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Report No. 1

A SURVEY OF

EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT IN SRI LANKA 1966–1975

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National Science Council of Sri Lanka

A SURVEY OF THE EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT IN SRI LANKA 1966 - 1975

A Report

presented to

the Ministry of Industries and Scientific Affairs

by

SHANTHA LIYANAGE

with

T. WIJESINGHE

N. ANBALAGAN

S. PEIRIS

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The National Science Council of Sri Lanka

47/5, Maitland Place, Colombo 7

The report describes the expenditure on research and development in the country for a period of ten years along with the trends and the national patterns established within this period.

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FOREWORD

The increasing interest shown throughout the world in methods of assessing national efforts directed to scientific and technical activities has led the Ministry of Industries and Scientific Affairs to focus attention on THE EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT IN SRI LANKA. This study will, by pointing out the weak points in the R & D structure of the country, indicate the areas where concentrated efforts would be needed in the field of R & D for an effective transfer of technology.

Social and economic development of the country demands an advance in science and technology, and we strongly believe that encouragement must be given to research scientists to evolve our own technological innovations by research and experimental development.

The information provided, in studies of this nature would facilitate the policy makers to get a clear picture of Sri Lanka's actual situation in regard to R & D and this Ministry is in favour of encouraging such studies.

This present study has been carried out by the staff of the National Science Council. It is the first comprehensive work of its kind and I must congratulate the National Science Council for its efforts in carrying out this study.

L.N. de L. Bandaranaike
Secretary
Ministry of Industries & Scientific Affairs

ACKNOWLEDGEMENTS

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We are indebted to L.C.A. de S. Wijesinghe and M.A.T. de Silva of the National Science Council for eidting the report and Mrs. C.M. Fernando for her patient and constructive criticism.

We are grateful to R.O.B.Wijesekera for initiating the survey during his tenure of office as the Acting Secretary-General of the National Science Council and Miss Eleanor Juriansz for helping in the preliminary work. We wish to thank Mrs. S. Ratnayake for typing the manuscript and members of the staff of the National Science Council who have contributed to the success of this survey in many ways.

Finally, we wish to thank all the heads and the members of the staff of the departments, corporations, university and private organizations for their co-operation, without which this study could not have been completed within a short period.

1.1 Highlights of the survey

* The Gross National Expenditure on R & D (GERD) is projected at rupees 45.1 million in 1975, 26 percent above the 1974 level of rupees 35.8 million.

* In real terms the national R & D total in 1975 was 21 percent higher than in 1974.

* Research expenditure was mainly concentrated in the field of agricultural science. Although the R & D expenditure in this sector grew steadily from rupees 9.5 million in 1966 to 23.7 million in 1975, the percentage of the National Expenditure on agriculture did not rise proportionately. The percentage has dropped from 74 percent in 1966 to 53 percent in 1975.

* The percentage of the National Expenditure on Manufacturing Industries has increased from 5 percent in 1966 to 16 percent in 1975.

* Only 3 percent of GERD was spent on medical sciences in 1975, when compared to 7 percent in 1966.

* The expenditure on socio-economic research gathered momentum from 1972 to 1975. The percentage of GERD spent on this rose from rupees 0.4 million in 1966 - about 3 percent of GERD, to rupees 1.4 million in 1972 - about 5 percent of GERD and to rupees 4.6 million in 1975 - about 10 percent of GERD.

* Research expenditure in transport and communication was found to be relatively insignificant when compared to other categories; about 2 percent of national R & D expenditure was spent in 1975.

* The research institutes were responsible for spending about 60 percent of national R & D total.

* Funds coming from the private organizations were very low; about 3 percent in 1975.

1.2 Major results

The national R & D co-efficient in 1975 was 0.205 percent of GNP. There has been a steady increase of the co-efficient over the last ten years. In absolute terms, amount spent on R & D rose from Rs. 13.01 million in 1966 to Rs. 21.8 million in 1971 and Rs.45.1 million in 1975. R & D expenditure on defence is not identified in the survey.

TABLE - 1 Distribution of the R & D expenditure with respect to major objectives, major fields and major activities for 1974 and 1975

	1975 Percentage	1974 Percentage
Major objectives		
ECONOMIC DEVELOPMENT	82	79
COMMUNITY WELFARE	18	21
	100	100
Major fields (Recurrent expenditure only)		
NATURAL SCIENCES	30	32
MEDICAL SCIENCES	6	6
ENGINEERING & TECHNOLOGY	16	11
AGRICULTURAL SCIENCES	39	42
SOCIO-ECONOMIC	9	9
	100	100
Major activities (Recurrent only)		
BASIC RESEARCH	3.8	3.9
APPLIED RESEARCH	77.5	78.3
EXPERIMENTAL DEVELOPMENT	18.7	17.8
	100	100

1.3 Comments

The UNESCO Intergovernmental Conference on the Application of Science and Technology to the Development of Asia (CASTASIA) held in 1968 recommended that "Governments of Asian countries should aim at reaching a minimum level of total national expenditure on research and development of 1 percent of their gross national products (GNP) as soon as possible, and hopefully not later than 1980".[1] At the present rate of increase of the expenditure on R & D and GNP at current factor cost, Sri Lanka will reach only 0.23 of GNP by 1980.

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1 UNESCO, Conference on the Application of Science and Technology to the Development of Asia (CASTASIA) - New Delhi 1968

2.1 Introduction

The survey of expenditure on research and experimental development (R & D) was undertaken to quantify the gross national expenditure on R & D (GERD) in Sri Lanka and to identify the patterns, trends, relationships and deficiencies of research expenditure in different sectors of the economy for the period 1966-1975.

A comprehensive analysis of expenditure on R & D was a long felt necessity for science planners who require these data for scientific and technological forecasting, planning through the budgeting system, as well as for cost-benefit analysis and efficient programming of R & D projects. The measurement of scientific activities is often encouraged by international organizations as the data can be used to compare the state of scientific activities with that of other countries and for determination of their relative position in respect to technological achievements and management of resources.

Some of the limiting factors in a study of this nature stem from the differences in the accounting practices, difficulties in communicating concepts, large mismatch between the recording procedures of the organizations and the R & D data items being requested, and the lack of uniformity in the financial years in different sectors. In the collection of data, direct personnel investigation, which is considered to be one of the best known methods has been used in this study.

It is often reported by UNESCO* and OECD** member countries that perfection can rarely be achieved in this study. Even industrialized countries with several years experience in the collection of science statistics by systematic surveys, have encountered problems in obtaining accurate data. For example, the Department of Science in Australia which is now preparing for its 'Third National R & D Survey' have not overcome all the difficulties.[1] In this survey too, numerous problems were confronted. Most of these were due to the unawareness of the relationship between scientific activities and economic development,

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1 Personal communication with D.J. Baines, Head (Scientific Activities), Department of Science, Australia.

* United Nations Educational Scientific and Cultural Organization

** Organization for Economic Co-operation and Development

resources devoted to R & D being a small portion of the national budget thus attracting less attention, and lack of interest for presenting the science and technological potential in quantitative terms.

The survey covered sixty-three institutions which included public corporations, statutory bodies, government departments and private organizations. Research expenditure was analysed according to the source of funding and according to the various disciplines and areas where funds were utilized. The national co-efficient in R & D was calculated in order to indicate the position of this country in relation to others.

The survey which was initially planned by the National Science Council was mooted by the Ministry of Industries and Scientific Affairs, in order to prepare the ground work for the establishment of a Centre for Transfer of Technology.

A similar study was carried out in 1970 by the CISIR for the period 1955 - 1966. This study which covered only the public sector had obtained its information mainly from the Government Estimates and Annual Reports.

The present study has shown that estimates rarely tally with actual expenditure, and even if it does, the entire expenditure as figured out in Annual Reports does not represent the amount commited entirely to R & D activities.

The Ministry of Scientific Research and Housing carried out another study later to determine R & D funding for the year 1968. In this study, an attempt was made to collect data by sending out questionnaires. Here again success depended on the response of the participants.

In the two studies carried out earlier, an attempt had not been made to separate R & D activities from other related activities. Therefore, the Gross National Expenditure on R & D (GERD) in these studies was unavoidably over estimated.

The measurement of manpower resources in scientific activities (STP) is as necessary as a survey of expenditure. The STP survey is currently underway, and its results will be published in a later report. An attempt was also made to gather information on the development of

scientific research in Sri Lanka. The information gathered was incomplete and will not be dealt with in this report.

This study does not deal with the analysis of future trends. The past trends and relationships established in this study would be useful to those in charge of science planning and research funding. It is believed that the contents of the report will reveal the patterns of research expenditure that have been established in the country and throw some light on the use of national financial resources more profitably in research areas of more value in the years to come.

2.2 Principles of the survey

2.2.1 Scope and Method

The purpose of the survey was to determine the actual expenditure incurred on Research and Experimental Development (see definitions) to the nearest approximation possible. The survey attempted to identify this expenditure in the following manner.

1. INTRAMURAL EXPENDITURE BY TYPE OF COST
2. INTRAMURAL EXPENDITURE BY ACTIVITIES
3. INTRAMURAL EXPENDITURE BY SECTORS
4. INTRAMURAL EXPENDITURE BY MAJOR FIELDS
5. EXTRAMURAL EXPENDITURE BY SOURCE OF FUNDING

The study was planned in four stages. The first or the preparatory stage was to identify the scope of the survey and to formulate the definitions. The definitions were selected from the UNESCO publications[1]; while

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1 UNESCO, Frank R. Ptetsch, An introduction to statistics on Science and Technology, Paris 1976
UNESCO, Questionnaire on statistical survey of scientific & technological activities, Paris 1976
UNESCO, Manual for surveying national scientific & technological potential, Paris 1970
UNESCO, Christopher Freeman, Measurement of scientific & technological activities, Paris 1969

the OECD[1] source materials were referred for further clarification in order to determine the elements to be included or excluded from the survey.

In the second stage, the organizations and institutions where research work is being carried out were listed, classified and categorized according to the sector of performance. Almost all the institutions where research is being actively carried out or is likely to be carried out were listed. The private sector industries were identified by the Ministry of Industries.

The most important task in the survey, the collection of data, was carried out by direct personnel investigation. The available data in the Annual Reports, government estimates and appropriation accounts were collected before visiting the organizations. The information was fed into a data collection sheet which was specially designed for this survey. Armed with these data, respective institutions were visited.

The heads of the institutions and the accountants were consulted in order to understand the recording patterns, history and type of research activities carried out in the institutions. The data in hand and the definitions adopted by the investigator, aided by illustrations, were used for communicating concepts. This was followed by the extraction of data from the final accounts by personnel supervision. Any uncleared points were referred back to the accountant for further clarification.

Depreciation, printing, publicity, seminars and conferences and other direct identifiable items of expenditure were excluded. Whenever possible, detailed expenditure, according to sections and departments, was separately recorded. Once this was accomplished, the research scientists in the institutions were consulted for the refinement and

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1 OECD - The measurement of scientific & technical activities, Paris 1970

editing of the collected data. The task became more problamatic in the institutions where the same personnel were engaged in routine testing, general purpose data collection, consultation and other related activities in addition to R & D work. The recording system of the institutions do not facilitate the separation of R & D expenditure from the other activities mentioned above. The method adopted to surmount these problems was as follows.

1. Any item of expenditure that could be identified as being outside the scope of R & D to be excluded.

2. After this was done, the balance expenditure was taken and then the proportion of the expenditure spent on R & D activities is estimated with the help of the research scientists of the institutions.[1]

For the second step, initially an overall picture was obtained from the Chief Executive as to what should be the expected breakdown of working time for duties of a routine nature, and work involved in R & D, by the members of the staff. This was followed by interviews with the Head of the sections and other scientists who could work out a reliable breakdown for each section. The expenditure of each section was apportioned according to the percentages provided and this was verified by reference to the Chief Executive. In most cases, the figures derived by analysis of this expenditure in the individual sections agreed finally with the overall picture given by the Chief Executive for the Institution as a whole.

This method injects a certain degree of subjective errors into the data, but it prevents the over-estimation of R & D expenditure and gives a fairly reliable breakdown of expenditure.

This proved to be particularly useful in the case of certain institutions where the actual research work was started long after the provision for research expenditure was made in the budgets. The

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1 This approach has been considered to be valid by the Dept. of Science, Australia. Personal communication - D.J. Baines, Dept. of Science, Australia.

expenditure in such cases, in the initial years, had generally been on quality control or other activities of a routine nature.

In some cases, funds for research were drawn from the budgets of various non-research or quasi-research sources. It was only the actual expenditure recorded in the budgets that were taken into account. Wherever the actual expenditure on salaries were not recorded, it was worked out on the basis of actual manpower employed during the year.

Uniformity in the method of calculation of the proportionate expenditure on R & D was maintained in order to ensure that the data collected was comparable. Care was taken to minimise the subjective element, so that the different persons applying the method would obtain results with no more than 5 percent difference. This, we believe ensures that aggregates obtained by summing over all organizations are meaningful from survey to survey for the purpose of constructing time series and estimating growth rates.

2.2.2 Definitions and concepts used

Research and Experimental Development

In general, R & D is defined as any creative systematic activity undertaken to increase the stock of scientific and technological knowledge and to devise new applications.

Fundamental Research

Any activity directed towards the increase of scientific knowledge or discovery of new fields of investigation, without any specific practical objective.

Applied Research

Any activity directed towards the increase of scientific knowledge but with a specific practical aim in view.

Experimental Development

Systematic use of the results of fundamental and applied

research and of empirical knowledge directed towards the introduction of new materials, products, devices, processes, and methods or the improvement of existing ones, including the development of prototypes and pilot plants.

The R & D activities differ from the other related activities in the presence of an appreciable amount of novelty. For an activity to be classified as R & D there should be something innovative, e.g. the introduction of an improved technique. The standard procedure is not classified as R & D.

Sector of performance

Productive Sector

This sector includes :

(a) both domestic and foreign owned industrial and trading establishments located in the country, which produce and distribute goods, and services for sale, and organizations directly serving them, whatever their form of ownership, private, non-profit or government.

(b) in addition, governmental or non governmental organizations and private non profit institutions mainly or exclusively serving industrial or trading establishments, except those institutes, experimental stations etc., operating under the direct control or being associated with institutions of higher education.

Higher Education Sector

This sector includes all the universities and technical colleges and research institutes operating under the direct control of Institutions of Higher Education.

General Service Sector

This sector should include all bodies, departments and establishments of government-central or provincial, district or country, municipal, town or village - which serve the community as a whole and engage in a wide range of usual government services such as administration, defence and regulation of public order, health, cultural, recreational and other social services and promotion of economic growth and welfare and technological development.

Field of Sciences

(1) Natural Sciences

Includes astronomy, bacteriology, biochemistry,biology, botany, chemistry, entomology, geology, geophysics, mathematics, meteorology, mineralogy, physics, zoology and related subjects.

(2) Engineering and Technology

This category includes engineering proper, such as chemical, civil, electrical and mechanical engineering and specializations there-under; applied sciences such as geodesy, industrial chemistry and the like; architecture; specialized technologies or interdisciplinary fields such as industrial engineering, metallurgy, mining, systems engineering, textiles and related subjects.

(3) Medical Sciences

Comprises anatomy, dentistry, medicine mid-wifery, nursing, optometry, osteopathy, pharmacy, physiotherapy, public health and related subjects.

(4) Agriculture

Covers agronomy, dairying, fisheries, food processing, forestry and forest products, horticulture, rural sciences, veterinary medicine and related subjects.

(5) Social Sciences

Includes anthropology and ethnology, demography, juridical sciences, economics, education and training, geography, linguistics, management, political sciences, psychology, sociology, other social sciences and interdisciplinary, methodological and historical research related to the disciplines of this group.

(6) Humanities

Includes arts, philosophy and religion, prehistory and history, other disciplines or research subjects belonging to this group and interdisciplinary, methodological, historical, etc. research related to the disciplines of this group.

Intramural Expenditure

Refers to funds used for the performance of R & D within a particular organization or sector of the economy, regardless of the source.

Recurrent Expenditure

This includes wages and salaries and all related elements of labour, including such "fringe benefits" as bonuses, holiday pay, contributions to pension funds, payroll taxes, etc. Also included are expendable supplies and minor equipment and other supporting costs including share of overheads, for example: rent, maintenance and repair of buildings, replacement of office furniture, water, gas, electricity, administrative expenses such as expenses for security, janitorial and maintenance personnel engaged in general housekeeping activities.

Capital Expenditure

Includes actual expenditure or investment in land, building,

major equipment and purchase of books and journals.

Other capital includes the additions during the year for vehicles, books and journals.

Extramural Expenditure

Refers to payments made for the performance of R & D outside a particular organization or sector of performance.

Source of Funds

(1) Governmental funds

This includes all funds originating from the ordinary or extraordinary budget or from extra-budgetary government sources of both the central government and by local government bodies. It also includes the funds originating from those intermediary public and private organizations which are set up by government and whose financial means are exclusively provided by government.

(2) Productive enterprise funds

This includes all those funds allocated to R & D which originate from the economic activities of establishments in the productive sector, that is, the R & D funds made available from the production of goods and services for sale on the market.

(3) Special funds

This includes, for the most part, the financial means originating from the "Technical and Economic Progress Fund" (TEPF) and from similar funds. In Sri Lanka context, this applies to the cess collection from tea, rubber and coconut.

(4) Foreign funds

This category includes all funds received from abroad for R & D performed inside the reporting country by establishments, departments and institutions which are included in the sectors of performance.

(5) Other funds

Includes all funds which cannot be classified in one of the preceding categories, such as endowments or gifts. As far as possible these should be specified. This category also includes own funds of institutions of higher education.

Gross National Expenditure on Research and Experimental Development (GERD)

In accordance with the 'Frascati Manual', GERD comprises current and capital R & D expenditures financed by both government and by private sources and undertaken in any facilities within the country, excluding those used and financed by international organizations, but including those facilities abroad which are used to undertake an integral part of the national governmental R & D programme.

National R & D coefficient

Country's total expenditure on R & D expressed as a percentage of the Gross National Product.

2.2.3 Related Activities

The following related activities were specifically excluded from this R & D Survey along with the other activities as defined by UNESCO.[1]

1 Manual for surveying national scientific & technological potential - UNESCO 1970

Teaching and training activities
Scientific observations (Astronomy, Meteorology, etc.)
Scientific and technical information and documentation services
Organization of scientific or technical meetings
Scientific studies, experts' or consultant's services
Testing standardization and quality control
Design and Engineering services
Feasibility studies
Prospecting for natural resources
Agricultural and technological extension services

In the separation of related activities from R & D, examples and illustrations were given to the parties furnishing the data.

> "In so far as the activity follows an established routine pattern, it is not R & D. In so far as it departs from routine and breaks new ground, it qualifies as R & D. Thus, for example, the collection of daily routine statistics on temperature or atmospheric pressure is not R & D but the investigation of new methods of measuring temperature or the investigation of temperature under circumstances in which they have never been previously recorded is research."[1]

2.2.4 Expenditure classification covered -

TOTAL INTRAMURAL EXPENDITURE (GERD)
SECTOR OF PERFORMANCE
EXPENDITURE BY OBJECTIVE
TYPE OF ACTIVITY
MAJOR FIELD OF SCIENCE
FUNDING BY SECTOR
BY OBJECTIVES

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1 UNESCO, The measurement of scientific & technological activities - Paris 1969

2.3 Drawbacks and remedies in data collection

The financial year in most of the institutions was from October to September up to 1972; this was changed to the calendar year thereafter. Therefore, 1972 covers a 15 month period. Certain institutions continue to follow April to March as the financial year.

The accounting procedures adopted by certain institutions, specially the government departments and the Universities, do not permit the extraction of desired data. Most of the R & D programmes were not properly recorded and the expenditure could not be directly identified. Therefore, it was necessary to exercise judgement in deriving the actual expenditure. In the case of personnel emoluments which were usually itemized with the rest of the non R & D staff, it was necessary to evaluate the portion due to personnel engaged in R & D.

The direct visits to institutions facilitated the employment of a uniform method applicable to all institutions and enabled the formulation of a suitable procedure to reduce the error in calculating the unrecorded expenditure. Although the original proposal envisaged inclusion of related activities in R & D in the Survey, this was not done owing to the voluminous nature of work involved.

The quality of data, especially where it applies to the years 1966, 1967, 1968, 1969 and 1970 depended on the officers detailed to furnish them. Some were well informed on the history of the scientific activities of the institutions concerned, others had to postulate provide answers. In such cases, institutional history was studied closely by examining the research papers published and the Annual Reports.

The detailed expenditure appearing in the Annual Reports were based on the financial transactions made through the institutional budgetary system and generally excluded research grants received by individual scientists directly from the foreign agencies.

TABLE - II No. of Institutions covered and number of persons consulted

Number of Institutions	
Visited/consulted	63
Engaged in R & D	49
Where the R & D component cannot be identified	8
Number of persons visited/consulted	
Directors	11
General Managers	20
Heads of Depts. and other	114
Total -	145

It should also be noted that any individual attempts outside the institutional research programme are not included here.

The Capital Expenditure in the higher education sector, specially foreign aid received in terms of equipment could not be identified from existing records of accounts. The identification of foreign funds from the institutional budgets proved to be a difficult task whenever the existence of such funds were not clearly indicated. These funds might have been included in the government funds.

However, it is difficult to overcome all the problems in surveying the scientific activities in the country and this study gives evidence to the following statement.

> "It is important to bear in mind that judgement is often necessary in classifying the data. Because of the scope of R & D programmes and their multi-disciplinary nature, it is difficult to establish consistant criteria for allocating efforts among the character of work categories and various fields of science."[1]

1 National Science Foundation, Federal funds for R & D and other scientific activities, Washington 1976

2.4 Assessment of the extent of R & D

The most difficult problem in assessing R & D expenditure was to draw a distinction between R & D expenditure and expenditure on other related activities in industrial enterprises. It is extremely difficult to distinguish between industrial development work that has scientific value and would qualify for inclusion under R & D and development that is mainly of a routine commercial nature. It was also difficult to draw the line between where the development is completed and commercial production begins.

Efforts were made to solve this problem by explanations, and when relevant, using Fascati Manual[1] definitions and other source materials.

> "If the primary objective is to make further improvements in the product or the process, then the work comes within the definition of research and development. If, on the other hand, the product or process is substantially 'set' and the primary objective is to develop markets or to do pre-production planning, or to get the production process going smoothly, then the work is no longer R & D.[2]"

These problems also pin point the draw-backs of this kind of study. There are serious problems of definition, particularly in separating research and development from related but routine activities, and in industry, in drawing the line between development work and production. The data depend to some extent on the estimation of respondents who may not always interpret definitions in the same way. Such differences are greater between countries than within countries, even when definitions are standardized.[3]

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1 OECD, Proposed Standard Practice for Surveys of R & D, Paris 1963

2 National Science Foundation, Methodology of Statistics on R & D, Washington 1959

3 OECD, C. Freeman and A. Young, The Research and Development effort in Western Europe, North America and Soviet Union, Paris 1965

NOTE

Detailed tables are presented in order to give an overall picture of the expenditure patterns on Research and Experimental Development (R & D) in Sri Lanka. The preparation of these tables are to a certain extent on a subjective judgement which was unavoidable due to the absence of up-to-date detailed records in many cases.

The detailed breakdown of the expenditure invariably carries an element of uncertainty and this is particularly true for the type of activity (Tables 9 and 10) and the field of science (Tables 5 and 11). This is specially so in respect of the earlier part (1966 - 1971) of the 10 year period. The extramural expenditure shown in Table 15 represents the funds given to the spending organizations. This expenditure was taken into account when the spending organizations were surveyed. Therefore, the extramural expenditure in Table 15 was not taken directly into an account when GERD was calculated.

The tables have been prepared by rounding up figures to the nearest thousand.

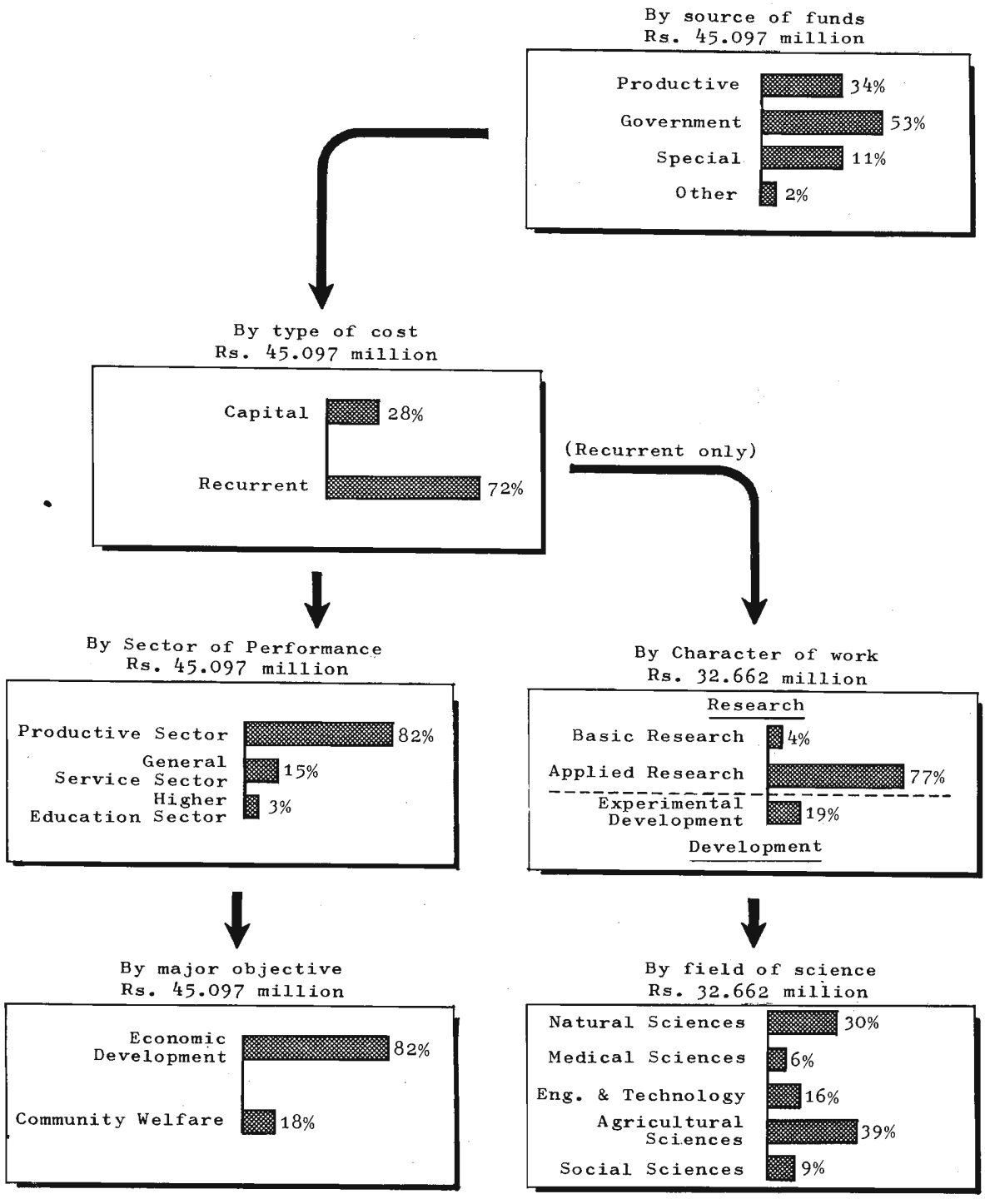

Fig. 1 - Distribution of Expenditure on R & D, 1975

3.1 Summary of significant sources (government and private)

Intramural Expenditure - Overall distribution of type of cost.

	1975	1974
Recurrent		
Personnel emoluments	47%	51%
Other current	25%	24%
Capital		
Land, building & fixed assets	19%	15%
Equipment	5%	6%
Other	4%	4%

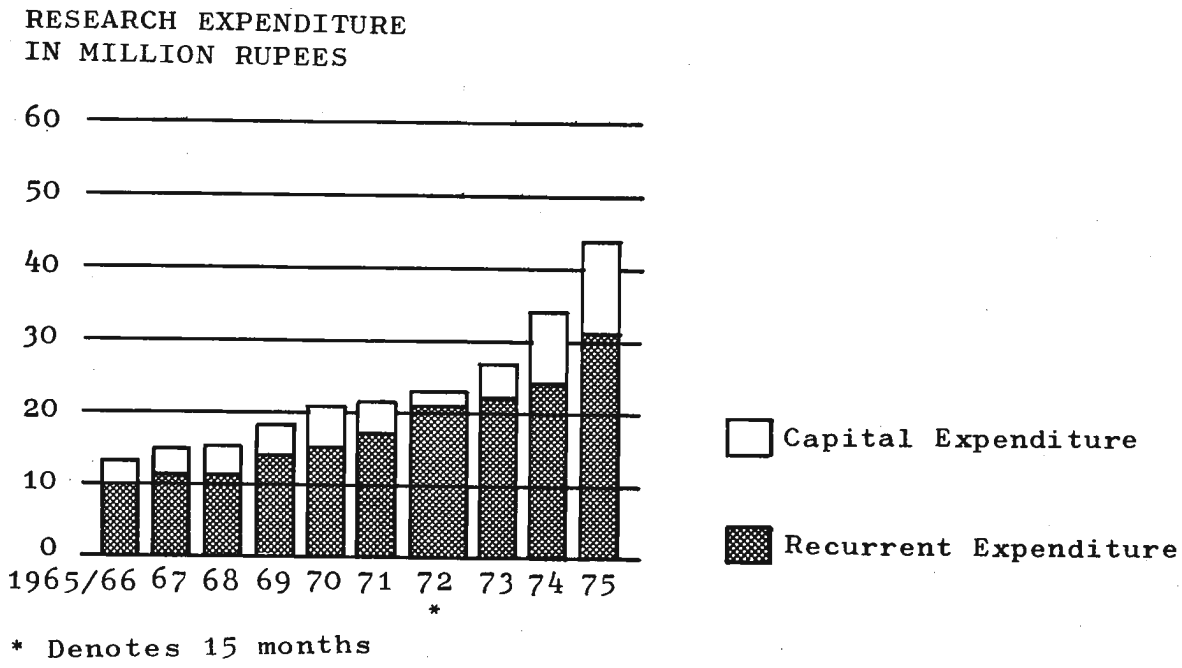

FIGURE - 2 A comparison of recurrent and capital expenditure on R & D

3.2 Intramural Expenditure

TABLE -III Gross National Expenditure on R & D - by major type of cost (recurrent and capital)

Table III describes the major components of research expenditure in the country for the last ten years. Some idea of the relative strength of capital and recurrent expenditure is presented in Fig. 2. In the absence of a reliable R & D cost index, the GNP implicit price deflated was used for the ten year period as shown in page 61 . The average rate of exchange of a US $ is given in the table as an indication of the changing value of the rupee. The amounts appearing here represent the expenditure in all sectors.

Year 1975 - 72 percent of GERD spent as recurrent expenditure

28 percent of GERD spent as capital expenditure

TABLE - III

Gross National Expenditure on Research and Development - by major type of cost

Year	Capital Expenditure Rupees x 10^3	Recurrent Expenditure Rupees x 10^3	Total Expenditure on Research Rupees (US $) x$10^3$	Average exchange rate of US $ Rupees *
1966	2891	10118	13009 (2732)	4.7619
1967	3534	10843	14377 (2432)	5.9124
1968	2557	12556	15113 (2556)	5.9124
1969	3233	14848	18081 (3058)	5.9124
1970	4828	16689	21517 (3639)	5.9124
1971	3555	18332	21887 (3702)	5.9124
1972	5743	22964	28707 (4696)	6.1136
1973	5320	22505	27825 (4373)	6.3623
1974	8836	26961	35797 (5388)	6.6438
1975	12435	32662	45097 (6367)	7.0833

* Source - Central Bank of Ceylon

Note: From 1966 to 1971, financial year from October to September. 1972 represents 15 months.

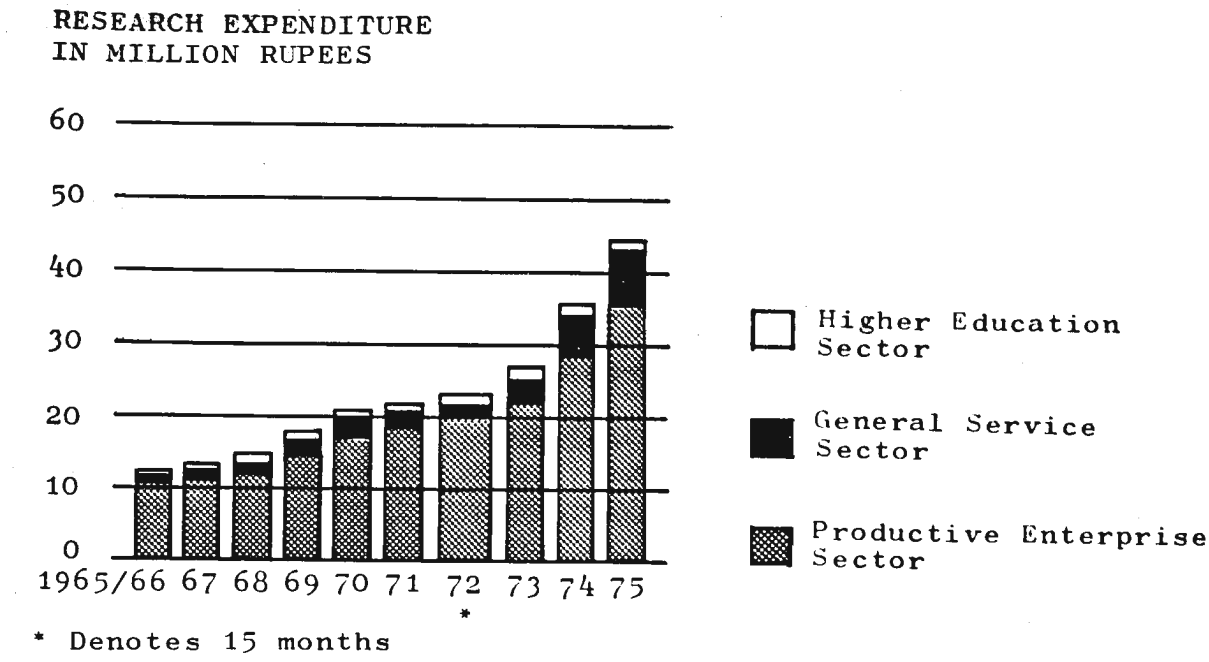

FIGURE - 3 Distribution of expenditure in the productive, general service and higher education sectors

TABLE -IV Gross National Expenditure on R & D - by sector of performance

The table describes the distribution of expenditure among the three major sectors. In the case of the higher education sector, the compilation of data was based on a fair amount of subjective assessment. The absence of detailed records led to this situation. In addition to that, the direct operation of certain research grants between the researchers and the funding organization in the higher education sector, posed a problem in the identification of expenditure. The relative magnitude of expenditure on R & D in different sectors is illustrated in Fig. 3.

Year 1975-82 percent of expenditure by the productive sector

15 percent of expenditure by the general service sector

3 percent of expenditure by the higher education sector

TABLE - IV

Gross National Expenditure on R & D - by sector of performance

(in thousand rupees)

Year / Sector of performance	1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths.	1973	1974	1975
Productive Enterprise	10940 (84%)	12282 (85%)	13032 (86%)	15523 (86%)	18546 (86%)	18698 (85%)	23914 (84%)	22323 (80%)	28186 (79%)	36970 (82%)
General Service	1367 (10.5%)	1441 (10%)	1476 (10%)	1760 (10%)	2012 (9%)	2149 (10%)	3546 (12%)	4285 (15%)	6516 (18%)	6745 (15%)
Higher Education	702 (5.5%)	654 (5%)	605 (4%)	798 (4%)	959 (5%)	1040 (5%)	1247 (4%)	1217 (5%)	1095 (3%)	1382 (3%)
TOTAL	13009	14377	15113	18081	21517	21887	28707	27825	35797	45097

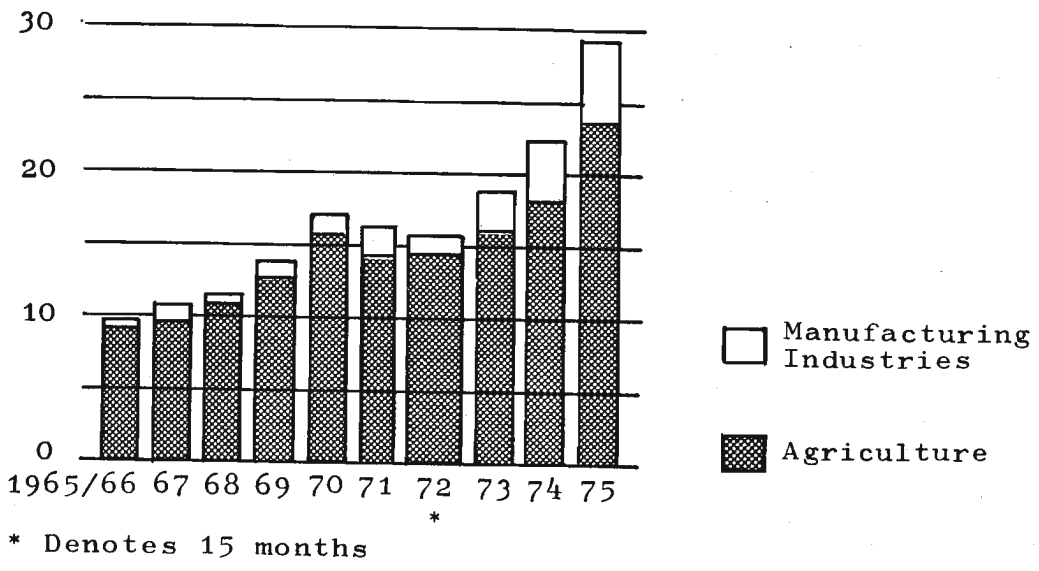

FIGURE - 4 A comparison of expenditure between Agriculture and Manufacturing Industries

TABLE - V Total intramural expenditure (GERD) - by sector of performance and objective category/field of science.

The table represents the distribution of expenditure in different sectors according to the objective category or field of science. In the process of classification into these, the entire institute or entire section was considered under a particular category/field of science. It may be that a particular institute or section is engaged in some other areas besides the classified category/field of science. This fraction was neglected. In the higher education sector, the identification of expenditure according to the field of science was not an easy task. The expenditure incurred on agriculture and manufacturing industries is compared and contrasted in Fig. 4. The expenditure incurred in extraction industries could not be identified easily due to the fact that it was profusely integrated with the activities related to research. The organizations that comes within the category of extraction industries, like the Petroleum Corporation, are not involved in R & D activities. The Geological Survey Department has to be classified as an institute where the R & D expenditure could not be extracted.

Year 1975 - 53 percent of GERD devoted to agriculture in comparison to 51 percent in 1974.

TABLE - V

Total Intramural Expenditure (GERD) - by sector of performance & objective category/field of science

(in thousand rupees)

Sector	Year / Objective category or field of sciences	1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths.	1973	1974	1975
Productive	1.Agriculture	9583	10511	10865	12448	15285	14526	17387	15741	18179	23727
	2.Forestry,Hunting & Fisheries	148	161	141	215	216	456	1576	1237	3267	3247
	3.Extrac.Industries	-	-	-	-	-	-	-	-	-	-
	4.Manu.Industries	641	810	1152	1930	1991	2640	3832	3550	4853	7105
	5.Construction	568	800	874	930	1000	1033	1094	1771	1830	2812
	6.Transport & Communication	-	-	-	-	54	43	25	24	57	79
Total		10940	12282	13032	15523	18546	18698	23914	22323	28186	36970
General Service Sector	1.Natural Science	-	55	56	62	142	151	400	515	471	645
	2.Eng. & Tech.	-	-	-	-	-	-	-	-	-	232
	3.Medical Science	927	922	939	1178	1228	1452	1755	1067	1290	1256
	4.Agriculture	-	-	-	-	-	-	-	-	-	-
	5.Social Sc. & Humanities	440	464	481	520	642	546	1391	2703	4755	4612
Total		1367	1441	1476	1760	2012	2149	3546	4285	6516	6745
Higher Education Sector	In all fields	702	654	605	798	959	1040	1247	1217	1095	1382
Total		13009	14377	15113	18081	21517	21887	28707	27825	35797	45097

3.2.1 Details of Capital & Recurrent Expenditure

TABLE - VI Intramural Expenditure on R & D - by sector of performance and type of cost (Capital only)

The table describes the capital expenditure on Research and Development in different sectors. In the higher education sector, the capital expenditure incurred on research could not be identified and also the equipment are extensively used for teaching purposes as well as for R & D. It was noted that a fair amount of equipment were received as foreign aid but detailed expenditure could not be identified.

Year 1975 - 17 percent of capital expenditure spent on equipment

83 percent on buildings, fixed assets, vehicles etc.

TABLE - VI

Intramural Expenditure on Research & Development - by sector of performance & type of cost
(Capital only)

(in thousand rupees)

Sector	Type of cost		1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths.	1973	1974	1975
Productive Enterprise	CAPITAL	Bldg.& fixed assets	1891	1532	1030	1124	1059	543	1289	1886	2831	6472
		Equipment	384	528	547	962	1709	1788	2308	2243	2004	1985
		Other	616	1456	978	1120	2052	1153	1668	461	1363	1728
		Total	2891	3516	2555	3206	4820	3484	5265	4590	6198	10185
General Service Sector	CAPITAL	Bldg.& fixed assets	-	-	-	-	6	17	198	607	2241	1924
		Equipment	-	-	-	-	-	33	220	70	311	89
		Other	-	18	2	27	2	21	60	53	86	237
		Total	-	18	2	27	8	71	478	730	2638	2250
Higher Education	CAPITAL	Bldg.& fixed assets	-	-	-	-	-	-	-	-	-	-
		Equipment	-	-	-	-	-	-	-	-	-	-
		Other	-	-	-	-	-	-	-	-	-	-
		Total	-	-	-	-	-	-	-	-	-	-
Total			2891	3534	2557	3233	4828	3555	5743	5320	8836	12435

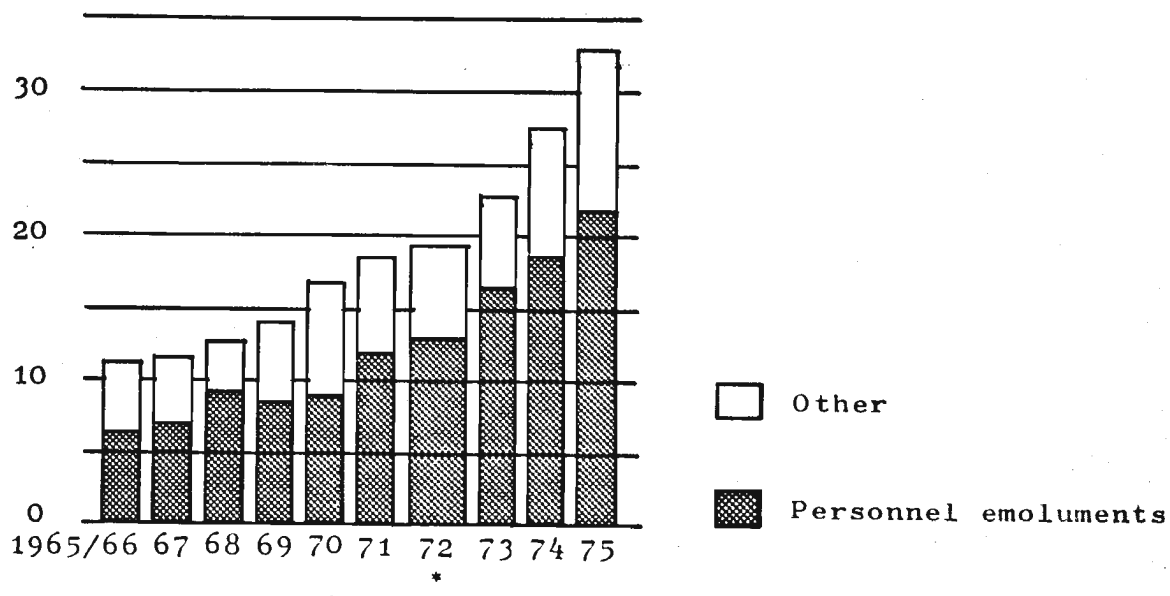

FIGURE - 5 A comparison of personnel emoluments and other recurrent expenditure

TABLE - VII Intramural expenditure on R & D - by type of cost (Recurrent only)

The table describes the recurrent expenditure in all sectors. The recurrent expenditure is made up of personnel emoluments and other - i.e. rent, gas, electricity, maintenance etc. The personnel emoluments shared a bigger portion of recurrent expenditure than the other, which is illustrated in Fig. 5.

Year 1975 - 65 percent of Recurrent Expenditure sanctioned to personnel emolument in 1975 in comparison to 51 percent in 1974.

TABLE - VII

Intramural Expenditure on R & D (Recurrent only) - by type of cost

(in thousand rupees)

Year / Type of cost	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	65/66	66/67	67/68	68/69	69/70	70/71	15 mths.			
Personnel emoluments	6111 (60%)	6315 (58%)	7346 (58%)	8016 (54%)	9080 (54%)	11051 (60%)	12561 (55%)	16059 (71%)	18201 (67%)	21240 (65%)
Other	4007	4528	5210	6832	7609	7281	10403	6446	8760	11422
TOTAL	10118	10843	12556	14848	16689	18332	22964	22505	26961	32662

TABLE - VIII Intramural expenditure on Research & Development - by sector of performance and type of cost

The table describes the distribution of recurrent expenditure in each sector according to the type of cost.

	Salary	Other
Year 1975 -		
Productive Sector	63 %	37 %
General service sector	77 %	23 %
Higher Education sector	70 %	30 %

TABLE - VIII

Intramural Expenditure on R & D - by sector of performance and type of cost (Recurrent only)

(in thousand rupees)

Sector	Year / Type of cost	1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths.	1973	1974	1975
Productive	Salary	4510	4738	5799	6185	6889	8897	9375	12382	14168	16803
	Other	3539	4028	4678	6132	6836	6317	9274	5351	7820	9982
	Total	8049	8766	10477	12317	13725	15214	18649	17733	21988	26785
General Service Sector	Salary	940	1004	1040	1159	1458	1392	2158	2793	3086	3470
	Other	427	419	434	574	547	686	910	762	792	1025
	Total	1367	1423	1474	1733	2005	2078	3068	3555	3878	4495
Higher Education	Salary	661	573	507	672	733	762	1028	884	947	967
	Other	41	81	98	126	226	278	219	333	148	415
	Total	702	654	605	798	959	1040	1247	1217	1095	1382
All Sectors	Total Recurrent	10118	10843	12556	14848	16689	18332	22964	22505	26961	32662

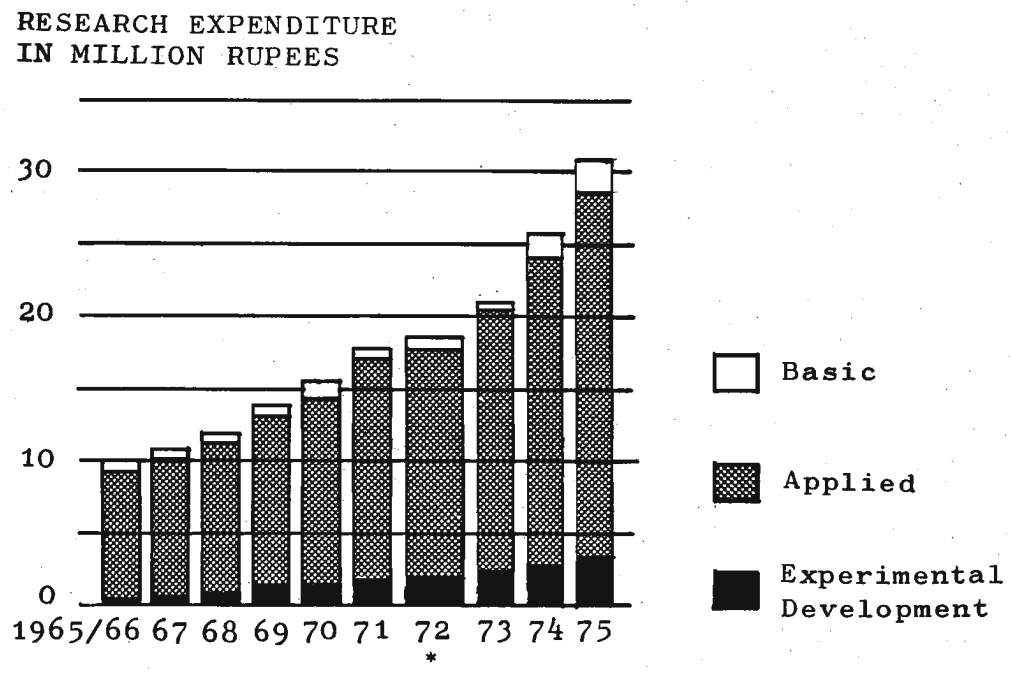

FIGURE - 6 A comparison of expenditure on basic, applied research and experimental development

3.2.2 Expenditure by type of activity

TABLE - IX Intramural expenditure on R & D - by type of activity (Recurrent only)

The table shows the detailed breakdown of recurrent expenditure into various types of activities. It was not possible to give a similar breakdown for the capital expenditure as in the case of current expenditure because the capital assets were used in all types of activities from time to time and detailed records were not available. The expenditure incurred on applied research was greater than the others and the relative strengths of basic, applied and experimental development are illustrated in Fig. 6. In the process of preparing this table, the projects and nature of work, which were undertaken by the institutions, were reviewed.

Year 1975 - 4 percent of recurrent expenditure was devoted to basic research;

77 percent of recurrent expenditure to applied research;

19 percent of recurrent expenditure to experimental development

TABLE - IX

Intramural Expenditure on R & D (Recurrent only) - by type of activity

(in thousand rupees)

Year / Type of activity	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	65/66	66/67	67/68	68/69	69/70	70/71	15 mths.			
Basic	589	598	598	650	767	891	1027	825	1042	1231
Applied	8118	8624	9925	11728	13180	14422	18171	17722	21122	25316
Experimental Development	1411	1621	2033	2470	2742	3019	3766	3958	4797	6115
TOTAL	10118	10843	12556	14848	16689	18332	22964	22505	26961	32662

TABLE - X Intramural expenditure on R & D - by sector of performance and type of activity (Recurrent only)

This table was prepared to show the distribution of expenditure in the different sectors according to the type of activities.

Year 1975 -	Basic	Applied	Ex.Dev.
Productive sector	4%	75%	21%
General service sector	2%	95%	3%
Higher education sector	10%	75%	15%

3.2.3 Expenditure by major field of science

TABLE - XI Intramural expenditure on R & D - by major field of science (Recurrent only)

The table describes the distribution of expenditure according to major fields of science. A study of the institutional activities were required in the preparation of this table. The expenditure was categorised into the major fields on a percentage basis with the help of senior scientists in the institutions. Unlike in Table 5, page 37 , the entire spectrum of the institution's activities were reviewed. A similar detailed breakdown of capital expenditure was not attempted for the same reason mentioned in Table 9, page 45.

Year 1975 -	
Natural Science	30%
Engineering & Technology	16%
Medical Science	6%
Agriculture	39%
Social Sc. & Humanities	9%

TABLE - X

Intramural Expenditure on R & D (Recurrent only) - by sector of performance and type of activity

(in thousand rupees)

Sector	Year / Type of Activity	1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths.	1973	1974	1975
Productive Enterprise	Basic	473	488	491	513	607	714	816	642	866	1019
	Applied	6308	6793	8082	9500	10573	11692	14327	13369	16678	20020
	Experimental Dev.	1268	1485	1904	2304	2545	2808	3506	3722	4494	5746
	Total	8049	8766	10477	12317	13725	15214	18649	17733	21988	26785
General Service sector	Basic	46	45	47	57	64	73	86	61	67	74
	Applied	1283	1341	1389	1630	1888	1950	2909	3440	3673	4259
	Experimental Dev.	38	37	38	46	53	55	73	54	138	162
	Total	1367	1423	1474	1733	2005	2078	3068	3555	3878	4495
Higher Education	Basic	70	65	60	80	96	104	125	122	109	138
	Applied	527	490	454	598	719	780	935	913	821	1037
	Experimental Dev.	105	99	91	120	144	156	187	182	165	207
	Total	702	654	605	798	959	1040	1247	1217	1095	1382
TOTAL		10118	10843	12556	14848	16689	18332	22964	22505	26961	32662

TABLE - XI

Intramural Expenditure on R & D (Recurrent only) - by major field of science

(in thousand rupees)

Year / Major field	1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths.	1973	1974	1975
Natural Science	3888	4031	4391	4886	5713	6386	7621	6796	8509	9916
Eng. and Technology	961	1256	1462	1720	1918	2291	2191	2507	3020	5196
Medical	1173	1188	1206	1491	1656	1838	2161	1609	1680	1891
Agriculture	3611	3858	4970	6171	6685	7180	9658	9268	11252	12768
Social Science & Humanities	485	510	527	580	717	637	1333	2325	2500	2891
TOTAL	10118	10843	12556	14848	16689	18332	22964	22505	26961	32662

TABLE - XII Intramural expenditure on R & D - by sector of performance and major fields of science (Recurrent only)

The table describes the distribution of recurrent expenditure in different sectors according to major fields of science. The contribution of expenditure from the productive sector to the medical science was almost insignificant. Priority was given for the medical science by the higher education sector.

In 1975, 35% of higher education expenditure was spent on medical science as against 30% on natural sciences. Similarly, social sciences and humanities was given priority in the general service sector; about 62% of general service sector expenditure. Agriculture was given priority in the productive sector; 46% of productive sector expenditure.

TABLE - XII

Intramural Expenditure on R & D (Recurrent only) - by sector of performance & major field of science

(in thousand rupees)

Sector	Major Field of Science	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
		65/66	66/67	67/68	68/69	69/70	70/71	15mths			
Productive Sector	1.Natural Sciences	3677	3835	4210	4647	5398	6042	7172	6336	8066	9354
	2.Eng.& Technology	891	1191	1401	1640	1819	2180	2055	2372	2895	4951
	3.Medical Sciences	-	-	-	-	-	-	-	-	-	-
	4.Agriculture	3471	3727	4850	6011	6487	6960	9381	8992	10991	12440
	5.Social Sc. & Humanities	10	13	16	19	21	32	41	32	36	40
Sub Total		8049	8766	10477	12317	13725	15214	18649	17732	21988	26785
General Service Sector	1.Natural Sciences	-	-	-	-	27	32	75	95	115	147
	2.Eng.& Technology	-	-	-	-	3	7	11	13	16	107
	3.Medical Sciences	927	959	994	1212	1321	1474	1724	1183	1297	1407
	4.Agriculture	-	-	-	-	6	12	28	32	41	52
	5.Social Sc. & Humanities	440	464	481	521	648	553	1230	2232	2409	2782
Sub Total		1367	1423	1475	1733	2005	2078	3068	3555	3878	4495
Higher Education Sector	1.Natural Sciences	211	196	181	239	288	312	374	365	328	415
	2.Eng.& Technology	70	65	61	80	96	104	125	122	109	138
	3.Medical Sciences	246	229	212	279	335	364	437	426	383	484
	4.Agriculture	140	131	120	160	192	208	249	244	220	276
	5.Social Sc. & Humanities	35	33	30	40	48	52	62	61	55	69
Sub Total		702	654	604	798	959	1040	1247	1218	1095	1382
Total R & D Recurrent		10118	10843	12556	14848	16689	18332	22964	22505	26961	32662

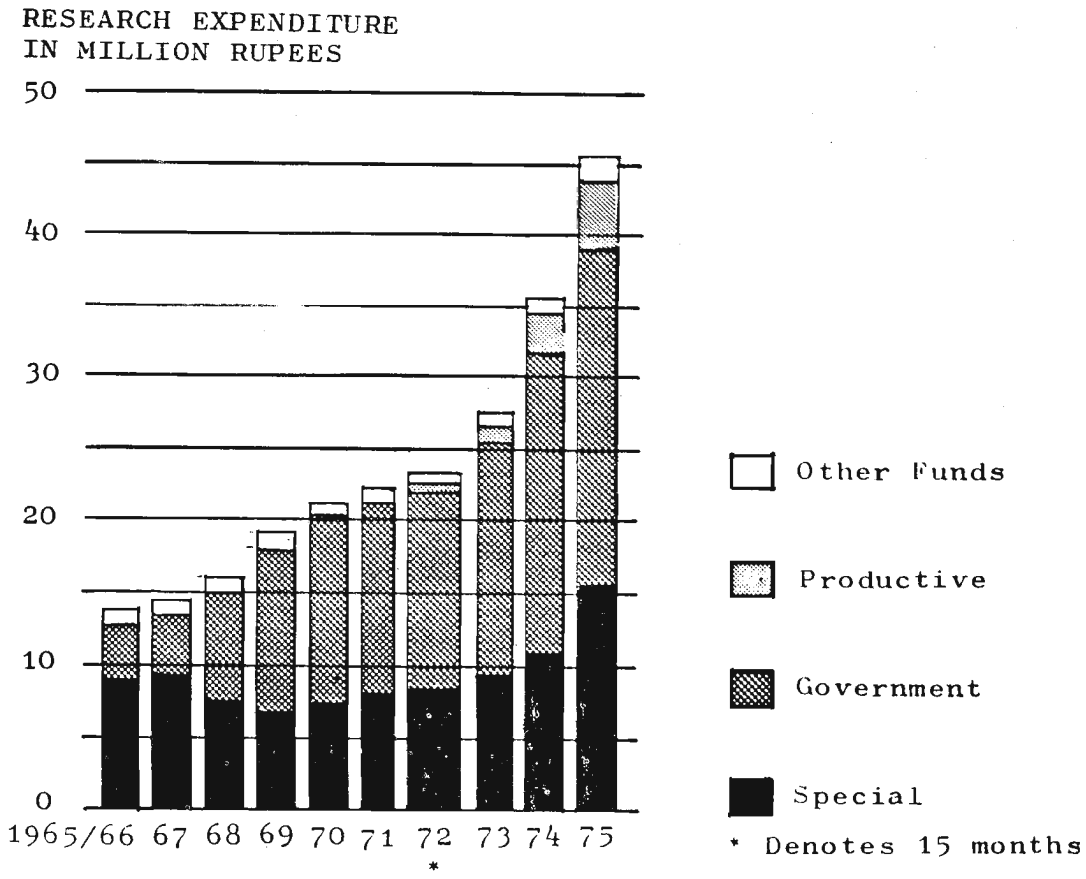

FIGURE - 7 A comparison of source of funds

3.2.4 Expenditure by source of funds

TABLE - XIII Total intramural expenditure on R & D (GERD) - by source of funds

The table describes the major sources of funds received by institutions to perform R & D activities. The comparison of relative strength of government, productive, special and foreign funds is shown in Fig. 7.

Year 1975 - Special Funds 34%
Government Funds 53%
Productive Funds 11%
Other Funds 2%

The identification of foreign funds from the institutional budgets proved to be a difficult task whenever the existence of such funds were not clearly indicated. These funds might have been included in the government funds.

TABLE - XIII

Total Intramural Expenditure on R & D - by source of funds

(in thousand rupees)

Source of Funds	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	65/66	66/67	67/68	68/69	69/70	70/71	15 mths			
Special Funds	7948 (61%)	7904 (55%)	6810 (45%)	6895 (38%)	8894 (41%)	8577 (39%)	10193 (35%)	9368 (34%)	10881 (30%)	15188 (34%)
Govt. Funds	5002 (38%)	6471 (45%)	8266 (55%)	10778 (60%)	12216 (57%)	12911 (59%)	17569 (61%)	16069 (57%)	20575 (58%)	24140 (53%)
Productive Funds	59 (1%)	2 ( )	37 ( )	408 (2%)	407 (2%)	399 (2%)	732 (3%)	1619 (6%)	2500 (7%)	4759 (11%)
Other Funds	-	-	-	-	-	-	213 (1%)	769 (3%)	1841 (5%)	1010 (2%)
TOTAL	13009	14377	15113	18081	21517	21887	28707	27825	35797	45097

TABLE - XIV Total intramural expenditure on R & D (GERD) - by source of funds and objective category

The table describes the distribution of funds in various objective categories. The objective category for each institute was selected by examining the major functions of the institute.

Year 1975 - 35 percent of the government funds spent on agriculture;

13 percent on fisheries and forestry

5 percent on health

3.3 Extramural Expenditure

TABLE - XV Extramural expenditure on R & D - by funding organization

Table XV summarizes the sources of extramural funds as indicated by the amounts allocated to or utilized by the spending organization during the different years. This expenditure on R & D was not measured from funding sources, because the amount received by the spending organization from the funding agency were not necessarily spent during the same year. The University, Central Agricultural Research Institute, Coconut Research Institute, Tea Research Institute and the Rubber Research Institute were the major spending organizations. The donor organizations were the National Science Council, Department of Agriculture, Minor Export Crops Department, Atomic Energy Authority, National Engineering Research and Development Centre.

TABLE - XIV

Total Intramural Expenditure on R & D - by source of funds and objective category

(in thousand rupees)

Sources of Funding	Objective Category	1966 65/66	1967 66/67	1968 67/68	1969 68/69	1970 69/70	1971 70/71	1972 15 mths	1973	1974	1975
Special Funds	ECONOMIC DEVELOPMENT										
	Agriculture	7948	7904	6810	6895	8894	8577	10193	9368	10881	15188
Productive Enterprise	Manufacturing Industries	59	2	37	408	353	356	707	1535	2291	4492
	Construction	-	-	-	-	-	-	-	60	186	220
	Transport	-	-	-	-	54	43	25	24	23	47
Govt. Funds	Agriculture	1635	2607	4055	5553	6391	5949	7194	6372	7298	8540
	Fisheries & Forestry	148	161	141	215	216	456	1576	1237	3267	3247
	Construction	568	800	874	930	1000	1033	1094	1711	1644	2592
	Communication	-	-	-	-	-	-	-	-	34	31
	Other Economic Development	582	808	1115	1521	1638	2284	3125	2015	2562	2613
	COMMUNITY WELFARE										
	Health Environment Public Welfare & Advancement of Science	927	922	939	1178	1228	1452	1755	1067	1290	1256
		702	709	661	861	1101	1191	1647	1733	1539	2259
	Community services	440	464	481	520	642	546	1178	1934	2941	3602
Other funds	Community services	-	-	-	-	-	-	213	769	1841	1010
TOTAL		13009	14377	15113	18081	21517	21887	28707	27825	35797	45097

TABLE - XV

Extramural Expenditure on Research & Development - by funding organization

(in thousand rupees)

Funding Organizations	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	65/66	66/67	67/68	68/69	69/70	70/71	15 Mths.			
AEA	-	-	-	-	-	162	249	209	228	429
NSC	-	-	-	-	-	298	219	281	229	321
NERD	-	-	-	-	-	-	-	-	-	10
Geological Survey Dept.	-	-	-	-	-	-	-	-	-	-
Cement Corporation	-	-	-	-	-	-	-	5	1	15
Minor Export Crops	-	-	-	-	-	-	-	142	100	119
Dept. of Agriculture	699	703	703	674	89	332	198	350	29	25
TOTAL	699	703	703	674	89	792	666	987	587	919

3.4 Expenditure and the relationship with the Gross National Product and the population

TABLE - XVI Gross National Expenditure on R & D (GERD) and the relationship with the gross national product (GNP) of the country

The relationship between R & D expenditure and Gross National Product is usually expressed as a percentage of GNP which is referred to as the national coefficient of R & D. This percentage has been increasing steadily during the period surveyed. The GNP at market price also is given in the table.

TABLE - XVII The relationship between gross national expenditure on R & D (GERD) and the population of the country

The table describes the expenditure on R & D per unit population for the last ten years.

Year 1975 - Rupees 3 and 32 cents spent on research per capita

Year 1966 - Rupees 1 and 14 cents spent on research per capita

TABLE - XVI

Gross National Expenditure on R & D (GERD) and its relationship with the Gross National Product (GNP) of the country

Year	Fixed based* index numbers for GERD	GERD as a % of GNP at current factor cost	GERD as a % of GNP at market price	Extra GERD necessary to reach 1 % of GNP at current factor cost Million Rupees
1966	100	.1688	.1560	64.041
1967	111	.1739	.1594	68.273
1968	116	.1530	.1433	83.647
1969	139	.1686	.1555	89.169
1970	165	.1861	.1698	94.103
1971	168	.1857	.1720	95.973
1972	221	.2275	.2058	97.453
1973	214	.1834	.1668	123.855
1974	275	.1818	.1679	161.143
1975	347	.2056	.1899	174.253

From 1966/1971, the financial year is from October to September.

1972 represents a 15 month period.

* Price relative index

TABLE - XVII

The relationship between Gross National Expenditure on R & D (GERD) and the population of the country

Year	GERD in million rupees	* Population in millions	GERD per Capita Rupees	US $	Per Capita GNP** at current factor cost Rupees	Extra GERD per Capita necessary to reach 1% of GNP Rupees	US $
1966	13.009	11.439	1.14	0.24	673	5.59	1.17
1967	14.377	11.703	1.23	0.21	706	5.83	0.98
1968	15.113	11.992	1.26	0.21	824	6.97	1.18
1969	18.081	12.252	1.48	0.25	875	7.27	1.23
1970	21.517	12.516	1.72	0.29	924	7.52	1.27
1971	21.887	12.699	1.72	0.29	928	7.56	1.28
1972	28.707	12.951	2.22	0.36	973	7.52	1.23
1973	27.825	13.18	2.11	0.33	1144	9.39	1.47
1974	35.797	13.393	2.67	0.4	1480	12.03	1.81
1975	45.097	13.603	3.32	0.47	1623	12.8	1.81

* Source - Dept. of Census & Statistics
** Source - Central Bank of Ceylon- Annual Reports

From 1966/1971, the financial year is from October to September.

1972 represents a 15 month period

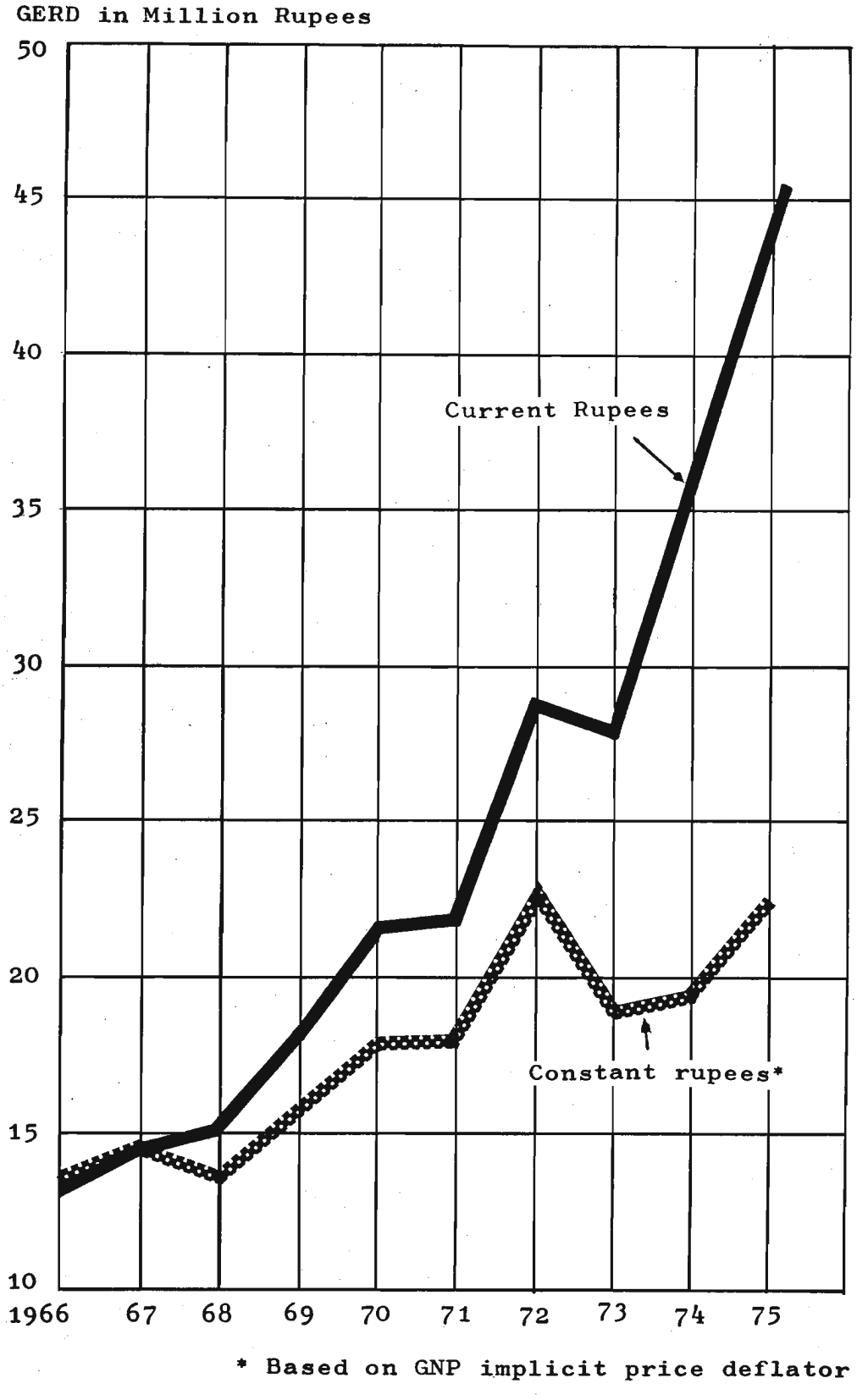

Fig. 8 - A comparison of GERD at current and constant rupees, 1966 - 1975

4.1 Trends and relationships

* From the financial year 1966 to financial year 1975, the total expenditure on Research and Development reflect an increase from Rupees 13 million to Rupees 45.1 million or an annual average growth rate of 15.8 percent. Most of this growth has taken place in the recent years. The figure for 1975 is 26 percent above the 1974 level of Rupees 35.8 million. In real terms, the national R & D total in 1975 was 21% higher than in 1974.

* In the absence of a reliable R & D cost index the GNP implicit price deflator was used for the years 1966 - 75 to account for inflation. Despite a high rate of inflation a steady increase in expenditure is shown in constant Rupees over the period, from 13.2 million Rupees in 1966 to 22.9 million Rupees in 1975. This indicates a healthy sign with regard to funding of research.

* The per capita expenditure has seen a three fold increase during the decade from Rupees 1.14 in 1966 to Rupees 3.32 in 1975.

* An average 75 percent of the total expenditure on R & D has been in the form of current expenditure. The capital outlay was mainly for buildings and such fixed assets, while the expenditure for equipment has been relatively modest. In 1966, the percentage expenditure for equipment was 13 percent. By 1971, this had increased four fold to 51 percent. However, since 1971, a gradual decline is shown with the percentage expenditure dropping to 16 percent in 1975. This may be related to the foreign exchange difficulties faced by the country during this period.

* A major portion of recurrent expenditure for research has been for personnel emoluments. In 1975, 65 percent of the recurrent expenditure was for personnel emoluments and this trend has remained the same for even the earlier years.

* An average of 85 percent of the research funds have been allocated to the productive sector while expenditure by the general service sector was 1/8 of this figure. Higher Education appears to be poorly funded with a meagre 5 percent of the allocations. The research institutes were responsible for spending about 60 percent of national R & D total. Funds coming from the private organizations were very low; about 3 percent in 1975 of the national R & D total.

* Research was mainly concentrated in the fields of agricultural science. Although the R & D expenditure in this sector grew steadily from Rupees 9.5 million in 1966 to 23.7 million in 1975, the percentage of the National Expenditure on agriculture did not rise proportionately. The percentage has dropped from 74 percent in 1966 to 53 percent in 1975. The percentage of the National Expenditure on Manufacturing Industries has increased 5 percent in 1966 to 16 percent in 1975. Only 3 percent of GERD was spent on medical sciences in 1975, when compared to 7 percent in 1966. The expenditure on socio-economic research gathered momentum from 1972 to 1975. The percentage of GERD spent on this rose from Rupees 0.4 million in 1966 - about 3 percent of GERD, to Rupees 1.4 million in 1972 - about 5 percent of GERD and to Rupees 4.6 million in 1975 - about 10 percent of GERD. Research in transport and communication was found to be relatively insignificant compared with other categories; about 2 percent of national R & D expenditure was spent in 1975.

* The emphasis in research has been firmly directed towards Applied Research during the period concerned. The percentage expenditure

for basic research has dropped from 6% in 1966 to 4% in 1975, and that for Applied Research from 80% in 1966 to 78% in 1975. The percentage drop in these two activities has been due to a relative increase in expenditure for experimental development, to 19 percent in 1975. However, all major research institutes continue to be strongly committed to Applied Research.

4.2 Research and Development efforts in Sri Lanka

In the measurement of R & D activities in terms of inputs of resources, the R & D effort is generally given as a percentage of GNP of the country. There are controversial views on this matter. However, it has been widely used in the evaluation of the R & D efforts in other countries.

> "Percentage of GNP devoted to R & D are useful in comparing a country's R & D effort with resources devoted to competing national objectives or to track its growth over time. International comparison of GNP percentages are, however, not good yardsticks for science planning. Such an evaluation can be made only in the light of the R & D aims a country sets itself, some of which are more costly to realise than others".[1]

Table XVI describes the relative situation of Sri Lanka. These percentages are comparable with that of USA in nineteen thirty.

4.3 Co-relation of GNP with R & D

The co-relation co-efficient between R & D and GNP is 0.97 for Sri Lanka for the period reviewed. This shows a significant co-relation between R & D and GNP. The national R & D co-efficient of 0.23 percent for 1975 was a low value and this situation should be reviewed and rectified if the horizontal transfer of technology is to have a significant impact on our national economy.

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1 OECD, The overall level and structure of R & D efforts in OECD member countries - Paris 1967

"It is absolutely essential for the developing countries that their rate of growth of both GNP per habitant and national R & D co-efficient should be higher than those of the industrialized countries; otherwise, the evolution of the world would take an irreversibly disruptive course".[1]

4.4 GERD in Sri Lanka projected to 1980

The projection of R &D over the next decade could be attempted by simple extrapolation of past trends or it could be derived by consideration of principle goals with an attempt to forecast what proportion of national income the society might choose to allocate to the pursuit of these goals.[2]

In the absence of a national science policy in Sri Lanka, the projection of R & D expenditure to 1980 is merely based on curve fitting and by simple extrapolation of past trends.

Curve fitting -

The following eight models were tested to fit the best curve for the R & D and GNP data, for the purpose of forecasting the expenditure to 1980. The equation of the best fitting curve was selected with respect to the 'F value' for this purpose. The data corresponding the year 1972 which represents fifteen months were omitted in calculating the F values.

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1 UNESCO, Jacques Spaey, Science for Development, Paris 1971

2 Science Council of Canada, Background studies in Science Policy, Ottawa 1969

$y = A+Bx$ $\qquad$ $y = Ae^{Bx}$

$y = A+\frac{B}{X}$ $\qquad$ $y = Ax^{B}$

$\frac{1}{y} = A+\frac{B}{X}$ $\qquad$ $y = A+B\ln x$

$y = A+B\sqrt{x}$ $\qquad$ $y = A+Bx+Cx^{2}$

The best model in both cases happened to be $Y = Ae^{Bx}$.
The corresponding graphs (Fig.9 & 10) are presented in pages 67 and 68.

GERD projected to 1980 = 80.2697 million rupees from the

equation $y = Ae^{Bx}$

$A = .002$

$B = .1325$

$F = 250.6$

GNP projected to 1980 = 34889.49 million rupees from the

equation $y = Ae^{Bx}$

$A = 5.259$

$B = .110$

$F = 152.71$

Therefore, the national R & D coefficient in 1980 is calculated to be .23 percent.

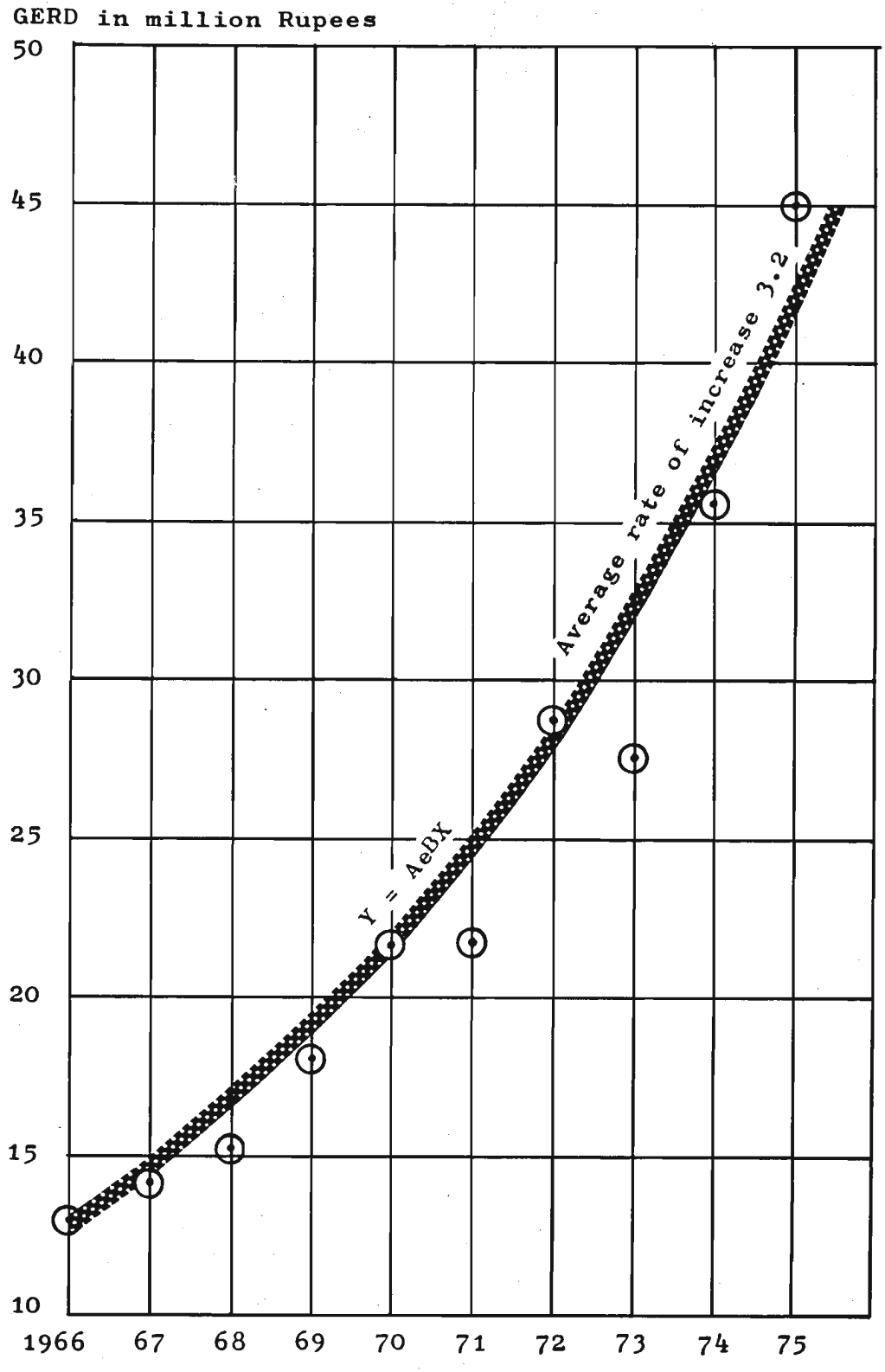

Fig. 9 - Increase in GERD in Sri Lanka, 1966 - 1975

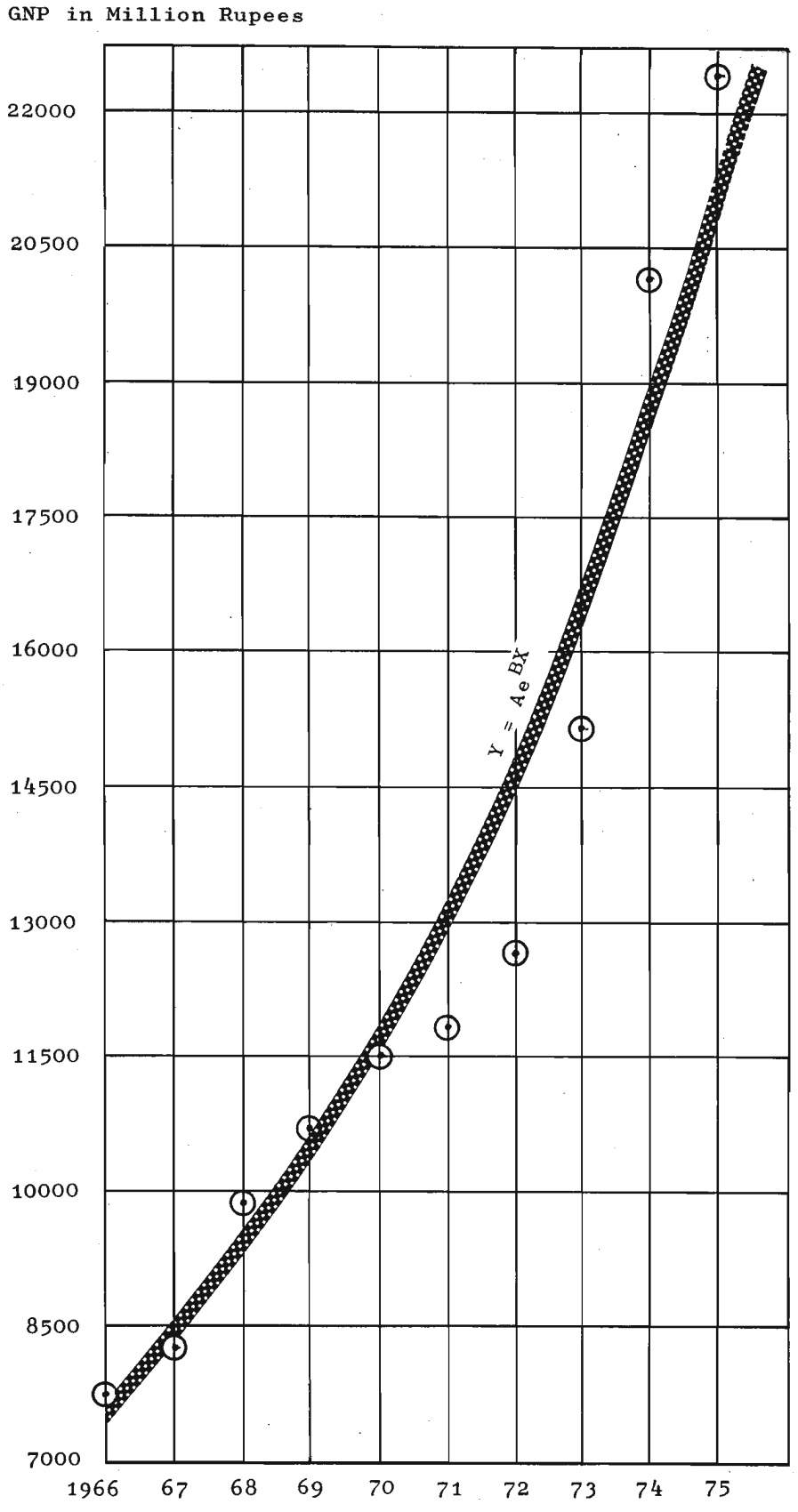

Fig. 10 - Increase in GNP at current factor cost in Sri Lanka, 1966 - 1975

4.5 Conclusions

The survey indicates that there has been a definite growth of expenditure on Research and Development both in absolute and real terms, during the decade surveyed. However, the national co-efficient of R & D still remains at a very low level (0.2% in 1975). There were no significant changes in the growth patterns of expenditure with respect to activities of work, sectors of performance, fields of science and objective categories. However, towards the latter part of the decade, the areas of socio-economic research, transport and communication research, and environmental pollution have shown an increase of activity. Some of the areas neglected in the R & D structure were the extraction industries, energy research, material research and environmental studies. More emphasis has been given for applied research throughout the decade. Nearly sixty percent of the recurrent expenditure on R & D was spent on personnel emoluments.

A close examination of patterns of R & D activities indicate, that the allocation of financial resources had not significantly changed towards increasing the productivity and effectiveness of the national scientific potential.

The expenditure on R & D for manufacturing industries stands well below that of agriculture. This was evidently due to the fact that the sector of agriculture on which the national economy was heavily dependent, received heavy state patronage for research activities. On the other hand the industrial sector which comprises of public corporations and private enterprises have directed most of its efforts to fulfill the production targets and less to R & D. The absence of tax concessions, and other incentives for R & D activities for private enterprises must be partly responsible for this situation.

Even though the national expenditure on R & D had been low, it was considered desirable to make a critical analysis of trends so that future patterns of funding may be suitably adjusted in order to make the best use of available resources. There are for example, small scale projects, which with very little inputs of research and development can

increase their productivity, and thereby make a significant impact on the economy. Such cases should not be neglected in the face of large projects requiring heavy inputs of R & D expenditure.

It is also desirable to review and readjust periodically different kinds of R & D efforts in order to accelerate the economic development. The regular measurement of scientific activities therefore, is a very important and responsible task. Such data would help the policy makers to understand the country's actual situation when formulating the science and technological policies. The findings of the report warrant an urgency to assess and determine the causes for any imbalances in funding for the various disciplines and areas of work, so that major defects and deficiencies may be remedied.

This report forms the basis for those who are directly responsible for economic development and policy making in the country, to study and establish a Science Policy Research Unit, which could monitor the scientific activities on a permanent basis. The importance of this is further supported by the recommendations of the CASTASIA report, one of which reads as follows :

> "Recommends that the Governments of Asian countries carry out studies on the structure of their science expenditure and budgetary allocation mechanisms, and particularly devote special attention in surveying their scientific and technological potential, to measurement of expenditure for research, experimental development and related activities."[1]

Recognizing the importance of such measurements, this report points out the necessity of keeping comprehensive records on the R & D activities by both administrators and scientists in the organizations. Research organizations may be advised by the government, to maintain as far as possible a uniform pattern in recording expenditure on R & D programmes.

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1 UNESCO, Conference on the Application of Science and Technology to the Development of Asia (CASTASIA) - New Delhi 1968

APPENDIX

APPENDIX A

Detailed Statistical Table

(in thousand Rupees)

Institution	Actual Expenditure on R & D				
	1966	1967	1968	1969	1970
CRI	1359	1262	1489	1771	1984
RRI	1670	1903	1771	1975	2905
TRI	4920	4739	3551	3148	4004
Dept. of Agriculture	1634	2607	4055	5553	6391
Minor Export Crops	-	-	-	-	-
Fisheries Dept.	110	110	98	141	159
Forest Dept.	38	41	44	73	57
Lever Brothers Ltd.	59	2	1	36	21
Tobacco	-	-	-	-	-
CCC	-	-	-	-	-
Walker Sons Ltd	-	-	-	-	-
Ceramics Corp.	-	-	-	-	-
Paper Corp.	-	-	36	36	36
Sugar Corp.	-	-	-	336	296
Paranthan Chemical Corp.	-	-	-	-	-
Steel Corp.	-	-	-	-	-
CWE	-	-	-	-	-
CISIR	582	808	1115	1521	1638
State Engi. Corp.	-	-	-	-	-
Irrigation Dept.	568	800	874	930	1000
Lambretta (Cey.)Ltd.	-	-	-	-	54
Telecommunication	-	-	-	-	-
NSC	-	-	-	-	65
AEA	-	-	-	-	-
NERD	-	-	-	-	-
MRI	756	751	760	939	942
BMARI	171	171	179	240	285

(in thousand Rupees)

Institution	Actual expenditure on R & D				
	1966	1967	1968	1969	1970
Occupational Hygiene	-	55	57	61	77
ARTI	-	-	-	-	-
NIM	-	-	-	-	-
Marga	-	-	-	-	-
Central Bank	440	464	481	520	642
University	703	654	605	798	959

(in thousand Rupees)

Institution	Actual Expenditure on R & D				
	1971	1972*	1973	1974	1975
CRI	1657	2358	3296	4014	4024
RRI	2763	3089	3704	3385	5899
TRI	4157	4746	2368	3482	5265
Dept. of Agriculture	5949	7194	6326	6814	7948
Minor Export Crops	-	-	47	483	592
Fisheries Department	313	1418	1097	3106	3079
Forest Department	143	158	140	161	168
Lever Brothers	6	4	379	646	638
Tobacco	20	254	252	263	483
CCC	-	20	84	54	291
Walker Sons Ltd.	-	-	-	55	131
Ceramics Corp.	-	-	141	184	847
Paper Corp.	36	36	56	56	56
Sugar Corp.	284	299	474	762	1412
Paranthan Chemicals Corp.	-	-	29	29	29
Steel Corp.	11	94	108	228	590
CWE	-	-	13	15	15
CISIR	2284	3125	2014	2561	2613

(in thousand Rupees)

Institution	Actual expenditure on R & D				
	1971	1972	1973	1974	1975
State Engineering Corp.	-	-	60	186	220
Irrigation Dept.	1033	1094	1711	1645	2592
Lambretta (Cey.) Ltd.	43	25	24	23	47
Telecommunication	-	-	-	54	31
NSC	87	250	318	288	395
AEA	11	40	40	62	59
NERD	-	-	-	-	232
MRI	1016	1350	711	907	817
BMARI	435	405	356	382	439
Occupational Hygiene	53	110	157	122	190
ARTI	-	245	731	1395	1679
NIM	-	218	325	555	886
MARGA	-	213	769	1841	1010
Central Bank	546	715	878	964	1020
University	1040	1247	1217	1094	1382

* 15 months period

APPENDIX B

LIST OF INSTITUTIONS COVERED BY THE SURVEY

1/	Agricultural Research & Training Institute	ARTI
2/	Agriculture Department	
3/	Atomic Energy Authority of Sri Lanka	AEA
4/	Bandaranaike Memorial Ayurvedic Research Institute	BMARI
5/	British Ceylon Corporation	BCC
6/	Cashew Corporation	
7/	Ceylon Institute of Scientific & Industrial Research	CISIR
8/	Central Bank	
9/	Chemical Industries (Colombo)	CIC
10/	Ceylon Cement Corporation	
11/	Ceylon Ceramics Corporation	
12/	Colombo Campus, University of Sri Lanka	
13/	Ceylon Electricity Board	CEB
14/	Ceylon Government Railway	CGR
15/	Ceylon Plywood Corporation	
16/	Ceylon Transport Board	CTB
17/	Corporative Wholesale Establishment	CWE
18/	Coconut Research Institute	CRI
19/	Coconut Board	
20/	Colombo Commercial Company	
21/	Demographic Research & Training Institute	
22/	Department for Development of Marketing	
23/	Department of Geological Survey	
24/	Division of Occupational Hygiene - Labour Department	
25/	Forest Department	
26/	Fisheries Department	
27/	Government Analyst's Department	
28/	Industrial Development Board	IDB
29/	Irrigation Department	
30/	Jinasena Limited	
31/	Katubedda Campus, University of Sri Lanka	
32/	Lever Brothers Limited	

33/	Lambretta (Cey.)Ltd.	
34/	Marga Institute	
35/	Maharaja Organization	
36/	Minor Export Crops Department	
37/	Milk Board	
38/	Medical Research Institute	
39/	Meteorology Department	
40/	Mineral Sands Corporation	
41/	National Science Council	NSC
42/	National Paper Corporation	NPC
43/	National Textile Corporation	NTC
44/	National Engineering Research & Development Centre	NERD
45/	National Institute of Management	NIM
46/	Oils and Fats Corporation	
47/	Paranthan Chemical Corporation	
48/	Paddy Marketing Board	PMB
49/	Post and Telecommunication Department	
50/	Peradeniya Campus, University of Sri Lanka	
51/	Petroleum Corporation	
52/	Rubber Research Institute	RRI
53/	Research Station, MahaIlluppalama	
54/	Steel Corporation	
55/	State Engineering Corporation	
56/	State Fertilizer Manufacturing Corporation	
57/	State Flour Milling Corporation	
58/	Sericulture Authority	
59/	St. Anthony's Hardware	
60/	Survey Department	
61/	Sugar Corporation - Hingurana, Kantalai and Haldemulla	
62/	Tobacco Company	
63/	Tea Research Institute	TRI
64/	Veterinary Research Institute	
65/	Vidyalankara Campus -University of Sri Lanka	
66/	Vidyodaya Campus - University of Sri Lanka	
67/	Walker & Sons Ltd.	
68/	Water Supply and Drainage Board	

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