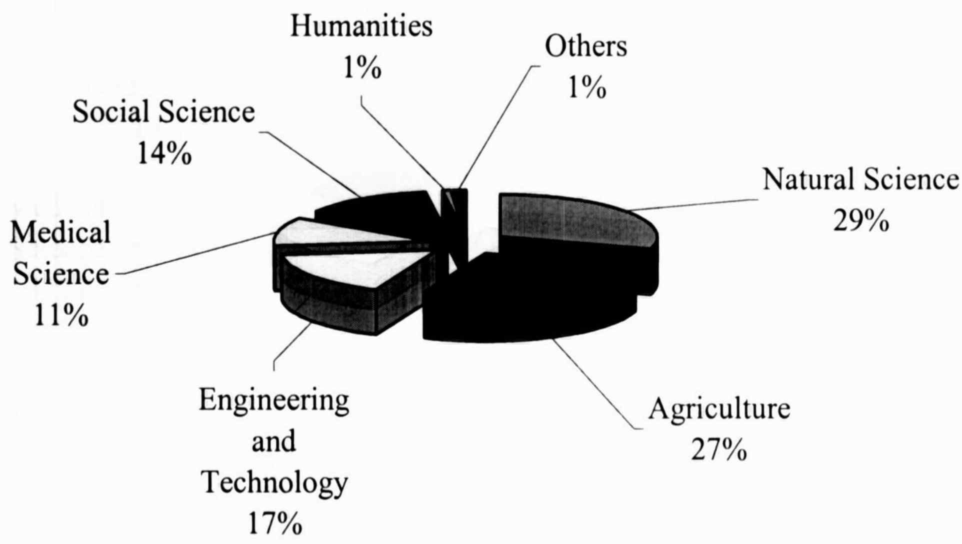

Figure 2.2: Distribution of R&D expenditure of Sri Lanka by major discipline in year 2000

2.5 R&D in Medical Science sector in Sri Lanka

The National Institute of Health plays major role as a funding organization in health science research in Sri Lanka. The National Science Foundation (NSF) promotes health research by awarding grants and disseminating research information. The major research institutes that involved in medical science research in Sri Lanka are Medical Research Institute (MRI) and Bandaranayake Memorial Ayurvedic Research Institute (BMARI).

The MRI is mainly involved in biomedical research work while BMARI is involved in indigenous medical (Ayurvedic) research work. Apart from these institutes the Medical Faculties in universities, operational units at the Ministry of Health and Nutrition such as the Family Health Bureau, Epidemiology Unit and some other organizations such as Sri Lanka Medical Association and some non governmental associations are also involved in health related research work in Sri Lanka.

The health R&D expenditure mainly came from the Government sector, as research institutes are function under central government of the country. The total expenditure in health R&D in year 2000 was Rs. Million 159. This was 3% from the expenditure on total health sector in the country. However, there was 2% clear reduction in R&D funds from 1996 to 2000. The Total R&D devoted to health research was 5% of the health budget in 1996. The expenditure for R&D for health from national budget was 0.21% in 1996 and 0.01% in 2000. However the percentage of health budget from national GDP has increased 0.34 to 0.47 from 1996 to 2000 (Table 2. 4).

Table 2.4: R&D funding in Medical science compared to the national health budget

Year	Health R&D (Rs. Million)	Health budget (Rs. Million)	% Health R&D of total health budget	GDP (Rs. Million)	R&D as a % of GDP	Health budget as a % of GDP
1996	137	2653	5.2 %	769,900	0.21	0.34
2000	159	5302	3%	1,125,259	0.01	0.47

Source: Central Bank of Sri Lanka & NSFSL

Table 2.5. Total Number of persons (FTE) involved in the R&D in all sectors

Discipline	1996		2000	
	No	%	No	%
Scientist	3,448	81	1,379	60
Other supportive staff	808	19	931	40
Total number	4,256	100	2,310	100

Source: National Science Foundation Sri Lanka

The total head count of technicians involved in R&D activities in all disciplines in year 2000 is accounted to 1552. This number composed of the total number of technicians worked in Universities and R&D institutes. Thus, the actual number involved in R&D activities in year 2000 was less than 1552 as all the technicians in University sector were not actively involved in research work. The total supportive staff worked under all disciplines was 1,280. This was calculated taking into account the University staff and staff in R&D institutes. Like the technical staff all the supportive staff in the university sector were not involved in full time research activities. However, in University sector there are supportive staff that come out side of the university sector and worked as full time contract basis in particular research work and these persons were not taken into account during the R&D survey done by the NSF. If these persons were taken into account the total number of supportive staff would have exceeded the current number.

The R&D personnel in Health sector reported here are one attached to the universities or the research institutes (Table 2.6). There are 6 universities that have medical faculties in Sri Lanka and most of the academic in these faculties are involved in research activities as well as teaching. However, the number of scientist worked full time basis in research institutes are small in number, they can consider in FTE basis. Therefore, FTE figure of scientist involved in research work in all sectors in Sri Lanka amounted to 1,379 in year 2000. This was comprised of 70.6% of male scientists and 29.4% of female scientists. The FTE scientists in medical science sector equal to 145 and this was comprised of 54% of male scientists and 46% of female scientists. The total number of postgraduates students involved in Ph.D., M. Phil. and MD were also considered as full time equivalent research workers and were added to the number of FTE scientists. However, compare to the number of FTE scientist in 1996 the number recorded in 2000 has declined 30%. This decline was mostly affected by the reduction in number of full time scientist in year 2000 (Table 2. 5&2.6).

The distribution of scientist in different discipline in research showed that there was a dramatic reduction in the total number of scientist in the fields of medical science, social science, natural science and agriculture (Table 2.6). The scientists in engineering research showed slight increase and this may relate to the increasing funds in year 2000 (Table 2.3).

Table 2.6: Distribution of scientists (FTE) (in all sectors)-by gender

Discipline	1996				2000			
	M	F	Total	%F	M	F	Total	%F
Natural Science	532	325	857	38	227	94	321	29
Agriculture	489	106	595	18	241	107	348	31
Engineering	170	34	204	17	197	47	244	19
Medical Science	528	295	823	36	79	66	145	46
Social Science	626	343	969	35	229	92	321	29
Total	2345	1103	3448	32	973	406	1379	29

Source: National Science Foundation Sri Lanka

The study of the scientist in gender showed that the male dominated the research field in Sri Lanka. However, there was more involvement in female scientist in year 2000 in the fields of agriculture and medical science fields compared to year 1996. In the field of Engineering there was slight increase in the female number in research but still male dominated the field compared to other fields (Table 2.6).

2.6 Research out put in medical science in Sri Lanka

The research out put in medical sector in Sri Lanka can be measured using number of international publications, patents and postgraduates out put. However, the number of patents acquired in the field of medical science was very low and negligible compared to the other discipline. However, the number of international publications made by the Medical science sector is the highest compared to other sectors.

The number of international publications in Sri Lanka is low in number. However there was an increases in number of publications appeared in the period of 1996 to 2003 (Figure 2.3). The increasing rate of the number of publication with time had declined in year 2001. This may accounted to the declined of funds for the research in the period of 1999/2000 (Table: 2.7). This declined was seen in all the other disciplines too, except in field of engineering and technology (Figure 2.4).

Table 2.7: Number of ISI publications in Health sector in Sri Lanka

Year	No. of publications
1996	2
1997	9
1998	7
1999	9
2000	16
2001	14
2002	19
2003	20

Source: ISI web

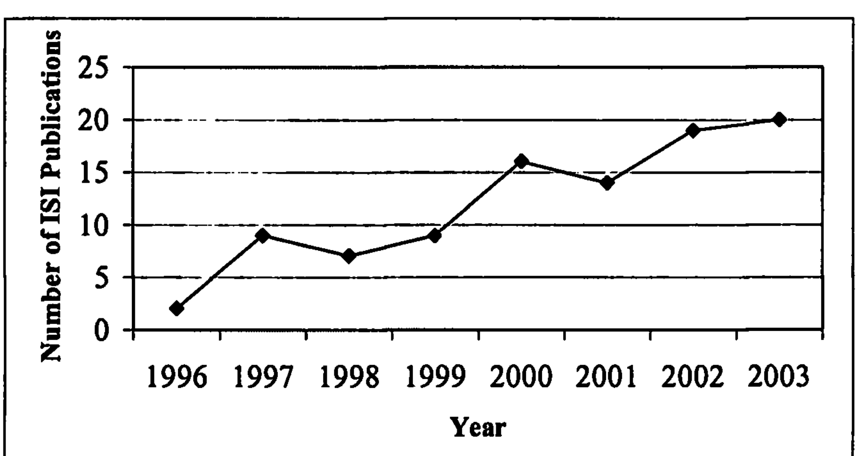

Figure 2.3: ISI medical Science publications of Sri Lanka in the period of 1996-2003

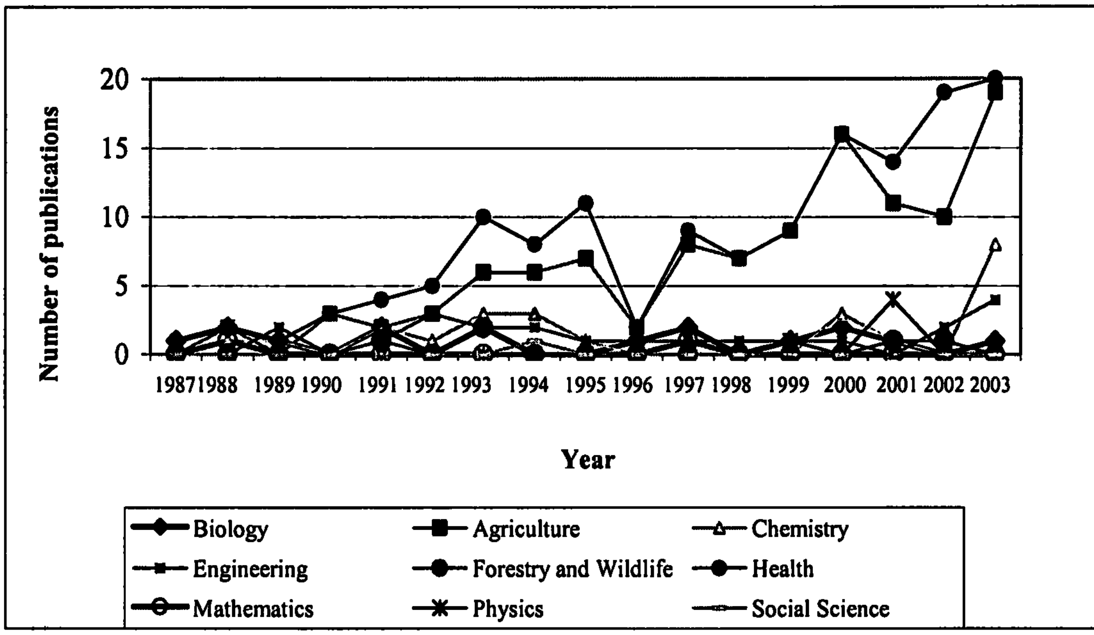

Figure 2.4: International publications (ISI) in all sectors in Sri Lanka (1996-2003)

The number of postgraduate degrees in medical science accounted for the number of Ph.D., M. Sc., MD and Postgraduates Diplomas awarded by the universities in Sri Lanka and the Post Graduates Institute of Medicine in Sri Lanka (PGIM).

Table 2.8: Postgraduates out put in medical science sector in Sri Lanka

Year	No. of Postgraduates*
1995	150
1998	263
1999	373
2000	307
2001	346

Source: University Grant Commission

*included PhD, MD, Diploma in medicine

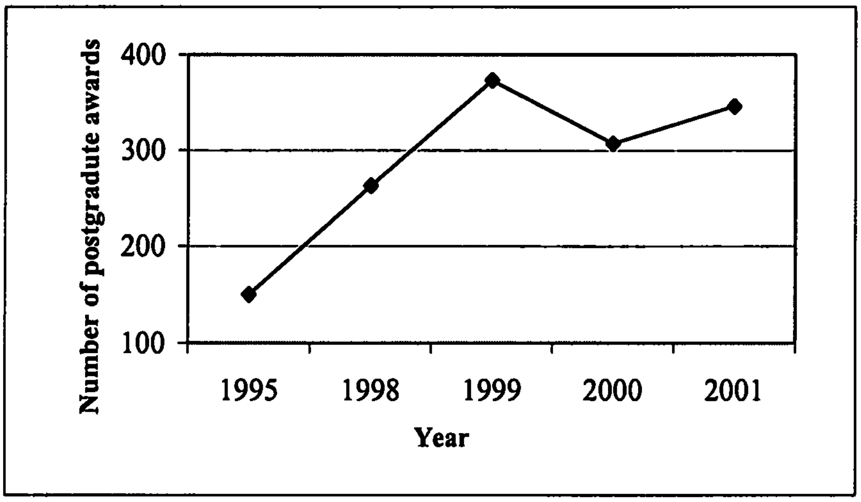

Figure 2.5: The trend in Postgraduates out put in medical science sector in Sri Lanka

The number of postgraduate output showed steady growth in 1995-1999. However, there was a decline in number in year 2000 with a slight growth in year 2001 (Figure 2.5).

2.7 Discussion

The study showed that R&D funding for research activity in the country mainly coming from the government sources. Though, the participation of private sector in research activity in the country was low, there was a tendency toward increasing partnership of private sector in research activity in country. The overseas funding for the research was very low. This may due to several reasons. Most of the overseas funds were directed towards the social science sector and it is difficult to trace the sources as they are directed to individual researches or non-governmental organizations. Another difficulty in recording this funding was the reluctance of scientist to declare the amount of funds they received from foreign sources as there is a risk of having less funds towards their research activities form government sources.

The research system can consider to be made up of several types of investigatory activities extending from fundamental research to experimental development. When considered the research activities in Sri Lanka, it can see that they are moving towards the applied research to experimental research work. Though still a large amount of research is carried out in the country fallen into applied research work. This can resulted by the shift in country economy more toward industrial based economy. According to the central bank annual report 2002, the industrial sector contributed 26.6% to the national GDP while agricultural sector shared 19.8%. The major industrial out put was based on the industries of garment and textile, processed food and beverage. Therefore it can assumed that the R&D sector also shifted towards experimental research as the industrial sector is more concerned over improving their product to compete with the other product in the open market in the country as well as international market.

Though the funds devoted for the health sector in the country increased from 1996 to 2000, the funds devoted towards the research activity was reduced 2%. This may due to the devotion of more funds toward welfare activities, development of sanitation, nutrition etc. in the war affected areas in the country.

The reduction of funds toward the research activities in the country may have affected the reduction of the number of scientists participated in the research activities in the country. Though Sri Lanka has recognition in equal opportunities for the gender, still the participation of women in the research sector in the country is low compared to the male participation. This may due to several factors such as sex discrimination in working environment of the female scientist and also the family commitments that cannot ignore with the demand of the more time toward research activities as female still play main role in the household activities in the country.

The research out put of the country can measure by looking at the number of international publications made by the research and evaluation of the citation of these papers. The medical science sector in Sri Lanka has higher number of international publications compared to other disciplines in the country. This number was low compared to other countries like India and Australia. However, low number of international publication may not be an indication of low standard in the medical research in the country as most of the research in the medical sector was oriented towards the national issues rather than the international concept and have low level of international importance. It is well known that the relevance and importance of research funding in the national context gives no guarantee for its acceptance by an international journal for publication. International journals generally tend to accept work that have a regional or global significance or work of a fundamental character. Therefore use of international publication alone would not sufficient to evaluate the research activities within the country.

The use of patent also is not good criteria for country like Sri Lanka as price that should pay for the patent certificates is not affordable to many researchers in the country. However, it is felt that government should take some action to secure the ownership of some important invention and long standing Ayurvedic medicinal formulas, as there is a growing demand globally for the herbal medicine today. In this context the national Science foundation in Sri Lanka is in the process arranging necessary funds towards obtaining patents for findings that have significant importance for the country.

The number of postgraduates degrees achieved in the R&D sector is another criteria that can used to measure the research output in the country. During the period of 1996-2000 there was a slow growth in the postgraduates degree achievements. However, there was a depression in the number of postgraduates passed out in year 2000. This may due to the financial set back in the country during period of 1996/99 and also may have affected by the severe drought and constant and long period of power cuts occurred in the country that led to the slow down of the research activities.

Though, Sri Lanka is cited as an example of a developing country, which has achieved spectacular health gain from a comparative small investment in health, to maintain these gain, health sector needs massive additional resources (WHO 2003). The health sector in the country now face the challenges of the epidemiological and demographic transitions, the rising number of life style diseases associated with fast moving economy and industrialization, demand to keep abreast with the technological advances and the vexed issue of health finance, inequity health outcomes geographically and across income gradient. Therefore new strategies have been made to meet these challenges by the ministry of health and nutrition in its ten years master plane for health development. The objectives involved the increase of the investment in the health that was reduced in the past years but there was no emphasis on R&D activities in this strategic ten-year plane.

However, it is felt by the National science foundation of Sri Lanka, that devoting more funds toward the research work alone would not increases the research activities in the country. The capacity of the research institutions and universities should first improve to utilize the funds that are devoted to R&D in full scale. This includes increasing the number of research staff, giving training to existing staff on modern technologies etc. and giving more space, facilities and advance laboratory equipments to the research institutions to do more researches that have global importance. In accordance with this, national science foundation in Sri Lanka has undertaken a task of evaluating the capacity of the research institutions and universities to conduct research in the areas on demand and advising policy planners in the relevant organizations and ministries to devote more funds toward improving the infrastructure of the these institutions.

The National science foundation has been in process gathering information of S&T sector in the country in formation of Management information system (MIS). The main aim of this is to gather all S&T information in to one central system and disseminate the information to interested parties and also to create a link between industrial sector and research institutes to have better understanding of the current development in the research sector in the country. The attempt also has made to formulate one net work between research institutions, universities, S&T industrial sector to create better link and understanding on the on going research activities in the country and capacity of the research institutions. Another aspect of the programme is to form a data exchange mechanism with the institution that do same activities and share their databases among institutions to prevent duplication. The major constrains in carrying out this activities in regular basis is lack of sufficient funds and lack of cooperation in relevant authorities.

Further, the National Science Foundation has taken a task of arranging training programs, workshops and symposia to the scientist in the country and giving travel grants for the scientist to participate international training and symposia. Apart from that NSF also is giving scholarships to graduates to carry out post gradates degrees in the areas of national importance and post doctoral scholar ships for young scientist to carry out researches in areas of national of importance. The main purpose of these initiatives of NSF is to promote the R&D in the country toward the development.

3. Research and development in Australia

Commonwealth government is the largest financer and performer of R&D in Australia. It spent about 50 % of allocated funds in its own agencies and the remaining being distributed to joint research institutes, to universities as a part of their recurrent and their special research funds as peer adjudicated grants and R&D support industries. The state governments are responsible for the discovery, conservation and development of natural resources and promotion of agricultural production and extension. Thus Australia has public research sector, and rank third among OECD countries in 1998/99 in expenditure (GOVERD/GDP) in R&D.

The R&D in the health sector in Australia well recognized internationally therefore R&D activities in medical and health sector in Australia has selected as a case study to look at the R&D activities in Australia and compare it with Sri Lanka which is still in developing stage.

3.1 Research and Development in Health sector in Australia

The Australian contribution to the world health and medical knowledge is well recognized. The National Health and Medical Research Council (NHMRC) is the main organization that involved in the medical and health research in Australia. In the area of funding Commonwealth and state government provide infrastructure for support for the conduct of research work. NHMRC grants to the marginal cost of research, the people who are employed to conduct research and consumable they use.

Australia recognized seven areas of chronic disease as National health priority areas. Well over half of all research funds awarded by the NHMRC have been allocated to these priority areas for research. The health sector in the country achieved high standard among OECD countries. The average life expectancy is 79.75 and the infant mortality is 5.04 for 1000 births.

3.2 Research Expenditure in Australia

The Research and development expenditure on all sectors in Australia amounted to A$ 2,307,578 million in year 1996 and 2,774,564 million in year 2000. The GERD/GDP ratio was 0.39 in year 1996 and 0.43 in year 2000.

The Expenditure on the Research and Development mainly came from the general university funds 65 % in 1996 and 64% in 2000 of the total funds allocated for research respectively. The commonwealth government contributed 23% while state local government contributed 2% and 3% respectively in 1996 and 2000 to the total research and development activities in the country. The Business sector and overseas funding agencies contributed 5% and 3% respectively in 1996 and 2000 (Table 3.1 and Figure 3.1).

Table 3.1: Total R&D expenditure for the all sectors in year 1996 and 2000 (A$ million)

Source	Year			
	1996		2000	
	Expenditure	%	Expenditure	%
Commonwealth schemes	363 430	15.8%	483 416	17.4%
Other Schemes	12 983	0%	12 065	0%
State local government	50 977	2.2%	87 859	3%
Other commonwealth government	161 393	7%	166 504	5.6%
Business	120 674	5.2%	136 221	5%
General university funds	1 508 282	65.4%	1 745 693	64%
Other Australian funds	65 203	2.8%	82 154	3%
Overseas	24 637	1.06%	60 652	2%
Total	2 307 578	100.0	2 774 564	100.0

Source : ABS

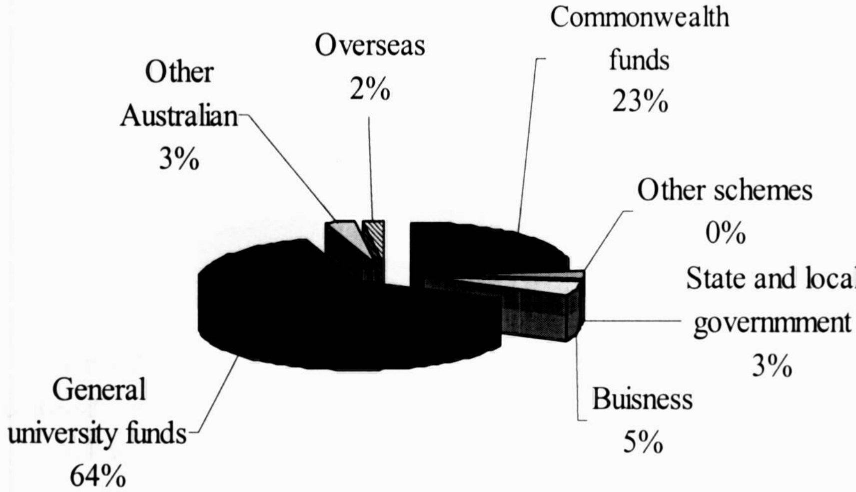

Figure 3.1: The R&D funding sources for all sectors in year 2000

The funds directed toward different type of R&D activities showed that more funds were devoted towards applied research and pure basic research activities. However, the percentage of funds allocated for the basic research decreased from 1996 to 2000 (Table: 3.2). The funds devoted to the applied research increased 3 % from 1996-2000. Similarly funds for the experimental research also was increased 1% from 1996-2000.

Table 3.2: Expenditure by field of research, type of activity in all sectors

Research activity	1996		2000	
Pure Basic research	786,938	34%	847,358	31%
Strategic basic research	576,429	25%	665,769	24%
Applied research	800,680	35%	1,047,741	38%
Experimental development	143,530	6%	213,696	7%
Total	2,307, 578	100	2,774,564	100

Source: ABS

According to the nature the research fields can be categorized into two broad areas as follows: a- Natural Science, Engineering and Technology; b-Social Science and Humanities. The highest percentage of funds for the research directed towards the field of Natural Science, Technologies and Engineering field (73 % in 1996). In this sector major portion of the fund was devoted to the research on Medical and Health Science (29% in 1996) followed by Biological Science (17% in 1996) (Table 3.3). However the percentage of funds devoted to Medical and Health Science and Biological Science has deceased 5% in year 2000 from that of the 1996. General engineering showed slight increase (1%) in the funds from 1996 to 2000 (Table 3.3).

Table 3.3: Distribution of funds devoted to natural Science, technologies and engineering by the field of research (A$ million)

Field of research	1996		2000	
Medical and Health	491	29%	667	24%
Biological Science	286	17%	324	12%
Agricultural Science	127	8%	204	7%
General Engineering	163	10%	309	11%
Physical Science	102	6%	112	4%
Chemical Science	109	7%	127	5%
Information technology	139	8%	113	4%
Others	257	15%	918	33%
Total	1674	100	2774	100%

Source: ABS

3.4. R&D in the medical and Health sector in Australia

The funding for the medical and health sector in Australia mainly comes from the University sector and the government agencies (Tables: 3.4 a, b & c). The business, private non-profit agencies (PNP) and overseas grants contributed around 40% for total research funds in the medical and health sector. The University funds included the funds from the commonwealth government, state government funds as well as the funds from the business sector, non profit private sector and the overseas agencies. Thereby funding sources for the medical and health sector can generally categorize as commonwealth government, state government, business, overseas agencies and other organizations such as non-profit private agencies (Figure 3.1).

Table 3.4. Australian Medical research funding system 2000 (A$ m) ABS Data on R&D source of funds:

a. Sectors doing research: Government (A$ m)

Commonwealth government research agencies own funds	21.33
Commonwealth government funding government research agencies	27.71
State government research agencies own funds	51.85
State government funding government research agencies	18.94
University funding government research agencies	4.02
Business funding government research agencies	27.60
Joint business / government funding government research agencies	0.17
Other Australian (including private non profit) funding government research agencies	25.5
Overseas funding government research agencies	5.56
Total medical and health science conducted in government agencies	**182.66**

NHMRC Benchmark research final report

b. Sectors doing research: University sector (A$ m)

Commonwealth government funding universities	130.50
State government funding universities	27.82
Other schemes funding universities	6.78
Other commonwealth government funding universities	39.57
University own funding (general University Funds)	360.41
Business funding Universities	37.92
Joint business / government funding Universities	0.00
Other Australian (including private non profit) Universities	38.65
Overseas funding universities	26.06
Total medical and health science conducted in Universities	**667.72**

NHMRC Benchmark research final report

c. Sectors doing research: Other Australia (including private non profit) (A$ m)

Other Australian own funds	60.55
Commonwealth government other Australia	44.84
State Government funding other Australian	20.59
Universities funding other Australian	2.05
Business funding Australian	14.21
Joint business/ government funding other Australian	0.72
Other Australian (PNP) funding other Australian	24.19
Overseas funding of other Australian	13.64
Total Medical and Health science research conducted in other Australian research institutes	**180.78**

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Table 5: Total Funding for R&D 2000 (A$ m)

Total commonwealth funding	224.37
Total State funding	119.20
Total Business funding other than business*	79.73
Total other Australian	88.34
Total overseas	45.22

** Business R&D – pharmaceutical 2000-2001 198.57 A$ m*
NHMRC Benchmark research final report

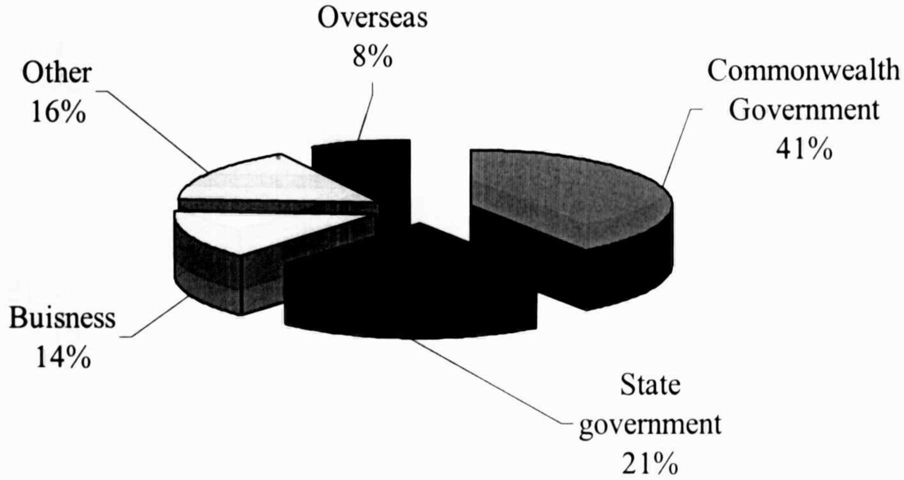

Figure 3. 1: Total Funding for R&D in the health sector in Australia in Year 2000

In Australia, the National Health and Medical Research Council (NHMRC) is the pilot organization that carried out the health related researches. The NHMRC received 36% of total National R&D funds in the year 2000 for the research activities. This is somewhat higher compared to the funds received by the NHMRC in other years. However this amount declined to 21% in year 2001 and was again increased into 28% in year 2002 (Table 3.6). The distribution of funds across the states was done basis on the location of best universities, research institutions and teaching hospitals.

Table 3.6: Comparing NHMRC funding with other major commonwealth R&D funding programs and other support for science and innovation through commonwealth budget ($Million)

	1998	1999	2000	2001	2002
NHMRC	176	186	309	248	327
Total	738	770	916	1159	1171
NHMRC as % of total	24%	25%	36%	21%	28%

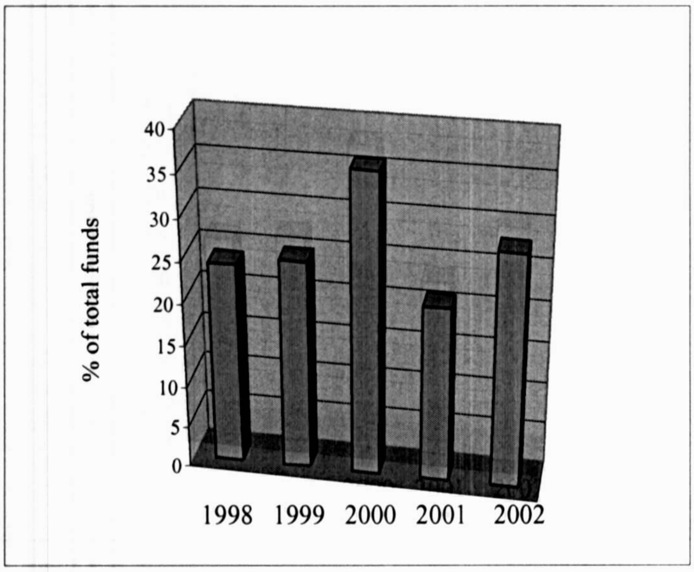

Figure 3.2: NHMRC funds as a percentage of total R&D of commonwealth funds

Table 3.7: NHMRC research expenditure as proportion of Australian GDP and commonwealth health budget

Financial year	NHMRC investment $ Million	Australian GDP ($ Million)	NHMRC funds as % GDP	Australian Health Budget ($ Million)	NHMRC funds as Percentage of Australian health Budget
1999-2000	186.3	633,000	0.029	23,840	0.8 %
2000-2001	308.9	659,000	0.047	26,340	1.2 %
2001-2002	245.5	672,000	0.037	29,090	0.9 %
2002-2003	339.2	697,000	0.049	30,870	1.1 %

NHMRC performance measurement report 2000-2003

The NHMRC funding in research can broadly categorized as basic science research, clinical medicine science, health service research, preventive medicine science, public health research and others. Of that, a larger portion of the research funds directed towards the basic research and clinical medicine research works. This was amounted to 52% and 34% respectively of the total funds allocated by the NHMRC in year 2000 (Table 3.7).

Table 3.8: Funding of NHMRC for new awards by broad research areas

Broad Research Area	2000		2001		2002		2003	
	$ M	%	$M	%	$M	%	$M	%
Basic Science	100.19	57	142.02	65	196.14	46	196.67	52
Clinical Medicine Science	44.00	25	60.29	27.5	102.40	24	130.45	34
Health service Research	2.66	1.5	3.29	1.5	8.04	2	16.12	4
Preventive Medicine and Science	3.08	1.5	1.5	0.5	3.75	1	3.75	1
Public Health	26.05	1.5	11.53	5.5	64.51	15	33.79	9
Other					49.06	12		
Total	175.98	100	218.63	100	423.9	100	380.79	100

Data source: NHMRC

The funding for the basic science research has declined form 2001 to 2003. Similar occurrence was seen in the research in clinical medicine as well. The funds for the public research have increased from 2000 to 2003 (Table 3.8).

The NHMRC strongly support fundamental research in Basic science whilst providing significant and increasing level of funds to clinical Medicine, Public Health, and Health Service Research. Whilst the amount of investment in public health continues to improve, it has declined as a proportion of the total NHMRC research investment.

3.5 R&D Personnel in health and medical research

The distribution by type of R&D employee in health sector increased from 1996 to 2000. There was a change in composition of employee from 1996 to 2000. There was a steady growth of postgraduates number starting from 1996 to 2000. Accordingly, the percentage of supportive staff got reduced from 1996 to 2000. Similarly academic also showed reduction in percentage to the total. However when consider the numbers alone there was an increase in the academic and supportive staff in health research in the period of 1996-2000. However, number of postgraduates involved in the research increased in higher degree compared to other categories involved in the research in year 2000 (Table 3.8).

Table 3.8: Human recourses devoted to R&D in Medical and health science

R&D person by category	Year		
	1996	1998	2000
Total (person years)	6,487	7,338	10,171
Academic (person years)	2,055 (32%)	2,274 (31%)	3,016 (30%)
Postgraduates (person years)	2,860 (44%)	3,558 (48%)	5,197 (51%)
Supporting staff (person years)	1,571 (24%)	1,507 (21%)	1,959 (19%)

Data source: ABS

3.6 Research output in Medical science sector in Australia

In general it has seen that NHMRC publications has very strong citation performance. The number of international publications recorded in ISI during the period of 1996-2003 showed that there is gradual increase in the number of publications (Figure 3.3). However, there was a slight declined in the number of publications in the year 2001 with high number of publication appearing in the following year (Table 3.9).

Table 3.9: Number of international (ISI) publications in Health and Medicine

Year	Number of ISI publications
1996	397
1997	482
1998	659
1999	732
2000	730
2001	624
2002	1441
2003	846*

Source ISI Web

*number not represent whole year publications

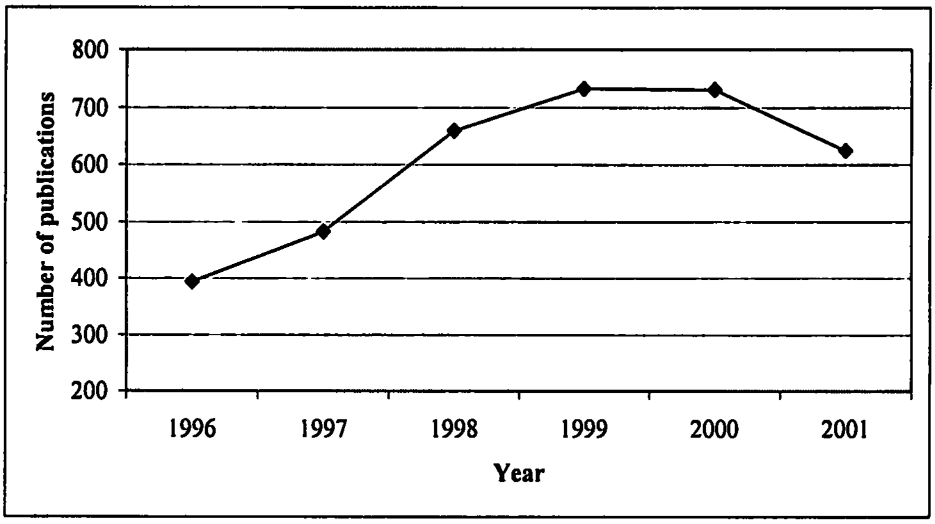

Figure 3.3: Number of ISI publications made by the medical and health sector

Table 3.10: International Medical and Veterinary Science Patents granted in Australia (1996-2001)

Year	Australian	International
1996	140	1114
1997	191	1256
1998	232	2087
1999	190	2153
2000	209	2097
2001	254	2308

Source: IP Australia

In the period of 1996-2001 Australian medical and veterinary science patents applied and granted in Australia has increased more than three folds (38-125) while the number of patents for foreign inventions doubled (Table 3.10).

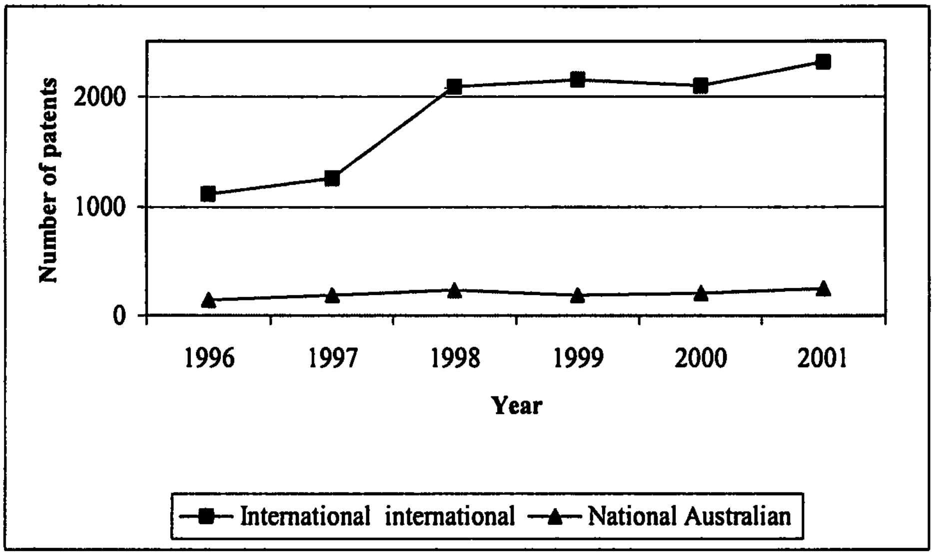

Figure 3.4: Number of patents acquired by the medical and health sector

Table 3.11. Number of Postgraduate degree awarded in medical and health sector

Year	Number of doctorates awarded
1996	423
1997	477
1998	523
1999	533
2000	568
2001	544
2002	679

Source DEST

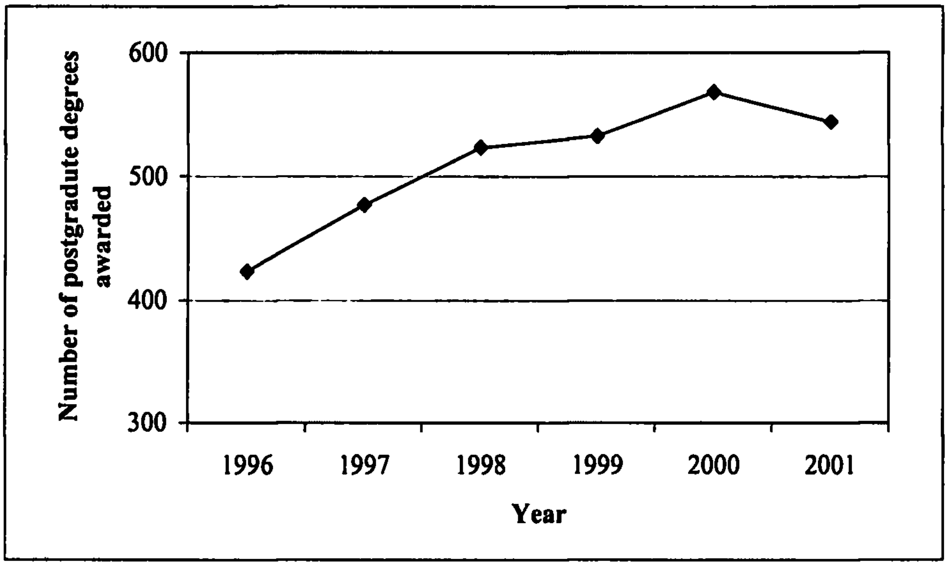

Figure3.5:Number of Postgraduate degree awarded in medical and health sector

The number of postgraduates passed out during the period of 1996 to 2001 showed increasing trend (Figure 3.5). However, the rate of increase has fallen in 1999 and again in 2001. The postgraduates passed out included the Ph.D. and M. Sc. (Table 3.11).

3.7 Discussion

Expenditure on research and development is a pre-cursor to the innovation and indicates nation's ability to create knowledge and innovate. Australian investment in research and development steadily increase since 1992. The expenditure on higher education (HERD) as a percentage of GDP has risen from 0.32 in 1996, an average annual increase of 4.3% until 1998. This was decreased from 0.43 to 0.41 in year 2000. It is compared favorably with those available for other OECD countries, being higher than those for Germany, the United State of America, France and Canada.

In the area of health expenditure Australia ranks in the mid range of countries in term of total national public and private health expenditure. Its also ranks mid range in terms of 'over-the –counter' health expenditure per capita. In year 2000 Australia rank 3rd in the expenditure on health research per capita among OECD countries. This applies for research expenditure per head of population as well as research expenditure as a share of total health expenditure.

Health researches are more successful when finds expression in improved health and economic outcomes for the community. Improved health can result directly from the application of knowledge, or indirectly from better efficiency, equity and quality of health service. It was seen that the Australian investment on health has increased in year 2000 dramatically. The key research objectives of the health research sector is creating international competitive knowledge, developing research capacity resources within Australia. Implementing research findings to support better health policy and improve health care practice and realizing the economic benefit of research by fostering commercial development of new product and therapies. In accordance to that

The type of R&D activity comprise pure basic research, strategic basic research, applied research, and experimental development research. The funding for strategic research initiative according to the strategic priorities that are being funded at the time. In year 2000 awards that research with commercial involvement represented approximately one tenth of 1% of NHMRC funding. But since then it has increased significantly as industry related research has high level of importance (NHMRC, 2003). This may have contributed to the increasing of applied research and experimental development research in 2000 comparative to year 1996.

Strategic research priorities identified by the SRDC identified by the SRDC includes aboriginal and Torres straight islander health, oral health ageing, palliative care and injury are being addressed through targeted and many cases, collaborative funding programs. National health areas are receiving strong attention and national research capacity is boosted, especially in undeveloped areas. Collaborative and partnership with other national and international research funding agencies and with industry has become increasingly important facet of NHMRC.

Research results appears in many forms, but discoveries are most commonly announce through publications of papers in scientific journals. Publications ensure high standards of rigor, provide exposure of the result to the broader scientific community and enables others to refer to the works for further research developments. Compare the total publication output of 15 OECD nations adjusted for population size in three fields of research (ISI classification). They illustrate the strength of Australian health research output and reinforce previous bibilometric analyses that show Australia's citation performance is generally above the world average (NHMRC, 2003).

NHMRS aims to develop research capacity and capability by; providing more opportunities for new researches to seek career in health research; expanding training sachems and fellowships, building research capacity (with a particular emphasis on clinical practice, public health and health services), increasing capacity in population health research and working with other on a broad range of research matters.

The quality of Australian research and its, relevance to the development of commercial products have long being recognized. The citation of biomedical and clinical medicine research in US patents is five is to ten times higher than for other fields of Australian science, suggesting that a substantial amount of it is of commercial significance.

Australia would appear to have a higher percentage of its research prioritized, but uncertainty arises from the qualitative assessment of responsibilities of many health research agencies that indicate that they provide institutional support (Final report to NHMRC-AGIS). From its population size Australia perform well in terms of health and medical research publications. The international comparison on patenting and commercialization of research suggest that Australia's effort this regard does not match the scientific output recorded in publication performance. Further, Australia's performance in patenting, as proportion of world activity, is declining (Final report to NHMRC-AGIS).

4. General Discussion

Generally there are few similarities in the research sectors in Australia and Sri Lanka. One common feature is the large portion of R&D expenditure is provided by the government sector in both countries. The national R&D as a proportion of GDP (GERD/GDP) was 0.43 in Australia while this was 0.20 in Sri Lanka during the period of 2000. The percentage of funding received for the R&D activity from foreign sources was low in Australia compared to Sri Lanka. This phenomenon is understandable as Sri Lanka is a developing country. Many developed countries provide aid for research based development activities in Sri Lanka.

When considering the nature of the research activities, the highest amount of research carried out by the Australia and Sri Lanka can be described as applied research. But the proportion of basic and strategic basic research carried out by the Australia was higher than Sri Lanka. This may due to the low funding capacity of Sri Lanka. Basic research requires more funds over an indefinite time period. Thus, countries like Sri Lanka prefer to carry out research within a shorter time limit and with less finance.

The proportion of experimental research carried out by Sri Lanka was higher than Australia in the year 2000. However, data from both countries show a national tendency to move toward more experimental research. This may due to the increased involvement of the industrial sector in research activities in both countries.

The data when analysed by discipline show that more funds were directed toward agriculture and natural science research in Sri Lanka while in Australia more funds were directed toward medical and engineering sectors. As Sri Lanka is still predominantly agriculture-based more funds were directed towards agriculture based research activities. On the other hand as Australia is an industrially developed country compared to Sri Lanka the research funds are directed more towards industrial and tertiary sector based research work; although, it should be noted that by international standards, Australia still does not have a strong secondary level production structure.

R&D investments in health as a proportion of the total health budget of Sri Lanka was 3% in the year 2000 and this was 0.01 of the national GDP. In Australia the total health R&D as a proportion of the total health budget was 0.8 % while it was 0.02 as a proportion of the GDP. Therefore it can be seen that the percentage of funds devoted to the health research from the health budget is low compared to Sri Lanka, it was high as a percentage from the GDP. However, this discrepancy is probably due to the devotion of the higher proportion of funds to the health budget as a proportion of the total GDP in Australia compared to Sri Lanka.

In the Health sector in Australia comparatively more funds were devoted to basic science and clinical medicine research. However, in Sri Lanka the data for this type of category was not currently available. The number of persons involved in the national health research sector was very high in Australia compared to Sri Lanka. This may be one reason for the low performance in the health research sector in Sri Lanka. When comparing the R&D output in both countries, Sri Lanka records a very low performance in internationally comparable research output from the health research sector. In Sri Lanka more health research was directed toward national priority areas which may not produce much international publications. This may partly explained the comparative low number of international publications.

By contrasting the R&D performance in the two countries it is evident that because of limited resources Sri Lanka must very carefully plan for managing research activities in the country. For the better management of the research activities a strategic plan is needed and sectors or areas that need more attentions should be identified and progress toward priorities carefully monitored.

Science indicators can be used to support a vision of how to use R&D to meet goals and achieve better applications of S&T for long-term national interest. To achieve these goals research agencies do not only need structural development, more financial support and research staff, they also need management and planning tools to monitor and evaluate investments in these areas in the context of general national socio-economic objectives.

The R&D system in Sri Lanka is composed of government research institution and University based research. The private sector plays only a small role in the research activity in the country. As Sri Lanka is an agricultural based country, most of the research institutions are of agriculture based institutions that work under the department of Agriculture.

The Council of Agriculture Research Policy (CARP) monitors the funding for agricultural research institutions. and has a computer based information system that monitors the R&D activities in agriculture based research institutions. Here they publish detailed information on the R&D activity carried out by each research institutions on an annual basis. The system is updated annually and the data collection is comprised of the R&D expenditure, research personnel, publications, patents, academic achievements by the research personnel, number of supporting staff etc. However, information of the other research institutions that do not come under the category of agriculture is not available.

The University Grant Commission (UGC) also collects data on the university sector. However, these statistics are mainly based on undergraduate activities and research activities that carries less importance. This system does not cover the entire research activities performed by the university sector or the degree of the involvement of the academic staff in research activities.

Apart from that the Department of Rural Industry, the Department of Census and Statistics, the Central Bank of Sri Lanka and the Ministry of Tertiary Education collect information that are relevant for their internal policy activities and offers as indication of their performance. There is a need to seek greater national integration therefore of the various institutional data sets

However, to review data internally or internationally consistency and comparability are needed. The information collected by these institutions show wide divergence, as they are not collected in the same format and there is considerable overlap in the data sources. This is mainly due to the reason that different organizations are addressing different issues and their data reporting systems vary accordingly. Therefore the information provided by them is not comparable with the other organizations. Thus, the coordination of these data sources and collecting data on one similar format will save money and effort. However, to bring those institutions into a single network for common objectives needs a higher order of policy decision. This is because they are each operating under different regulations.

As Sri Lanka is moving toward an industrial based economy the partnership of the industrial sector also is vital for decision making in the country. The information on R&D activities in the industrial sector in Sri Lanka is non-existent as they are not actively participating in R&D activity with other public organizations in the country or there is a reluctance to reveal their activities as they are under constant competition with rival industries. Therefore, a strong measure should be under taken to form a partnership in all the R&D sectors in the country that include universities, research institutes, and private S&T sector to achieve productive environment for the research activities in the country.

In this context the National Science Foundation of Sri Lanka (NSFSL) has an important role to play. The NSFSL has set out a task to collect information on National R&D investments for the country. The data sources are Universities, R&D institutes and the Industrial sector involved in S&T activities. The information on organization (number of research personnel, supporting staff, specific equipments publications, patents, technology developed), research activities (type of research activities, funding organizations, research expenditure, involvement of other organizations), and details of research personnel (field of specialty, gender, publication, expertise) are collected in each organization on a regular basis. This information is collected using a set of questionnaires prepared by NSFSL. The software developed to collect these information was installed in each research institutions to facilitate the regular updating of the information. However, the main set back of this is the lack of response of the institution in providing the information or incompleteness in the information provided specially in the area of research findings. Therefore, information collected by the NSF is incomplete in some aspect and specific method should be employed to collect this information more effectively in future.

To avoid the duplication of data collection it is necessary to establish some understanding between the different organizations that collect similar data. Therefore NSFSL should take action to arrive at some understanding to data exchange within organizations to avoid data duplications and save time, labour and the cost involved in the task. As an initial step NSF had conducted a workshop on "Management of R&D information" with the participation of the organizations that involved in collecting data. The following were discussed in this meeting:

- type of data collected by each institution;
- sharing information;
- filling gaps in information;
- improving compatibility; and
- improving data quality.

However, it was realized that as each of these institutions operate under different ministries it will need further discussions and planning to achieve agreement and require intervention through a higher government order to share the information across organizations.

Another potential source of information that can be used by the NSF in upgrading their information is to make use of the curriculum vitae data and reporting that they receive from project proposals for grants and also final reports of the research carried out under the NSF funding. These sources can yield the information on publications, patents, about the persons involved in the research activities as well as outcomes and potential impact.

As a funding organization for R&D activities, NSF can inform some understanding of its own funding outcomes but also provide information collected by the NSF of the impact of the overall national research effort.

The information collected by the NSFSL can be used to create composite indicators to give information on the research activities carried out in different organization in the country to assist in benchmarking institutions. This information will be used to analyze the flow of research funds and identify the areas of importance and divert more funds toward gaps in certain areas. These data will provide comparable data to measure the R&D activities with other countries. The information also will provide useful guidelines for policy planners to make more informed decisions regarding S&T investments in the country. A recommendation of this study and training report is that the NSFSL take steps to investigate the ways that the Foundation's data, based on project proposals and reports, can be used to complement national socio-economic indicators for development.

5. References

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