

**Characteristics of S&T Manpower Engaged in R&D
Activities in the Institutions under the Socio
Economic Ministries of Central Government**

**Sponsored by
NSTMIS Division
Department of Science & Technology
Government of India**

**Techno Economic Services, New Delhi.
November, 1999.**

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**Part I
(Main Report)**

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ABBREVIATIONS

DA&C	: Department of Agriculture and Cooperation
DAHD	: Department of Animal Husbandry and Dairying
DCP	: Department of Chemicals and Petrochemicals
DOF	: Department of Fertilizers
DCA	: Department of Civil Aviation
MCS	: Ministry of Civil Supplies, Consumer Affairs and Public Distribution
MOC	: Ministry of Coal
MOC _o	: Ministry of Commerce
DOT	: Department of Telecommunication
DOD _e	: Department of Defence
DDPS	: Department of Defence Production and Supplies
MOF _o	: Ministry of Food
MPFI	: Ministry of Food Processing Industries
MHFW	: Ministry of Health and Family Welfare
MHA	: Ministry of Home Affairs
DOC _u	: Department of Culture
DHI	: Department of Heavy Industry
DID	: Department of Industrial Development
DSSI	: Department of Small Scale Industries, Agro and Rural Industries
MI&B	: Ministry of Information and Broadcasting
MOL	: Ministry of Labour
MOM	: Ministry of Mines
MPNG	: Ministry of Petroleum and Natural Gas
DOS _t	: Department of Statistics
MOP	: Ministry of Power
MOR	: Ministry of Railways
MRD	: Ministry of Rural Development
MOS _t	: Ministry of Steel
MST _t	: Ministry of Surface Transport
MOT _x	: Ministry of Textiles
MUD	: Ministry of Urban Development
MWR	: Ministry of Water Resources
MOW	: Ministry of Welfare
S&A	: Salary & Allowances

For definitions, see Annex 1.1

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Part 1

(Main Report)

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Foreword

The National Science and Technology Management Information System (NSTMIS) Division under the Department of Science and Technology has been doing pioneering work in providing R&D related Statistics. The present study also undertaken at the behest of NSTMIS is expected to provide reliable information on the Characteristics of S&T Manpower engaged in R&D activities in the Institutions and Public Sector/ Joint Sector Undertakings under the ambit of Central Socio-economic Ministries/ Departments. This information is of vital importance to plan scientific research by the Socio-economic Ministries/Departments, as there has been virtual void in the availability of reliable data in this segment of R&D activities.

Vital data were collected on the demographic profiles of the scientists, their employment records, allocation of their time for various research activities, problems faced by them in carrying out as well on some qualitative indicators of their scientific work. A large number of scientists responded to the TES's information seeking exercise.

The data were collected to provide detailed analysis of R&D manpower in relation to the utilization patterns, availability of professional and innovative skill, qualifications, specialization and matching of skills warranted for the jobs. Other parameters such as R&D output in terms of patents obtained/ filed, publications of scientists expenditure and funding of research and development activities in the institutions and undertakings under the purview of the Central Socio- economic Ministries were also covered by the study.

The first to be acknowledged is Sh. Rakesh Chetal, Director, NSTMIS, for the concept, initiation of the project and expert advice. We sincerely thank him for his contribution to the project. Thanks are also due to Dr. G. J. Samathanam, Sh. Parveen Arora and Dr. A. N. Rai for their cooperation and help.

This study was possible only through massive support from various Central Socio – economic Ministries/ Departments and their subordinate research institutes under operation within the country. Our sincere thanks are to all those coordinators from different Ministries/departments who participated in this project.

We express our gratitude to all the institutions and scientists who extended their wholehearted support through provision of information solicited in the filled – in questionnaires.

We thank our field staff who was never disheartened whenever they were faced with a non- cooperative attitude either at the institutional or individual scientist's level. We thank our colleagues at TES for their constant help and advice. Their suggestions have been of great help in successful completion of this project.

We appreciate the endeavour of NSTMIS division of DST for commissioning this study and related investigators for the successful completion of the project work. We hope that the project report would be useful to academicians, planners, policy makers, scientists and technologists and other interested individuals and institutions.

The project report is submitted in two portions – one dedicated exclusively to the coverage of INSTITUTIONS and the other to PUBLIC/JOINT SECTOR UNDERTAKINGS

(G.D.Kalra)
Director
Techno Economic Services

November . 1999

Executive Summary

The institutions under the Central Socio- economic Ministries/ Departments have a well-developed multi- dimensional Scientific and Technical (S&T) infrastructure spread across the country and fairly large number of R&D personnel. Another important sub-set

of S&T activities is the Research and Development (R&D) which employs a large proportion of highly qualified persons in creative work and thus acts as a prime mover of in- house S&T development under the jurisdiction of the Socio- economic Ministries/ Departments.

The Techno Economic Services (TES) undertook this study on the behest of Department of Science & Technology to fabricate a systematic DATABASE on the scientific manpower engaged in R&D activities in the institutions under study. Through an appropriately framed DATABASE, it is easier to answer various questions relating to:

- Utilization pattern of R&D personnel
- Professional and innovative skills available ,
- Problems of qualitative mismatch in specific discipline(s) ,
- Quality of motivation etc.

The DATABASE can also help to solve the problems of existing anomalies through proper planning of future intake of S&T manpower.

The data analyzed and processed in the report are based on the extensive fieldwork conducted by TES. This covered 117 institutions and 2,455 R&D personnel of category B responded. The response rate to this massive data seeking exercise through three sets of questionnaires viz. Listing Sheets, Questionnaire for Scientists of category B and above, Institutional Questionnaire is summarized below:

	Listing Sheets	Scientist Schedules	Institutional Schedules
1. Response received from Institutions	92	117	92
2. Percentage of Institutions covered	61.33	74.11	61.33
3. Response received from R&D personnel	3025	2455	
4. Percentage of total scientists listed		81.15	

Because of the commendable response, the data received through the Institutional Questionnaire and Scientist schedule constitute the core of the database. The data available from the filled- in listing sheets have been used as a cross- check.

Demographic Profile:

The demographic profile of scientists employed in the institution has a bearing on the inherent characteristics of the institution. The variations, therefore, also co-exist along with the commonalties of aims and objectives of the institution. On the basis of response received through the Institutional Questionnaires, the over all profile that emerges as under:

1. The female scientists formed about 14 per cent of population of scientists of category B and above. However, in respect of some of the institutions under the Ministry of Health and Family Welfare the percentage of female scientists was as high as 37 per cent.
2. The proportion of the female auxiliary and technical staff was higher i.e. 17.8 per cent and in certain institutions, their presence was about one- third of the total personnel of this category.
3. Age distribution of R&D personnel shows that majority of them (84 per cent) belonged to age segments falling within broader range of 33 to 56 years whereas only 16 per cent were in the age segments falling within the age range of 24 to 33 years.
4. Above 17.6 per cent of the total scientists were above 53 years of age and were likely to retire in the next five years. On an annual basis the institution needed about 100 new scientists per year to compensate for the retiring scientists.
5. Interestingly there were 75 scientists out of 2455 responding scientists (including 10 female scientists) who were involved in R&D activities even after the age of super- annuation (58 years). These were mostly the scientists engaged in research institutions under the Central Ministry of Health and Family welfare.
6. Since the essential and desirable qualifications for male and female candidates remain the same, the female scientists with higher qualifications compatible with high standard of research work in Central Institutions, also found direct entry to category B jobs along with their male counterparts. Out of 2455 responding scientists, 1135 (46.2%) got direct recruitment to grade B and above. There are the scientists who were considered academically highly qualified at the time of recruitment.

7. In a scientific pursuit, qualification has over riding influence and priority. Female scientists had an edge over the male counterpart in respect of having acquired higher qualification:

	Male Scientists	Female Scientists
M.Phil.	20.8%	26.86%
Ph.D./D.Sc.	7.32%	10.75%

8. But both the sexes had similarity in respect of minimum entry Qualifications i.e.:

	B.A B.Sc.
Male Scientists	20.14%
Female Scientists	20.95%

9. The area-wise configuration of responding scientists was as under:

Area of Specialization	Number	Per cent
Natural Sciences	641	26
Engineering & Technology	731	30
Medical Sciences	788	32
Agricultural Sciences	96	04
Social Sciences & Humanities	199	08

10. Medical sciences (inclusive of Indian System of Medicines & Homeopathy) dominate the scientific manpower followed by Engineering & Technology.
11. The salary profile does not present a comfortable picture. Ninety five per cent of male scientific manpower is concentrated up to grade 5 while only 5 per cent of the scientists are placed in the grades 6 and above. While in the case of female scientists, the corresponding figure is 87 per cent. There is a negative co-relation between pay scale and number of scientists as expected. As the pay scale rises, the number of scientists on the scale decreases. Also it is observed that the number of female scientists was nil in the higher pay scale. A large number of female scientists in some institutions as high as 95 per cent remained at the lower and middle rungs of pay scales.

Generally, despite having high academic background as many as 63 per cent of the scientists continued to be placed in the initial two grades.

12. In the institutions under the ambit of the Socio- economic Ministries it was observed that the scientists were engaged in research areas primarily linked with areas of qualification. This may probably be assigned to recruitment of scientific manpower in limited number and for the specific research by the institution in areas of R&D activities of specific application. The R&D personnel are invariably attached to the R&D cell of their respective institutions. This explains the overwhelming percentage (97.3) of the manpower to have been gainfully employed in their areas of qualification/ specialization:

Employment Profile:

Seventy per cent of scientists had no involvement in basic research while maximum involvement of the scientists (78.45 per cent) was in the applied research This implies that the research of applied nature had the maximum acceptance and operation. The next in preference (practiced by 61.2 per cent) was the experimental research followed by the other research activities (accounting for 56 per cent of involvement of scientists)

It is also discernible that 81.50 of the scientists were involved in non-research activities in some way or the other; the average duration of involvement during the year, of course, varied within a wide range.

Involvement in different types of research – basic, applied and experimental- depends upon the attitude of scientists, their qualification and inherent attributes of sustainable interest and efforts. On the basis of the response received from the filled- in scientists questionnaires, the weighted average time spent in various categories of research conducted in the institutions under study were as under:

Type of research activities	Weighted average of time spent in various research activities (%)
Basic Research	5
Applied Research	55
Experimental Research	25
Other activities	15

Since applied research provides the output of immediate application, 55 per cent of the time of the scientists was dedicated to applied research. Besides 15 per cent of their time was spent on 'Other activities' essentially related to research. Near the top level, the job content largely comprised functions of a managerial nature involving planning, supervision, control etc. This may lead to an important question whether a person would cease to be an R&D scientist as he approached higher levels. These issues deserve consideration and need to be addressed.

Revenue & Expenditure:

70.25 per cent of the funds came as a grant from the controlling ministries/ departments while 16.12 per cent of the funds were generated internally by the institutions and 4.2 per cent were made available by other ministries/ departments. Thus more than 90 per cent of the funds needed were available by the central government sources. The funds available from the private initiative were dismal 0.25 per cent.

Non-research activities usually encompass S&T management, planning and co-ordination, services like information and documentation, quality assurance/control involving testing, analysis of research output, testing etc. besides administration-cum-management.

It is desired that one-third of the annual expenditure on R&D on an average is dedicated to capital expenditure. The survey also comes out that average share of over all non-recurring expenses was 29.4 percent. The recurring expenses accounted for 70.6 percent of the total expenses.

This left an over all saving of Rs.2,050 lakhs between revenue and expenditure, which was about 4 per cent. Of course, the deficit between the revenue and expenditure in certain institutions was even more than 50 per cent thus leaving the institutions in the syndrome of resource crunch.

Research Projects Handled:

As expected, the number of research projects awarded by the Government accounted for more than 50 per cent of the projects sanctioned and if the projects undertaken at the behest of all the three government agencies viz. Govt., public sector and self-sponsored by the institutions are taken into consideration, their contribution rises to 68.73 per cent. The number of projects financed by the industry exceeded 40 per cent: out of which 26 per cent was the share of private sector.

Research output:

The development of new product/ new process/ new design and their subsequent commercialization is a real test of research-related competence of an institution and relevance of its output.

Thanks to the liberalization of economy in 1991, import substitution engages the lowest priority of research pursuits of an institution (0.3 percent). A very low level of involvement in this sub-segment of research activity amply manifests this. Otherwise once import substitution was the prime area of concern of R&D activities.

The assignments completed constituted about 65 per cent of total jobs assigned to the institutions while projects in progress accounted for 15.5 per cent and assignments transferred constituted the balance 17.5 per cent.

The research assignments related with the development of new products, new process and consultancy services formed the core of scientific base of the institutions. These

three combined together alone accounted for 63.5 per cent of total assignments. Modifications accounted for 14.2 percent of assignments.

Research Output Scientist- wise (in the institutions surveyed):

The research output expected from the scientist at his/her level is governed by a number of factors such as:

- individual scientist's interest and drive ,
- incentives available to him/her from the senior scientists .
- credit and rewards given to him/her for the output ,
- the research atmosphere prevailing in the institution that the scientist is attached with ,
- the proportion of time the scientist is called upon to dedicate to activities other than research.

Left to himself/ herself, the scientist would wish to do his/her best unless restricted by the constraints and limitations discussed in Chapter 9. The difficulties identified at the level of scientists impinge on his/her productivity the most.

Research output by R&D Personnel of Category B and above (Average of the year 1995-96 and 1996-97)

Output	Output per scientist reporting the specified output (in number)
Product/ process developed	1.9 (0.3)
Patents obtained	1.9 (0.019)
Patent applied for	1.75 (0.029)
Awards/merits earned	1.25 (0.094)
Articles published in Indian journals	3.8 (0.74)
Articles published in foreign journals	3.23 (0.55)
Books published	1.56 (0. 14)

Note: the data are derived from the filled- in scientist questionnaires from 2455 scientists of category B and above. The figures in parentheses represent the average of overall response. These are the average figures irrespective of gender.

Details of R&D Activities by the Institutions at National Level:

The seminars and training together engaged nearly two- thirds of the events that took place and 73.75 per cent of the participants were also attracted towards seminars and training.

The expenditure incurred as mentioned above was also commensurate with importance and relevance of events. The per cent share of expenditure on seminars and training was 72.6 per cent -- logically at par with the percentage of the participants.

Constraints Influencing R&D Activities of Institutions:

Ninty-two institutions expressed their opinion about the constraints impinging on research activities. These constraints are - inadequate funds, late receipt of funds, less R&D staff, less supporting staff, poor quality of R&D staff etc. On an average, more than 60 percent of responding units expressed that these constraints did not have any effect on the outcome of research output.

The existence of vacant post does interfere with the output efficiency of a research institution. The most conspicuous presence of vacant posts as revealed through the survey work was in the institutions under the perview of Department of Health, Department of Indian System of Medicine and Homeopathy, Department of Industrial Policy and Promotion, Ministry of Information and Broadcasting, Ministry of Home Affairs etc.

The vacant posts do exists in other institutions as well but these are usually limited to below 2 percent level of the total posts.

Work Culture, Job Satisfaction, Problems and Prospects:

The satisfactory work culture provides the much needed fillip to R&D output and maintains an atmosphere of mutual cooperation. The work culture is defined by a set of parameters such as area of work, present project, work atmosphere, support from the lower staff and encouragement from the seniors. The levels of satisfaction derived from all the four constituents of work culture add upto the composite work culture. This hovered within a range of 80 to 90 percent during the field work.

The job satisfaction was found to be between 82 to 87.5 percent depending upon the grade of the scientist. The highest job satisfaction was reported at grade 8.

Suggestions of Scientists:

Only 1117 scientists i.e.,45.5 percent of the response came forward with suggestions for betterment of research output at the level of scientists and ultimately the productivity of the institution. Their suggestions may be grouped into nine broad catagories and the number of suggestions ranged between 141 to 559 for each of the category. The suggestions are multiple in nature.

CHAPTER 1

INTRODUCTION

Science and Technology Institutions under the Central Government are grouped as:

- R&D organizations under Major Scientific Agencies i.e. organizations which have R&D or promotion of S&T as their predominant activity.
- R&D organizations under the Central Socio Economic Ministries/Departments which undertake R&D work occasionally in connection with their day-to-day problems or have one or more than one departments dedicated to R&D work on regular basis.
- In-house R&D units of Public/Joint Sector Undertakings under the Central Socio Economic Ministries.

The present study is related with the last two components of government intervention in R&D.

The role of the Government in the context of present economic liberalization:

The reduction of the discretionary role of the government is an important component of the public policy- making in economies across the world both developed and the developing. The more explicit articulation of this policy is to be seen in the policy with respect to privatization and de-regulation. A less virulent but nevertheless important part of this policy package is the conspicuous reduction of government intervention in all matters of economic activities. However there are some areas where such interventions or such support can not be wished away or even is *sine quo non*. Even the more virulent supporters of economic liberalization, such as the World Bank, have no hesitation in agreeing that certain activities like education and health can not be left entirely with the market as these are typically the areas where known market failures are significantly greater than government failures. To this list (which seems to be ever burgeoning) is added the area of Industrial R&D.

In the past 50 years among the handful of economies that have come long way towards closing the knowledge gap with global technological leaders, government was active in several including Japan, Korea and Taiwan. Korea which followed interventionist and nationalist route keeping Foreign Direct Investment (FDI) to a minimum and relying on other modes of technology transfer and concerted domestic technological efforts.

The government has, therefore, to play an important role in terms of increasing investment in R&D. This role has to be interpreted as initiating a set of policy instrument and institutions which will aid the private sector to overcome the problem of appropriability of research output and consequent possibilities of under-investment and it will be different for basic research, applied research and development research.

As far as basic research is concerned recent event and discussions have clearly shown that that there is no other alternative but for the government to shoulder this in its entirety. The investment in basic research is comparatively riskier.

Table 1.1

**R&D EXPENDIDURE BY TYPE OF WORK BY THE GOVERNMENT
(Central & State) –Rs. Crores**

Year	Basic Research	Applied Research	Experimental/ Development Research	Other Related S&T Activities	Total
1992-93	755.30	1635.80	1263.31	615.79	4270.20
1993-94	932.89	2014.46	1600.32	615.20	5162.87
1994-95	1028.88	2210.56	1776.68	676.58	5692.70

As far as applied and development research are concerned, government can put in place a variety of instruments through which its actual conduct in the private sector is strengthened. These instrument consist of tax incentive to private sector to do more R&D, provision of adequate quantities of venture capital, financial aid in the organization and maintenance of technical standards, administration of sharply focussed partnership program in areas of high – technology and strengthening of higher education sector.

Given the recent growth performance and growth potential, it is no longer meaningful to treat all developing countries as a homogenous bunch. The countries of East Asia, India and China and some of the Latin American countries have relatively more advanced national system of innovation. However even in this select group, with the exception of Korea and Taiwan, most of the countries do not have very clearly articulated instrument s and institutions embodying their respective governments' forays into technology policies. A classic example is that of India where more than one half of the civilian industrial R&D is done by the private sector.

Table 1.2

**INDUSTRIAL R&D EXPENDITURE
(Rs. Crore)**

Year	Expenditure (Rs.Crores)		R&D Expenditure as % of sales turnover (%)	
	Public Sector	Private Sector	Public Sector	Private Sector
1992-93	513.95	651.32	0.44	0.67
1993-94	542.81	794.32	0.44	0.71
1994-95	685.33	902.53	0.50	0.70

Source: DST, Research and Development Statistics

But whether the Indian government has a technology policy worth the name (notwithstanding the existence of so- called Technology Policy Standards) is a moot point. Singapore is usually regarded as a free market economy, but from 1991

onwards, the government of that country has been busy putting in place a very sharply focused technology policy. It is not that easy to wish away a role for the government with respect to the organization and conduct of Industrial R&D.

Need for the Study:

S&T Plan Outlays under Socio-Economic Ministries/Departments increased more than two folds during the 7th Plan and 8th Plan Periods:

S & T Plan Outlay under Socio-Economic Ministries (Rs.Crores)			
7 th Plan (1985-1990)		8 th Plan (1992-1997)	
Outlays	Actuals	Outlays	Actuals
1953.49	2408.14	5080.97	5501.16

Availability of comprehensive data in respect of demographic profile of current manpower engaged in R&D activities in the S&T institutions under the Socio-Economic Ministries/Departments and an in-depth analysis of their productivity is of importance for planning of research activities in the short term and long term in this sector. It enables identification of the trends, gaps and possible upgradations that may be warranted. Unfortunately, such manpower-related data are still grossly inadequate. The present work is an attempt in the direction of bridging this gap. In order to realize this goal, the present project was formulated with the following objectives.

Objectives of the Study:

1. To conduct a census of R&D personnel engaged in S&T activities in all the Socio Economic Ministries.
2. To prepare a profile on the various characteristics of R&D manpower in the Socio-Economic Ministries such as:
 - Age
 - Sex
 - Qualifications
 - Pay Scales
 - Level of annual income
 - Employment records
 - Type of work engaged in whether basic research or applied research or experimental research
 - Fields of specialisation
 - Stages of research activity
 - Research output
3. To compare selected aspects of auxiliary and administrative staff such as numerical strength, amount of expenditure etc. with that of R&D staff.
4. To analyze other relevant qualitative information such as problems faced by the research institutions as well as individual researchers in carrying out the envisaged activities.

5. To integrate the findings of the census of S&T staff in the Socio-Economic Ministries with the data already available in respect of other sectors and prepare a comprehensive document on workforce in all S&T activities in the country.

Utility of the Study:

The data presented in the study were obtained from 117 institutions under the Central Socio-Economic Ministries/Departments. The study provides information on the above mentioned activities of 117 institutions which is useful for R&D statistics and growth indicators needed for scientific R&D statistics in general and planning of captive research institutions under the jurisdiction of Socio-Economic Ministries.

The resources deployed in R&D activities in these institutions have direct impact on the technical upgradation of the overall operational activities of the institutions. The S&T institutions under the Socio- Economic Ministries constitute the second largest network of scientific manpower that are directly involved in the transfer of innovations and development in the entire gamut of science and technology. Thus this database will be useful in identifying the organizational resources vis-à-vis the scientific achievements.

Some pragmatic uses and applications of the database are:

- Preparation of a comprehensive information directory on R&D activities of the Central Socio-Economic Ministries.
- Identification of needs in terms of academic and research activities.
- Activities related to the specific R&D needs of the Ministry/ Department.
- Resource allocation to various activities and their comparative shares.
- Relative comparison of different Central Ministries/ departments and also the different subordinate departments within a Ministry in terms of the availability of various resources.
- Manpower planning.
- Women participation in R&D activities and their relative status in scientific hierarchy of the institution.
- Placement information.

The project provides a unified information system to all the Central Ministries/ Departments. The information is multi-faceted and obtained as brief as possible in self- coded formats to facilitate computerization. The detailed data on manpower, academic, R&D activities and financial allocations of Central Socio-Economic Ministries/ Departments are presented in the chapters to follow.

Basic Definitions:

In the presentation of analysis of data in the report, certain concepts and terms have been used. These are furnished in Annex 1.1. Most of the definitions have been standardized, used and published by OECD and UNESCO.

CHAPTER 2

METHODOLOGY AND COVERAGE

METHODOLOGY

The methodology for the systematic execution of the study warranted sequencing of a number of steps, which were dovetailed. The details are as follows:

- A list of all the major Central Socio-Economic Ministries/Departments and their subordinate offices was prepared from The Directory of R&D Institutions, 1994, assembled by the Department of Science and Technology (DST). There are 150 institutions under the ambit of the Central Socio-Economic Ministries/Departments reportedly engaged in S&T activities.
- Identification of data needs of the project, design of questionnaires and their finalization in consultation with PAC and officers of NSTMIS Division of DST, testing and printing of Schedules.
- Approaching the Central Socio-Economic Ministries at Delhi for their co-operation in such a massive information seeking exercise from their subordinate offices spread throughout the length and breadth of the country.
- Mailing of questionnaires to the subordinate offices as and when the letters from the respective controlling ministries were received authorizing the subordinate offices to part with the information sought from them in the pre-designed set of questionnaires.
- Orientation training to the field staff and supervisory officers who were to canvass the questionnaires through personal contact with institutions and scientific manpower of categories B and above.
- Collection of data from the institution head office through questionnaires and personal data from the individual scientist of category B and above through questionnaires.
- Data editing, codification, entry, verification for internal consistency and analysis.
- Formulation of tabulation programme and preparation of dummy tables.
- Software development for tabulation programme and taking out the tables.
- Analysis and preparation of report.

Soliciting Collaboration of Central Socio-Economic Ministries and their Subordinate Offices:

All the Central Socio-Economic Ministries stationed in New Delhi were approached individually on the strength of a general introductory letter issued by the Director, NSTMIS, DST dated 23.4.1997. The copy of the letter is enclosed as Annex 2.1

Letter was sent to the ministries by TES incorporating the rationale, objectives, scope and need for undertaking the study. The letter was accompanied with the copy of the above mentioned introductory letter of DST and a set of questionnaires designed for canvassing with their subordinate offices. A copy of the letter addressed to the ministries is enclosed as Annex 2.2

Preparation of questionnaires:

Three sets of questionnaires were designed, one for each of the levels:

- At the institutional level: The schedule sought information on manpower employed, research activities, outputs, financial data etc.
- At the R&D scientist's level: The R&D Personnel Schedule and the Listing Sheet for R&D Scientists were designed. Both these schedules incorporated personal and professional information relating to the respondents, including the particulars of their career, job status, etc

The copies of the questionnaires are appended as Annex 2.3, Annex 2.4 & Annex 2.5.

Pre-testing of questionnaires:

Before finalizing the questionnaires, the pre-testing of three schedules was carried out among sample of scientists drawn at random from two different heterogeneous institutions in and around Delhi. The specific problems encountered by the survey teams of TES during pre-testing were accorded due weightage before the questionnaires were passed on for printing.

Mailing of questionnaires:

As a prelude to the initiation of the fieldwork, questionnaires were mailed to the heads of all the 150 institutions under the jurisdiction of all the Socio-economic Ministries. The letter from the concerned ministry, introductory letter from the DST referred to above and a set of questionnaires fortified the TES request for co-operation.

Field Work

During the initial stages of fieldwork, officers of TES accompanied the field investigators to institutions for introductory discussion with the heads of the institutions. A number of follow-up visits to the individual institutions and the scientists therein were made to collect the information from the scientists of category B and above and the concerned institutions.

Problems faced in the fieldwork

The problems faced in the field work and the consequent delays in the execution of job are furnished in Appendix 2.8.

Coverage:

In spite of all these difficulties, overall response to this massive information seeking exercise has been quite encouraging:

Table 2.1

Response from the Institutions under the Central Socio- economic Ministries/ Departments

Number of institutions *	Number of Institutions covered	Percent Coverage	Number of Scientists Listed	Number of Scientists Covered	Percent Coverage
150	117	78.0 %	3025	2455	81.15 %

Details of institutions covered are furnished in Annex 2.9 and codes used for Annexures are furnished in Annex 2.10 to 2.13.

* Institutions as listed in Directory of R&D Institutions, 1994, DST

Chapter 3

Demographic Profile

The demographic profile of R&D manpower employed in research activities in institutions under the ambit of Central Socio-Economic Ministries is a function of a number of factors such as the historical background of individual institution, field of R&D work that the institution has been engaged in the past and further addition that it has made during its journey till date, outdoor field operations linked with research activities carried out by scientists of the institutions and predominance of discipline (s) of research areas which did not attract female students to opt for study.

The academic spectrum of the scientists employed in an institution is a reflection of vintage of the institution, and availability of scientists of the desired academic caliber at different stages of growth of the institution, levels of brain drain and the talent the institution has been able to attract from abroad and whether the areas in which the institution is conducting research have universal applicability and are relevant to problems faced by the industry at present.

In the light of the factors discussed above, demographic characteristics of R&D manpower in different institutions under different Socio-Economic Ministries are not comparable. Each of the institutions deserves to be looked at separately. The aggregation, if attempted, may just present the census of R&D manpower, but may fail to bring on the surface the inherent characteristics of each of the institutions. The institutions under the same ministries/departments have been clubbed together for analysis purposes taking into consideration what-so-ever the elements of commonality that exist between the institutions under the purview of the same ministry/ department.

Under manpower planning, taking stock of R&D personnel engaged in various fields vis-a-vis their qualifications and their competence becomes essential component of the exercise. It brings out the nature of deployment of manpower as against the requirements of qualification initially envisaged and the change it has already undergone over the years of its existence with respect to the accumulated availability of talent as against their requirements. This could bring on the surface the extent of mismatch, if any, that exists with respect to the scientists working in fields compatible with their academic specialization (subject of specialization). Accordingly, the planners and policy makers related with Socio-Academic Ministries/Departments can take appropriate measures to narrow down such differences in availability and requirements of scientists in various skills/ disciplines.

The mismatch, usually, manifests in two forms:

- Where the scientists work in an area which is outside their academic specialization (subject or qualification). This imbalance may arise because of shortage of scientists with the requisite qualification needed for that particular area of work. This reflects

a real shortage of qualified personnel in that particular field/ discipline.

- Where the availability of scientists with a particular academic specialization is much more than required by the profession but not utilized fully; instead it is utilized in some areas. This only reveals the problem of placement or in other words a mismatch, which needs to be tackled accordingly.

The salient outcome of the data has been presented in the paragraphs to follow while the institution wise sets of figures are appended as Annex. 3.1.¹

The Department of Agriculture & Co-operation (3 institutions)

The department has highly male dominated three research institutions under its ambit. The female scientists are only 6 per cent and that too at grade 1 level:

Scientists			
	Male	Female	Total
Grade 1	22	2	24
Grade 2	7	0	7
Grade 3	2	0	2
Total	31	2	33

5 administrative staff and 2 non-R&D officers provided administrative support to all the three institutions.

The Department of Animal Husbandry & Dairying (19 institutions)

The institutions under the purview of the department are stated to practice a field level scientific research. The institutions can be broadly classified as under:

- Cattle breeding farm
- Poultry breeding farm
- Station for forage production & demonstration
- Animal feed analytical laboratory etc.

The institutions are usually located in far off rural areas and manned by veterinary scientists. There is an overall dominance of male scientists because the females prefer not to opt for veterinary sciences:

¹ The main tables related with this chapter are furnished in Annex.3.1 of the report. The numbers and percentages stated in this chapter are meant only to substantiate the observations. Hence the percentages may not necessarily add up to hundred.

Scientists			
	Male	Female	Total
Grade 1	29	0	29
Grade 2	8	0	8
Grade 3	10	0	10
Grade 4	3	0	3
Total	50	0	50

Nearly 60 % of the scientific manpower is at the initial grade 1, while only 6 % of the scientists employed have graduated to grade 4.

Female have made their mark in auxiliary scientific staff and administration related with research in all the 19 institutions:

	Male	Female	Total
Auxiliary & Technical Staff	284	17	301
	94.4%	5.6 %	
Research-linked Administration	692	35	727
	95.0%	5%	

In each of the institutions there is an administrative set up dedicated exclusively to the general administration and revenue earning of the research activities of the institutions. The aggregate strength of the general administrative set up is 332 (12 females).

The overall distribution of manpower in research set up in all 19 institutions covered works out to be:

	Percent
R&D Personnel of Category B & above	4.6
Auxiliary & Technical Staff	28.0
Research Linked Administration	67.4

Department of Chemicals & Petrochemicals (one unit)

(Central Institute of Plastics Engineering & Technology, Chennai)

The Institute does not have any female researcher on its roll. There is an equitable distribution of scientists of Grade 1 and Grade 2 while there is one scientist in each of the Grade 3 and Grade 4:

Scientists			
	Male	Female	Total
Grade 1	2	0	2
Grade 2	2	0	2
Grade 3	1	0	1
Grade 4	1	0	1

Ministry of Civil Supplies, Consumers Affairs and Public Distribution

A. Bureau of Indian Standards (BIS)

BIS has a fair mix of researchers of both the genders but the shares of all grades are highly skewed in favor of male scientists:

Scientists			
	Male	Female	Total
Grade 1	44	9	53
	83.0%	17.0%	
Grade 2	105	9	114
	92.1%	7.9%	
Grade 3	129	4	133
	97.0%	3.0%	
Grade 4	106	9	125
	92.8%	7.2%	
Grade 5	49	0	49
Grade 6	6	0	6

The maximum that female scientists have reached is up to the Grade 4 only while their maximum concentration (17%) is restricted to Grade 1 level.

In the auxiliary staff and administrative staff linked with research activities, the females have better representation. This brings out that the female researchers are preferred as constituents of auxiliary and administrative assistants needed for research activities:

	Male	Female	Total
Auxiliary & Technical Staff	179	13	192
	93.2%	6.8%	
Research linked administration	1137	356	1493
	76.15%	23.85%	

The ratio of researchers of Grade B and above to auxiliary staff and administrative staff works out as:

	Number	Percent
Researchers of Category B and above	480	22.0
Auxiliary & Tech. Staff	192	9.0
Research Linked Administrative Staff	2165	69.0

There is curiously a high incidence of non- R&D officers of category B and above. While the highest grade of the post i.e. Grade 8 is in the non- R&D section of the organization and the head of BIS occupies that position:

Non R & D			
	Male	Female	Total
Grade 1	20	3	23
	86.95%	13.05%	
Grade 2	19	9	28
	68.0%	32.0%	
Grade 3	22	0	22
Grade 4	11	0	11
Grade 5	11	0	11
Grade 6	1	0	1
Grade 7	0	0	0
Grade 8	1	0	1

B. Indian Grain Storage, Management & Research Institute (4 Units)

The level of research is restricted at lower grades of employment while female researchers have found no avenues for themselves in these organizations:

R & D Manpower of Category and above			
	Male	Female	Total
Grade 1	18	0	18
Grade 2	13	0	13
Grade 3	1	0	1

Though of very limited nature, there is involvement of female researchers at auxiliary and research linked administration

	Male	Female	Total
Auxiliary & Technical Staff	134	2	136
Research Linked Administration	82	2	84

There is thus over dependence on auxiliary staff for research output:

	Number	Percent
R&D Staff of Grade B and above	26	12.4
Auxiliary & Tech. Staff	107	51.2
Research Linked administration	76	36.4

Ministry of Commerce (4 units-3 Plantation Research units and one packaging research unit)

The Ministry has fair representation of female R&D personnel both at the plantation research unit and packaging research units:

R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	65	26	91
Grade 2	33	6	39
Grade 3	7	1	8
Grade 4	6	0	6
Grade 5	1	0	1
Grade 6	0	0	0
Grade 7	1	0	1
Total	113	33	146
	77.4%	22.6%	

The major concentration of female R&D personnel is in the Grade 1. The placement in this grade alone accounts for 78.8 per cent of total female manpower and 40 per cent of the entire scientists of Grade 1. The involvement of female population is limited up to Grade 3 only.

The number of scientists at higher echelon gets reduced substantially as expected: it tapers off suddenly beyond Grade 4.

Because of the intensive field experiments needed in the plantation research units, the incidence of involvement of auxiliary research staff is of higher level and within that the percentage of female staff is about 20 per cent:

	Number	Percent
Male	185	80
Female	46	20

Practically same share (21%) is retained by the female staff in the area of research linked administration:

	Number	Percent
Male	265	81.5
Female	60	18.5

The share of R&D manpower of different categories thus works out as under:

	Percent
R&D Manpower of Category B & above	20.8
Auxiliary & Tech. Staff	32.9
Research Linked administration	46.3

The officers up to Grade 2 supported by the staff at the lower level manage the non-R&D wing:

Non- R&D Setup			
	Male	Female	Total
Grade 1	2	2	4
Grade 2	2	1	3
Supporting Staff	25	6	31

Department of Health (17 units)

Medical profession has attracted female students since long and in certain states the medical colleges are operated exclusively for education of girl students or seats are earmarked for them in some cases. This ensures the availability of female researchers for medical research in institutes operated under the purview of the Department of Health. The over all share of female researchers in these institutions was 27 percent: of course the percentage share varies at different grades:

R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	108	65	173
	62.43%	37.57%	
Grade 2	41	12	53
	77.36%	22.64%	
Grade 3	112	48	160
	70.0%	30.0%	
Grade 4	82	13	95
	86.32%	13.68%	
Grade 5	119	37	156
	76.28%	23.72%	
Grade 6	72	21	93
	77.42%	22.58%	
Grade 7	6	2	8
	75.0%	25.0%	
Grade 8	0	1	0
	0.0%	100.0%	
Total	540	199	739
	73.1%	26.9%	

The maximum involvement of female R&D personnel is at the initial Grade1 (37.57%). The grade 5 has the next highest concentration. Female scientist occupies the highest grade 8 posting in total conglomerate. The auxiliary research staff and research linked administrative is well dispersed in total research strength of all the medical institutes:

	Male	Female	Total
Auxiliary & Technical Staff	900	190	1090
	82.5%	17.5%	
Research Linked Administration	391	41	432
	90.5%	9.5%	

The share of all the three constituents of research manpower works out as under:

	Percent
R & D Manpower of Category B and above	32.7
Auxiliary & Technical Staff	48.2
Research Linked Administration	19.1

Because of unavoidable involvement of technical staff in medical research activity, the strength of auxiliary staff runs ahead of the R&D manpower of category B and above.

The non-R&D manpower that is mostly involved in general administration and maintenance of research infrastructure has satisfactory representation of female at all the grades of the set up and also at the lower cadres of the administrative staff:

Non R & D Setup			
	Male	Female	Total
Grade 1	36	12	48
Grade 2	52	3	8
Grade 3	3	11	14
Grade 4	3	4	7
Total	47	30	77
	61.0%	39.0%	
Adm. Staff	1156	720	1876
	61.6%	38.4%	

Department of Family Welfare (one unit)

The only institute, which represents the department, is all India Institute of Physical Medicines and Rehabilitation, Mumbai. The research conducted by a team of seven R&D persons of category B and above is substantially reinforced by the support of auxiliary staff:

R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	1	1	2
Grade 2	1	0	1
Grade 3	0	0	0
Grade 4	2	0	2
Grade 5	1	0	1
Grade 6	1	0	1
Total	6	1	7
	85.7%	14.3%	
Auxiliary & Tech. Staff	24	15	39
	61.5%	38.5%	

Female officer of Grade 6 heads the non- R&D outfit of the organization. The mouth to tail ratio appears to have tilted heavily in favor of tail. The ratio works out to be approximately 1 to 5:

Non R & D Manpower		
Male	Female	Total
170	48	218
78.0%	22.0%	

Department of Indian System of Medicines and Homeopathy (9 Units)

Nearly 15 per cent of Scientists of category B and above are from feminine gender. Bulk of their concentration (90%) is at Grade 1. The total manpower is confined within placement at first four grades:

R & D Manpower of Category B & above			
	Male	Female	Total
Grade 1	267	55	322
	83.0%	17.0%	
Grade 2	61	5	66
Grade 3	12	1	13
Grade 4	5	0	5
Total	345	61	406
	85.0%	15.0%	

As in other departments of Ministry of Health, the auxiliary staff and research linked administrative set up have their contribution to make:

	Male	Female	Total
Auxiliary & Technical Staff	250	55	305
	82.0%	18.0%	
Research Linked Administration	558	11	569
	98.0%	2.0%	

R&D researchers of category B and above, of course, corner the substantial share of total manpower engaged in research activity:

	Percent Share
R&D Manpower of Category B & above	31.7%
Auxiliary & Tech. Staff	23.8%
Research Linked Administration	44.5%

The administrative staff at the lower cadres substantially strengthens the non-R&D set up:

Non-R&D Setup			
	Male	Female	Total
Grade 1	2	0	2
Grade 2	1	0	1
Grade 3	3	1	4
Total	6	1	7
	85.7%	14.3%	
Supporting Staff	327	15	342
	95.6%	4.4%	

Ministry of Home Affairs (6 units)

All the six research institutions are engaged in criminological sciences and were heavily skewed in favor of male scientists while the female officers were limited to only 5.6%:

R & D Manpower of Category B & above			
	Male	Female	Total
Grade 1	26	0	26
Grade 2	27	3	30
Grade 3	8	1	9
Grade 4	5	0	5
Grade 5	1	0	1
Total	67	4	71
	94.4%	5.6%	

But female scientists are conspicuous by their presence in the auxiliary and technical staff and research – linked administrative set- up:

	Male	Female	Total
Auxiliary & Technical Staff	103	23	126
	81.75%	18.25%	
Research Linked Administration	158	20	178
	88.75%	11.25%	

In each of the institutions, there is a non- R&D cell headed by an officer of grade 2 and supported by the staff at the lower levels:

	Male	Female	Total
	99	9	108
	91.6%	8.4%	

Department of Culture (2 units)

In the institutions related with the research linked with cultural activities, the contribution of female scientists was 7% and their presence was restricted to first two grades of R&D manpower:

	Male	Female	Total
Grade 1	90	15	105
Grade 2	10	3	13
Grade 3	6	0	6
Grade 4	1	0	1
Grade 5	0	0	0
Grade 6	1	0	1
Total	108	18	126
	85.7%	14.3%	

But the contribution of female scientists was of the level of one third in Auxiliary & Technical Services:

	Male	Female	Total
Auxiliary & Technical Staff	63	31	94
	67.7%	32.3%	

The non-R&D set-up is manned by the officers of category lower than B and their over all strength exceeds the population of scientific staff in both the institutions under the Ministry:

Male	Female	Total
183	48	231
79.2%	20.8%	

Department of Industrial Development (2 units):

Female scientists of category B and above form only 5 % of the total population of scientists of that category. The overall level upto which the scientists are promoted is restricted to grade 6 only:

R&D Manpower of Category B and above			
	Male	Female	Total
Grade 1	41	3	44
Grade 2	66	4	70
Grade 3	17	0	17
Grade 4	8	0	8
Grade 5	8	1	9
Grade 6	3	0	3
Total	143	8	151
	94.7%	5.3%	

Except in research linked administration, the presence of female scientists remains below 5 %:

	Male	Female	Total
Auxiliary & Technical Staff	107	4	111
	96.4%	3.6%	
Research Linked Administration	48	11	59
	81.35%	18.65%	

In both the institutions, the officer supported by the staff at the lower cadres heads the non-R&D set- up.

	Male	Female	Total
Grade 1	1	-	1
Grade 2	1	-	1
Supporting Staff	42	-	42

Department of Industrial Policy & Promotion (One unit)

The institution has heavy concentration of scientists up to grades 4 and after that as expected the number of scientists is thinned in conformity with the formation of pyramid. The presence of female scientists in this category is below 5% only:

R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	23	1	24
Grade 2	42	3	45
Grade 3	23	1	24
Grade 4	20	0	20
Grade 5	4	0	4
Grade 6	1	0	1
Total	113	5	118
	95.7%	4.3%	

The institution has also got a substantial support of auxiliary and technical staff and research linked administrative linkage:

	Male	Female	Total
Auxiliary & Technical Staff	70	5	75
	93.34%	6.66%	
Research Linked Administration	50	10	60
	83.33%	16.67%	

The ratios of components of research manpower works out as under:

	Relative Composition of Research Manpower
R & D Manpower of Category B and above	46.65%
Auxiliary Staff & Technical Manpower	29.65%
Research Linked Administration	23.70%

The non- R&D set up is headed by officers of category B and above and manned by supporting staff at lower rungs:

Non R & D Manpower			
	Male	Female	Total
Grade 1	2	1	3
Grade 2	3	1	4
Grade 3	3	0	3
Grade 4	2	0	2
Total	10	2	12
	83.3%	16.7%	
Supporting Staff	133	15	148
	89.9%	10.1%	

Department of Small Scale, Agro and Rural Industries (3 units)

All the three units have low level of research activities with the result that the presence of R&D personnel of category B and above was of a limited extent. As a corollary, the other research staff had an over-riding prevalence in these units:

R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	2	1	3
Grade 2	1	0	1
Grade 3	1	0	1
Grade 4	2	0	2
Total	6	1	7
	85.7%	14.3%	
Auxiliary & Technical Staff	198	17	209
	92.1%	7.9%	
Research Linked Administration	44	17	61
	72.1%	27.9%	

The presence of female auxiliary staff was of the order of 8 per cent but it increased to 28% amongst the research – linked administrative assistance. The ratio gets highly tilted in favor of auxiliary and technical staff in the over all research manpower available in all three institutions:

	Percent
R & D Manpower of Category B & above	2.5
Auxiliary & Technical Staff	75.5
Research Linked Administration	22.0

Only 8 staff members carry out the non-R&D activities in all the 3 institutions

Ministry of Information & Broadcasting (one unit)

The single institution under reference represents the Research Department of All India Radio. This has a high level of incidence of auxiliary and technical staff who is supposedly engaged in field trials of research outputs of the institution:

R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	10	1	11
Grade 2	21	0	21
Grade 3	2	0	2
Grade 4	3	1	4
Total	36	2	38
	94.7%	5.3%	
Auxiliary & Technical Staff	44	10	54
	81.5%	18.5%	
Research Linked Administration	14	6	20
	70.0%	30.0%	

The interest in electronic engineering by female scientists is a recent phenomenon and this explain their low level of involvement (5%) in research activities of category B and above but their presence (18%) in the auxiliary and technical staff is laudable because of their having acquired the needed skill. The ratio of auxiliary and technical staff in the entire scientist manpower works out to be 48 %:

	Percent
R & D Manpower of Category B and above	34.0
Auxiliary and Technical Staff	48.0
Research Linked Administration	18.0

A notable characteristics of the unit was the existence of non-R&D set up manned by personnel of higher grades supported by administrative staff:

Non R&D
Grade 1
Grade 2
Grade 3
Grade 4
Grade 5
Total
Administrative Staff

R&D Manpower of Category B and above			
	Male	Female	Total
	8	0	8
	6	0	6
	2	0	2
	4	0	4
	1	0	1
	21	0	21
	100.0%	0.0%	
Administrative Staff	81	18	99
	81.8%	18.2%	

hour (one unit)

of the Office of the Director General of Mines Safety is the research wing is manned

by the R&D manpower concentrated at

R&D Manpower	
Grade 1	
Grade 2	
Grade 3	
Grade 4	
Grade 5	
Grade 6	
Total	

Manpower of Category B and above			
	Male	Female	Total
	3	0	3
	13	0	13
	0	0	0
	1	0	1
	18	0	18
	1	0	1
Total	36	0	36

power engaged in the research wing had Mining Engineering as the main discipline and female students are not allowed to join the course and this results in the absence of female R&D manpower of category B and above applicable to auxiliary and technical staff as well:

research wing had Mining Engineering as the main discipline and female students are not allowed to join the course and this results in the absence of female R&D manpower of category B and above applicable to auxiliary and technical staff as well:

Auxiliary & Technical Staff
Research Link Administration

	Male	Female	Total
Technical	18	0	18
Link Administration	14	2	16

be constituents of R&D

R&D wing of the institution works out to be

	Percent
R&D Manpower of Category B and above	51.5
Auxiliary & Technical Staff	25.7
Research Link Administration	22.8

Since non-R&D functions of the organization i.e. statutory inspection of mines for safety and other related aspects constitutes the core of the functions of the institute, the non- R&D wing of the institute dwarfs the R&D wing of the Institution.

Non-R & D Wing of the Institution			
	Male	Female	Total
Grade 1	99	0	99
Grade 2	84	0	84
Grade 3	0	0	0
Grade 4	76	0	76
Grade 5	21	0	21
Grade 6	0	0	0
Grade 7	1	0	1
Administrative Staff	198	26	224
	88.4%	11.6%	

Ministry of Power (One Unit):

The Central Power Research Institute is the unit under consideration. About 10 per cent of the R&D manpower of category B and above were feminine actively engaged in research investigations:

R&D Manpower of Category B and above			
	Male	Female	Total
Grade 1	52	9	61
Grade 2	74	8	82
Grade 3	28	1	29
Grade 4	16	1	17
Grade 5	7	0	7
Grade 6	1	0	1
Total	178	19	197
	90.4%	9.6%	
Auxiliary & Technical Staff	372	14	386
		3.62%	
Total	550	33	583
	94.3%	5.7%	

The over all percentage share of all the components of in the entire research outfit works out as under:

	Percent
R&D Manpower of Category B & above	16.9
Auxiliary & Technical Staff	33.1
Research Linked Administration	50.0

Staffs of category lower than category B mans the non- R&D outfit:

Non R&D Outfit		
Male	Female	Total
99	56	155
63.87%	36.13%	

Ministry of Surface Transport (2 units):

In both institutions of the Ministry, the R&D manpower of category B and above is limited to the grade 5 and the involvement of female scientists was restricted to only 8 percent:

R&D Manpower of Category B and above			
	Male	Female	Total
Grade 1	13	2	15
Grade 2	9	1	10
Grade 3	6	0	6
Grade 4	4	0	4
Grade 5	2	0	2
Total	34	3	37

The female participation in auxiliary and technical services was also restricted to a little higher than 10 per cent. But in research-linked administration it was as high as 50 per cent:

	Male	Female	Total
Auxiliary and Technical Staff	59	7	66
Research Linked Administration	5	5	10

The comparative share of each of constituents of research activity works out in favor of auxiliary and technical staff:

	Percent
R&D Manpower of Category B & above	32.75
Auxiliary & Technical Staff	58.40
Research Linked Administration	8.85

The non- R&D set-up of these two units was headed by the officer of the level of grade 6 supplemented by the officers at the lower grades:

Non R & D Manpower of Category B and above			
	Male	Female	Total
Grade 1	4	2	6
Grade 2	5	0	5
Grade 3	0	0	0
Grade 4	6	0	6
Grade 5	2	0	2
Grade 6	1	0	1
Total	18	2	20
Administrative Staff	160	6	166

Ministry of Textiles (4 units)

Three of four units under study are sericulture-related research and training institutes. In such establishments, most of the involvement of female researchers was at auxiliary and technical levels:

R&D Manpower of Category B and above			
	Male	Female	Total
Grade 1	52	04	56
Grade 2	19	0	19
Grade 3	8	0	8
Grade 4	3	0	3
Grade 5	0	0	0
Grade 6	0	0	0
Grade 7	1	1	2
Total	83	5	88

Nearly 64 per cent of the manpower of category B and above was at the initial grade 1 while 21.6 per cent only could cross over to grade 2. The involvement of female scientists was of the level of 5.5 per cent.

The incidence of involvement of female scientists enhances 9.4 per cent in auxiliary and technical staff category and further to 24.4 per cent in the research-linked administrative set-up:

	Male	Female	Total
Auxiliary & Technical Staff	328	34	362
	90.6%	9.4%	
Research Linked Administration	31	10	41
	75.6%	24.4%	

Auxiliary and technical staff comprises 73.7 per cent of entire manpower engaged in research activities:

	Percent
R&D Manpower of Category B & above	17.9
Auxiliary & Technical Staff	73.7
Research Linked Administration	8.4

Amongst the non- R&D manpower, females constituted 28 per cent of the staff at the administrative level while they had no representation amongst the personnel of category B and above:

Non-R & D Manpower			
	Male	Female	Total
Grade 1	4	0	4
Grade 2	1	0	1
Administrative Staff	1349	552	1898
	71.0%	29.0%	

Ministry of Urban Development (2 units)

In both the units of the Ministry, involvement of female scientists is nil. The gender is represented at auxiliary & technical level and research linked administrative set-up:

R&D Manpower of Category B and above			
	Male	Female	Total
Grade 1	13	0	13
Grade 2	20	0	20
Grade 3	9	0	9
Grade 4	4	0	4
Grade 5	1	0	1
Grade 6	1	0	1
Total	48	0	48
Auxiliary & Technical Staff	47	16	63
	75.0%	25.0%	
Research Linked Administration	10	2	12
	83.4%	16.6%	

The proportion of the scientific manpower of the different categories weighed in favor of auxiliary and technical:

	Percent
R&D Manpower of Category B & above	39
Auxiliary and Technical Staff	51
Research Linked Administration	10

Administrative staff manned the non-R&D set-up with 24.37% contribution by female supporting staff:

	Male	Female	Total
Non R&D Administrative Setup	90	29	119

Ministry of Water Resources (One unit)

The Soil & Material Research Station, the unit under study was manned by male researchers only with the apex of the pyramid structure having 2 scientists of grade 5:

R&D Manpower of Category B and above			
	Male	Female	Total
Grade 1	28	0	28
Grade 2	15	0	15
Grade 3	0	0	0
Grade 4	16	0	16
Grade 5	2	0	2
Total	61	0	61

But female researchers were conspicuous by their presence both at the auxiliary & technical staff levels and research-linked administration:

	Male	Female	Total
Auxiliary & Technical Staff	70	23	93
	75.3%	24.7%	
Research Linked Administration	99	30	129
	76.75%	23.25%	

The overall composition of the R&D outfit works out as under:

	Percent
R&D Manpower of Category B & Above	21.5
Auxiliary & Technical Staff	32.8
Research Level Administration	45.7

More than 50 per cent of share of involvement in the non-R&D set-up was bagged by male incumbents:

Male	Female	Total
60	62	122
49.2%	50.8%	

Ministry of Welfare (4 units)

The involvement of female scientists comprised 36 percent of total manpower of category B and above engaged in research activity but their presence was confined to grade 1 and grade 2 only. Their share in auxiliary and technical services was more or less of the same order:

R&D Manpower of Category B & Above			
	Male	Female	Total
Grade 1	12	12	24
Grade 2	13	4	17
Grade 3	1	0	1
Grade 4	1	0	1
Grade 5	2	0	2
Total	29	16	45
	64.0%	36.0%	
Auxiliary & Technical Staff	22	9	31
	71.0%	29.0%	
Research Linked Administration	11	3	14
	78.6%	21.4%	

The composition of over all R&D set up comprised of:

	Percent
R&D Manpower of Category B & Above	51.0
Auxiliary & Tech. Staff	33.0
Research Linked Administration	16.0

But the strength of non-R&D set up was over 4 folds the size of the R&D outfit comprising of mostly the administrative staff:

Non-R&D Establishment			
	Male	Female	Total
Grade 2	1	0	1
Grade 4	1	0	1
Supporting Staff	252	100	352
	71.6%	28.4%	

Ministry of Food Processing (One unit)

Paddy Processing research Institute Thanjavur is the only research institute under the Ministry. It had the R&D set up with nil non-R&D component. It had only male dominated research pursuits supported by female researchers as a part of auxiliary and technical staff:

R&D Manpower	
Grade 1	
Grade 2	
Grade 3	
Grade 4	
Supporting Staff	

Personnel of Category B & Above		
Male	Female	Total
0	0	0
1	0	1
3	0	3
1	0	1
5	0	5

S & T Manpower of Responding Institutions:

The total number of category B and above personnel who responded to the institutional questionnaire is 2906. The details are summarized in Table 3.1.

Personnel of Category B and above:

The details of personnel of category B and above listed with the institutions are summarized in Table 3.2.

Table 3.1

Manpower of Category I

Male	Female
918	206
600	58
379	56
290	24
217	38
87	21
8	2
1	1
2500	406

Personnel of Category B and above:

Male	Total	Per cent
1124	1124	38.7
658	658	22.6
435	435	15.0
314	314	10.8
255	255	8.8
108	108	3.7
10	10	0.34
2	2	0.06
2906	2906	100.0

From the above table that:

Male scientists constitute about 39 per cent of the total population of R&D manpower.

The bulk of the female scientists (79 %) were concentrated in first three grades while the figure for the male counterparts was a little lower (76 per cent).

The grade structure of R&D manpower of the typical institution follows the typical hierarchy. It has a wide base of 39 per cent of R&D manpower in grade-1.

Auxiliary Manpower

The personnel engaged primarily in auxiliary activities are invariably S&T manpower available with the institutions. The details are given in Table 3.2.

Female scientists constituted about 14 per cent of the total personnel of category B and above.

The bulk of the female scientists (79 %) were concentrated in the first three grades while the figure for the male counterparts was a little lower (76 per cent).

The grade structure of category B and above follows the typical hierarchy. It has a wide base of 39 per cent of R&D manpower in grade-1.

The personnel engaged primarily in auxiliary activities are invariably S&T manpower available with the institutions. The details are given in Table 3.2.

Table 3.2

Incidence of Auxiliary and Technical Manpower

Auxiliary & Technical Staff	Number	Per cent
Male	3,531	87
Female	533	13
Total	4,064	100

The proportion of female auxiliary and technical staff was comparatively slightly above 13.0 per cent of the total population of such staff engaged in proportion of R&D activities.

Research Linked Administrative Activities:

As seen in the earlier paragraphs, it is established that proportion of R&D and administrative personnel had a wide divergence amongst the institutions surveyed. The persons engaged in administrative activities in various institutions are summarised as under in Table.3.3:

Table 3.3

Personnel Engaged in Administrative Activities

	Number	Per cent
Male	4351	86
Female	699	14
Total	5050	100

The proportionate presence of female in the administration was of equal significance as compared to Auxiliary and Technical services. It was practically of the same level as that of other two departments. The overall comparative picture that emerges is furnished in Table 3.4.

Table 3.4

Comparative Picture of Employment in Institutions

Employment/ Activity	Percentage of R&D Personnel Employed (average of the years 1995-96 &1996-97)
R&D manpower of category B and above	24 %
Auxiliary & Technical Staff	34%
Research Linked Administration	42%

CHAPTER 4

REVENUE AND EXPENDITURE (AVERAGE OF THE YEAR 1995-96 AND 1996-97)

The funds needed for carrying out research activities by the institutions under the Central Socio- economic Ministries flow from six sources viz.:

- Grant from the controlling Ministry/Department .
- Other Ministries/Departments .
- Self-generation .
- International bodies ,
- Private agencies and miscellaneous channels.

The magnitude, frequency and intensity of flow of funds from different sources to a particular institution depend on the marketability of outputs of research activities of the institution and their linkages with the priorities fixed and pursued by the various Central Socio- economic Ministries/Departments. As such there are a number of variations in the intensity of flow of funds to the institutions and these differences have been captured in the ministry/department wise coverage to follow:

Department of Agriculture & Co-operation (three units)

The average annual receipt of funds for research activities of 3 research institutes under the department aggregated to Rs.775 lakhs. The percentage contribution by various agencies had configuration as under:

	Amount (Rs. Lakhs)	Percent
Controlling Department	692	89.40%
Self Generation	46	5.80%
Private Sector	30	3.87%
Others	7	0.93%
Total	775	100.0%

The controlling department financed nearly 90 per cent of S&T programme.

Department of Animal Husbandry & Dairying (19 Units)

The annual requirements of funds by the 19 units under the departments totaled to Rs. 11.77 crore; out of this the share of the controlling department exceeded 80 per cent:

	Amount (Rs. Lakhs)	Percent
Controlling Department	951	80.88%
Self Generation	82	6.97%
Private Sector	102	8.67%
Others	42	3.48%
Total	1177	100.0%

The accrual through the sale of frozen forage, fodder, improved seeds, poultry feed etc available during the pursuit of research activities constituted the core of funds categorised under self – generation.

Department of Chemicals & Petrochemicals (One unit)

The average annual grant needed to pursue research activities reached a level of Rs 2.54 crore; of this 47.24 per cent was contributed by the controlling department:

	Amount (Rs. Lakhs)	Percent
Controlling Department	120	47.24%
Other Departments	25	9.84%
Self Generation	109	42.92%
Total	254	100.0%

The unit succeeded to earn 42.82% of the funds that they needed through marketing of their expertise.¹

Department of Civil Aviation (One unit)

The average annual requirements of the funds for S&T activities was RS 1.26 crore and this was 100 per cent made available by the Department of Civil Aviation itself.

Ministry of Civil Supplies, Consumer Affairs & Public Distribution (5 units)

The annual R&D budget of the Ministry was Rs.53.36 crores and 76.20 percent of this was self generated. Out of this amount, Rs.47.74 crores(89.5%) was the annual budget of the Bureau of Industrial Standards alone. BIS generated 85.27% of its own budget.

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	822	15.40%
Own Resources	4071	73.29%
Others	443	8.31%
Total	5336	100.0%

Ministry of Commerce (4 units)

More than 54% of the funds needed were met by the controlling department while 16% of the funds flowed from the International Agencies- a substantial contribution. The average annual requirements of funds was Rs 15.92 crore with source wise dispersion as under:

¹ Detailed information is furnished in Annexure 4.1

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	873	54.84%
Other Departments	10	0.63%
International Sources	266	16.71%
Others	443	27.82%
Total	1592	100.0%

Ministry of Food (One unit)

Its annual R&D budget was Rs.35 lakhs and 100 percent was contributed by the Controlling Ministry.

Department of Health (17 units)

The annual financial requirements to carry out clinical S&T activities by 17 research institutions under the Central Department of Health averaged 276.11 crore of which 77% came from the Department. The contribution from each of the other next two sources was more or less equal and the other remaining three sources combined together contributed below 10%:

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	21289	77.10%
Other Departments	1844	6.67%
Self Generation	1719	6.22%
International Sources	632	2.29%
Private Sources	40	0.16%
Others	2087	7.56%
Total	27611	100.0%

Department of Family Welfare (one unit)

The annual flow of funds averaged Rs.3.17 Crore and as high as 94% of this came as budgetary support from the department and the balance about 6% from the other central government departments.

Department of Indian System of Medicines & Homeopathy (9 units)

The average annual funds requirements were Rs. 25.55 crore practically one tenth of the requirements of the entire Department of Health and conspicuously 99% of the requirements of funds were met by the Department.

Ministry of Home Affairs (6 units):

The average annual flow of funds was Rs.10.71 crore and as anticipated 100 per cent came from the Ministry of Home Affairs.

Department of Culture (2 units)

The average cost of the research conducted by both the units was Rs.5.55 crore and the department sponsored 100 per cent of this.

Department of Industrial Development (2 unit)

Rs. 8.82 crore was average annual receipt of funds and 47.85% came from the controlling department and record 52.15% came through internal generation and this reflects on the high incidence of marketability of the research undertaken by both of the institutions.

Department of Industrial Policy and Promotion (one unit)

The average annual flow of funds to the unit was Rs. 8.14 crore. The controlling department accounted for 40 per cent of the flow and a record 50.50 per cent came through internally generated funds. International sources funded 3.8 percent and the balance 5.65 percent by other departments.

Department of Small Scale Industries, Agro and Rural Industries (3 units)

The average flow of funds for research in three units of the department was Rs. 2.02 crore. The bulk of the funds (90%) came from the department while the balance came from the other sources.

Ministry of Information & Broadcasting (one unit)

The only institution of the Ministry engaged in R&D activities needed annually on an average Rs.3.17 Crore of funds and 100 per cent of the amount was made available by the Ministry.

Ministry of Labour (one unit)

The unit, on an average, draws Rs.9.40 crore annually from the Ministry.

Ministry of Power (one unit)

On an average funds needed by this single unit worked out to be of the level of Rs. 14.39 crore. The internal generation funded about 75.7 per cent of the research activity and this high level of funding through self- generation provides a yardstick of user friendliness of the research pursuits of the institution:

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	69	4.80%
Self Generation	1089	75.70%
Others	281	19.50%
Total	1439	100.00%

Ministry of Surface Transport (2)

The flow of funds to both the units was on an average Rs.3.36 crore with break up as under:

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	313	93.15%
International Agencies	23	6.85%
Total	336	100.00%

Ministry of Textile (4 units):

The average annual quantum of funds which were needed by all the 4 units of the ministry from all the sources aggregated to Rs.10.68 crore. The percentage of contribution by all the sources may be summarized as under:

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	870	81.46%
Other Departments	4	0.37%
Own Sources	1	0.10%
International Sources	4	0.37%
Private Agencies	32	3.00%
Others	157	14.70%
Total	1068	100.00%

Ministry of Urban Development (2)

The average budgetary support to both the units of the ministry from all the sources aggregated to Rs. 4.94 Crore with the Controlling Ministry being the single largest channel:

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	432	87.45%
International Sources	14	2.83%
Private Sources	27	5.46%
Others	21	4.26%
Total	494	100.00%

Ministry of Water Resources(one unit)

The Ministry provided 100 per cent budgetary support of Rs 4.89 crore needed by the unit under consideration for carrying out the research .

Ministry of Welfare (4 units)

The financial input for carrying out the research in all the four institutions of the ministry came 87.75 % from the ministry. The total finances needed by all the institutions averaged Rs 17.70 Crore per annum with contribution from other donors as stated:

	Amount (Rs. Lakhs)	Percent
Controlling Ministry	1290	87.75%
Other Departments	63	4.30%
Self Generation	39	2.65%
International Agencies	5	0.33%
Others	73	4.97%
Total	1470	100.00%

Ministry of Food processing (one unit)

The average annual requirements of funds aggregated to Rs.41 lakh out of which the controlling ministry contributed 60.97 % of the amount while 39.03% came from other sources.

The average of the funds received per annum for carrying out R&D activities by the units covered above (who responded to the information solicited through the institutional questionnaire during field investigations conducted in connection with the study) aggregated to Rs. 498. 97. The break up of contributions made the various agencies listed in the questionnaire is furnished in Table 4.1.

Table 4.1

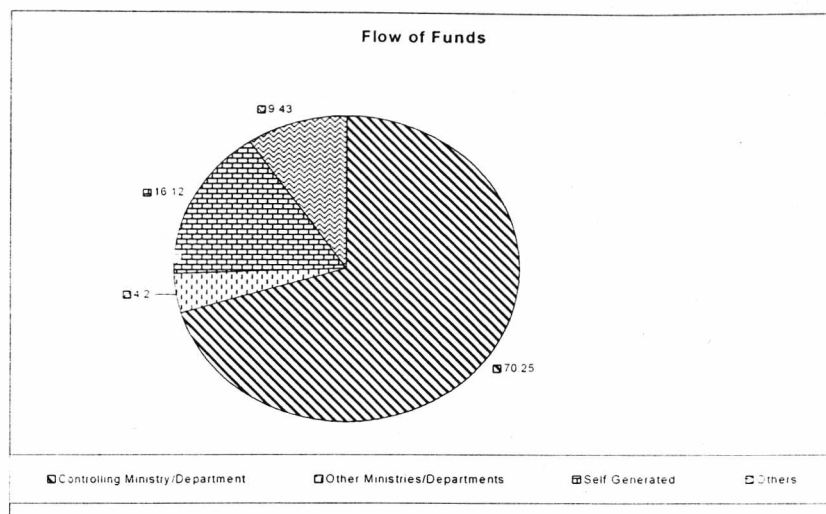
**Flow of Funds From Various Donors to the R&D Institutions under
the Socio-Economic Ministries
(Average of the years 1995-96 and 1996-97)**

(Rs. Lakh)

Annual Funds Received per Annum		
	Amount	Percent
Controlling Ministry/Department	35,050	70.25
Other Ministries/Departments	2,039	4.20
Self Generated Funds	8,046	16.12
International Agencies	990	1.98
Private Sector	129	0.25
Others	3,592	7.20
Total	49,896	100.00

It is discernible that 70.25% of the funds came as grant from the controlling ministries/departments, 16.12 % of funds were generated internally by the

institutions, and 4.2% were made available by the other ministries / departments. Thus more than 90 % of the funds needed for R&D pursuits were made available by the central governments sources; the funds available from private initiatives were dismal 0.25%.



Expenditure on R&D and Its Incidence in Total Expenditure:

Tooth to tail ratio defines the boundary of investible funds available for R&D activities. Besides, investment in capital formation ensures the availability, updating and maintenance of infrastructure and supporting devices, gadgets and instruments needed for sustaining the R&D activities.

There are wide variations in these ratios in different institutions under the purview of Socio-Economic Ministries as was revealed during the fieldwork. The information received in the filled-in questionnaires is presented in Annex 4.2 of the report and summarized as under in Table 4.2

Table 4.2
Break Up of Expenditure and Its Inter- relationship
(Average of 1995-96 and 1996-97)

Name of Deptt.	Recurring Expenses				Non-Recurring Expenses	Total Expenses
	S&A Of R&D personnel of Category B	S&A of Auxiliary & Technical Staff	S&A of Research Linked Administration	Other Expenses		
Department Of Agriculture & Cooperation	199	73	172	8	17	461
(3 Units)	43.16%	15.83%	37.31%	0	3.7%	
Dept. of Animal Husbandry	90	198	120	95	274	777
(19 Units)	11.58%	25.48%	15.44%	12.24%	35.26%	
Dept. of Chem. & Petro-Chemical	104	0	1	201	0	306
(1 Unit)	33.98%			65.68%		
Dept. of Civil Aviation	86	36	0	0	4	126
(1 Unit)	68.25%	28.78%			3.18%	

Dept. of Civil Supplies, Consumer Affairs & Public Dist.	729	978	27	1415	249	3398
(5 Units)	21.45%	28.78%	0.81%	41.64%	7.32%	
Ministry of Commerce	282	327	282	342	191	1424
(4 Units)	19.82%	22.98%	19.80%	24.02%	13.41%	
Ministry of Food	23	381	15	1	0	420
(1 Unit)	5.48%	90.71%	3.57%	0.24%		
Department of Health	10,381	1,366	847	293	2,116	15,003
(17 Units)	69.19%	9.10%	5.64%	1.95%	14.12%	
Dept. of Family Welfare	40	103	70	49	70	332
	12.05%	31.03%	21.08%	14.76%	21.08%	
Dept. of Indian System of Medicine & Homeopathy	609	479	193	37	1,081	2,397
(9 Units)	25.38%	19.97%	8.05%	1.54%	45.06%	
Ministry of Home Affairs	158	167	117	18	527	987
(6 Units)	16.01%	16.92%	11.85%	1.82%	53.42%	
Department Of Culture	204	65	48	51	0	368
(2 Units)	55.43%	17.60%	13.06%	13.05%		
Dept. Of Heavy Industry	26	20	73	0	125	244
(1 Unit)	10.65%	8.20%	29.92%		51.23%	
Dept. Of Industrial Development	167	31	56	113	3	320
(1 Unit)	45.13%	8.38%	15.13%	30.54%	0.82%	
Dept. of Industrial Policy & Promotion	179	80	203	46	50	508
(1 Unit)	32.08%	14.34%	36.33%	8.24%	8.24%	
Dept. of Small Scale Industry, Agro. & Rural Industries	20	140	17	5	18	200
(3 Units)	10.0%	70.0%	8.5%	2.5%	9.0%	
Ministry of Information & Broadcasting	57	60	55	23	25	220
(1 Unit)	25.9%	27.27%	25.0%	10.45%	10.45%	
Ministry of labour	590	360	0	0	0	950
(1 Unit)	62.10%	37.90%				
Ministry of Power	280	180	37	529	6,028	7,054
(1 Unit)	3.97%	2.55%	0.52%	7.50%	85.46%	
Ministry of Surface Transport	57	60	55	23	25	220
(2 Units)	29.87%	23.98%	21.27%	15.82%	9.05%	
Ministry of Textiles	124					
(4 Units)						
Ministry of Urban Development	84	127	230	32	12	486

(2 Units)	17.28%	26.15%	47.32%	6.58%	2.67%	
Ministry of Water Resources	350	138				488
(4 Units)	71.72%	28.28%				
Ministry of Food Processing	7	19	5	2	8	41
(1 Unit)	17.07%	46.34%	12.19%	4.87%	19.53%	
Total	14,854	5,542	2,828	3,501	11,122	37,847

Note: S&A=Salary & Allowance

From the above data, it may be concluded that the share of expenses on salary and allowances of the R&D personnel of category B and above fluctuated within very wide bands amongst the institutes of the various Socio-Economic Ministries:

Range of Share of Salary & Allowance of R&D Manpower of Category B and above	Number of Units & their percentage
+60%	23 (25.22%)
+50 to 60%	2 (2.20%)
+40 to 50%	4 (4.40%)
+30 to 40%	2 (2.20%)
Below 30%	60 (65.93%)

Over 2/3 of the institutions surveyed spent less than 30 per cent of their resources on the salary and allowances of the R&D personnel of category B and above.

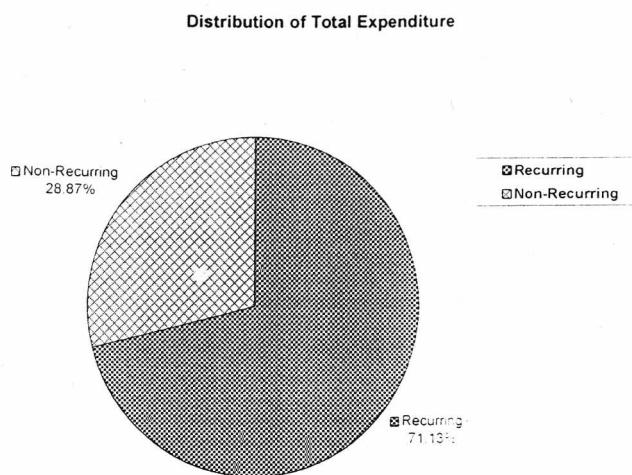
In some of the units auxiliary & technical research staff has important contribution to make in the research out put. As for instance, in all the units of the Ministry of Small Scale, Agro and Rural Industries, the expenditure on auxiliary staff was as high as 70 per cent and in respect of institutions under the ambit of Ministry of Food ; this share was above 90 percent. But these are exceptions. In respect of 43.68 per cent of the institutions covered, the expenditure on salaries and allowances of auxiliary and technical staff hovered within a band of 20 to 30 per cent of the total expenditure on R&D:

Expenditure on Auxiliary & Technical Scientific Manpower as percentage of Total R&D Expenditure (Range of Share in Percentage)	Percentage of Total Institution Covered Field Investigation (%)
Below 15%	24.14
+15 to 20%	27.58
+20 to 30%	43.68
+30 to 40%	2.30
+40%	2.30

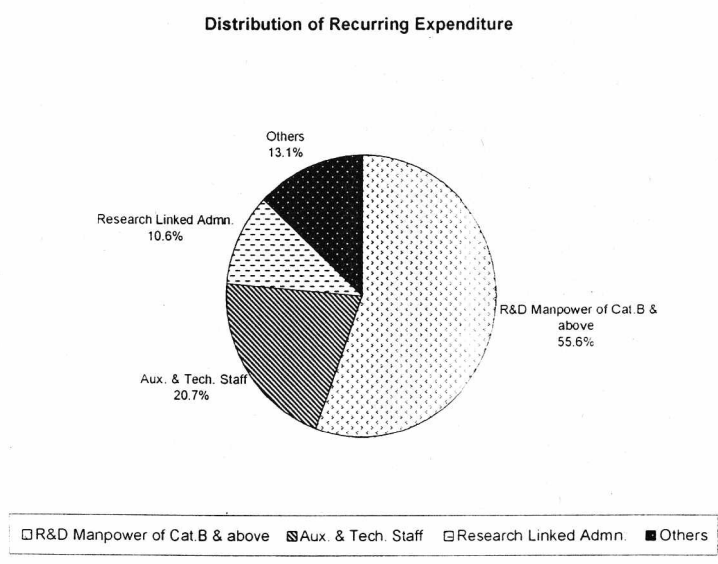
It is desired that one third of the annual expenditure on R&D, on an average , is dedicated to capital expenditure. This is the basic financial input for augmenting the available infrastructure. Against this, about 20% of the units spent less than

10% of the R&D expenditure on infrastructure while in certain cases the percentage share was as high as 40% and above. It means that these units accorded higher level of emphasis to the availability and maintenance of devices and instruments needed essentially

for carrying out R&D activities. The average share of overall non-recurring expenses was 28.87per cent.



The revenue expenditure accounted for 71.13 % of total expenditure on R&D. This manifests mainly through the salary and allowances of R&D manpower of category B and above, auxiliary and technical personnel and research-linked administration.



Hiatus Between Revenue and Expenditure on R&D Activities

The resource crunch casts its shadow on the output of research and the productivity of researchers due to inadequate availability of the much needed infrastructure, physical inputs for carrying out the research on sustainable stretch of time and restriction on training/ exposures of research staff within the country and abroad. It has also impact on the availability of channels of promotion that ultimately results in frustration at all the echelon of scientific manpower.

This aspect of deficiency of finances of units studied has been dealt unit wise in Annex 4.4 and summarized in Table 4.3.

Table 4.3

**Revenue and Expenditure – Surplus/ Deficit
(Department wise coverage – average of 1995-96 and 1996-97)**

Ministry/ Department	Revenue	Expenditure	+/-	Surplus/ Defecit
Dept. of Agri. & Coop. (3 Units)	775	687	+	88
Dept. of Animal Husbandry (19 Units)	1177	1190	-	13
Dept. of Chem. & Petro-Chemical (1 Unit)	254	206	+	48
Dept. of Civil Aviation (1 Unit)	126	126		0
Dept. of Civil Supplies, Cons. Affairs & Public Distribution. (5 Units)	4,921	3,401	+	1,520
Ministry of Commerce (4 Units)	1592	1424	+	168
Ministry of Food (1 Unit)	450	420	+	30
Department of Health (17 Units)	31856	28163	+	3673
Dept. of Family Welfare	317	262	+	55
Dept. of Indian System of Medicine & Homeopathy (9 Units)	2554	2458	+	96
Ministry of Home Affairs (6 Units)	1071	1087	-	16
Dept. Of Culture (2 Units)	555	546	+	9
Dept. Of Heavy Industry (1 Unit)	239	244	-	5
Dept. Of Industrial Development (1 Unit)	643	582	+	61
Dept. of Industrial Policy & Promotion (1 Unit)	814	814		0
Dept. of Small Scale Industry, Agro & Rural Industries (3 Units)	202	200	+	2
Ministry of Information & Broadcasting (1 Unit)	317	317		0
Ministry of labour (1 Unit)	940	950	-	10
Ministry of Power (1 Unit)	1439	8637	-	7198
Ministry of Surface Transport (2 Units)	336	336		0
Ministry of Textiles (4 Unit)	1068	1254	-	186
Ministry of Urban Development (2 Units)	494	486	+	8

Ministry of Water Resources (4 Units)	489	488	+	1
Ministry of Food Processing (1 Unit)	41	41		0

The annual level of deficit during the period under consideration was conspicuous in respect of the Central Power Research Institute, Bangalore under the Ministry of Power. The Expenditure was 6 folds of the revenue with the result that the deficit was multiple of the total receipts (5 folds). This is an isolated case. In majority of institutes, the deficit was within a manageable limit of 15 to 20 per cent while in certain cases the deficit was of the level of 40 to 50 per cent of the revenue. This is difficult to sustain in any particular year.

The units in the Department of Health retained a surplus of over 10 % and this was a usual level of surplus whenever it occurred.

CHAPTER 5

EMPLOYMENT PROFILE

Employment Record and Involvement in Research:

Many factors contribute to a sustained employment of research staff in an institution. The predominant amongst these are:

- The recognition that the scientist gets in his discipline and adequacy of incentives available. This facilitates an uninterrupted loyalty of the incumbent scientist to the institution.
- The avenues of promotion afforded by other institutions undertaking research in the same or related disciplines.
- The policy followed by the institution in respect of injection of talents at various grades of employment of scientists depriving the incumbents of the institution of the opportunities for promotion.
- The recognition accorded to standard of research conducted by the institution by foreign universities/ research institutions that sometimes make lucrative terms for employment to the scientists associated with the indigenous institution.

The employment record of the scientists is thus subjected to diverse forces. The intensity of these forces, of course, differs across the institutions depending upon the policy of Human Resource Development pushed by it supplemented by the instrument of recognition and rewards at specified intervals of time.

Involvement in different types of research – basic, applied and experimental – and the duration thereof, depends upon the aptitude of the scientist, his/her qualifications and competence compatible with the requirements of the research work and inherent attribute of sustainable interest and efforts by the scientist.

These aspects and other related issues as applicable to the institutions under the purview of Central Socio-Economic Ministries are analyzed and presented in this chapter.

Age-wise and sex-wise configuration of the responding scientists:

Amongst the responding scientists (2, 455 in number), 86 per cent were male while the balance 14 per cent belonged to the feminine gender. The age-wise configuration is furnished in Annex 5.1. It is discernible from the data that the percentage distribution of scientists at different age slabs was more or less similar for scientists of both the sexes. The bulk of concentration of scientists fell within the age slabs encompassing the wider range 33 to 56 years:

Age Range: 33 to 56 years	
	Percentage of Scientists
Male Scientist	84.84
Female Scientist	82.98

There were 75 scientists (including 10 female) who were involved in R&D activities even after the age of superannuation (58 years plus) These were mostly the scientists engaged in the institutions under the Central Ministry of Health and Family Welfare.¹²

Qualification-wise Dispersion of Scientists:

In a scientific pursuit, qualification has an over riding influence and priority. Female scientists had an edge over the male counterparts in respect of having acquired higher qualification:

	Male Scientist	Female Scientist
M.Phil.	20.8%	26.86%
Ph.D./D.Sc.	7.32%	10.75%

But both the sexes had similarity in percentage share in respect of minimum entry qualifications i.e.,

	B.A./B.Sc.
Male Scientists	20.14%
Female Scientists	20.95%

The details are furnished in Annex 5.2

Time Taken for Entry into Category B:

The time taken for entry into category B in various institutions depended primarily on qualification and promotional policy of the institution concerned. Qualification adequately fortified by the experience helped the scientists in direct recruitment to category B. The following data provide substance to the above premise. The proportion of direct recruitment has a very high level of co-relation with the qualification:

Proportion of Direct Entry to Category B Vis-a-vis Qualification

Qualification	Male	Female	Total
M.A/M.Sc	8	2	10
	50 %	100%	55.56%

¹ The chapter is based on the response of 2,455 R&D manpower of category B engaged in S&T in 117 institutions. The information was obtained through the data furnished in filled- in scientist questionnaires made available during the fieldwork conducted during the tenure of the study. For every scientist interviewed at personal level, there was a corresponding schedule dealing with professional, academic and personal questions pertaining to the scientist

² The details of information are furnished in Annex 5.1 to Annex 5.11

M.Phil.	280	55	335
	63.50%	61.11%	63.08%
Ph.D./D.Sc.	73	17	90
	47.10%	47.22%	47.12%
M.B.B.S	227	60	287
	64.67%	67.42%	65.22%
M.D/M.S	247	10	257
	60.84%	52.63%	60.47
B.E/B.Tech	111	12	123
	63.42%	75%	64.40
M.E/M.Tech	30	3	33
	36.58%	60%	37.93
Total	976	159	1135

Note: The figures in percentages represent scientists who had the qualifications under reference and succeeded in getting direct recruitment to category B and above.

While the period of 5 years and more needed for reaching category B and above was applicable to the cases with lower qualifications.

**Scientist taking 5 and more than five years
to enter category B and above**

Range(in years)	Male	Female	Total
5-7	189	38	227
	8.92%	11.38%	9.25%
8-10	152	19	171
	7.17%	5.69%	6.96%
>10	253	105	
	28.02%	31.44%	28.51%

Note: the percentages represent the share within the total scientists

Dispersion of Scientists According to payscale:

Ninety five per cent of the male scientific manpower is concentrated upto the grade 5 while only 5% of the scientists are placed in the grade 6 and above. While in case of female scientists, the corresponding percentage is 87%. Details of further break- up are furnished in Annex 5.4

Age-wise/Qualification-wise Distribution of researchers:

Total scenario of age-wise/qualification-wise distribution of scientists of category B is presented in Annex 5.5. It is discernible that the maximum concentration of researchers with qualifications Ph.D./D.Sc. and equivalent higher academic qualifications is within the age slabs bounded by 37 to 52 years of age. This may be attributed to the acquisition of higher qualification during service tenure thanks

to the individual initiative and support by the institutions. This may also be the result of allurements of better promotional avenues linked with the upgradation of academic qualification/ skill presumably defined in the promotional policy of the institutions.

**Age-wise/ Qualification-wise Distribution of Researchers
of Category B and above**

AgeSlabs (In years)	M.Phii	Ph.D.	M.D/M.S	M.E/ M.Tech
37- 40	61	27	69	11
	11.48%	14.14%	16.23%	12.64%
41-44	100	45	66	16
	18.85%	23.56%	15.53%	18.40%
45-48	103	40	52	14
	19.40%	20.94%	12.24%	16.10%
49-52	102	33	43	20
	19.21%	17.28%	10.12%	23.0%
Total	366	145	230	61
	68.86%	75.92%	54.12%	70.14%

Note: The percentages represent the shares of scientists with different vintages but having the qualifications under reference in the columns

Except in the case of scientists with qualification of M.D/M.S, the age bands as defined above were found to have the distinction of encompassing near about 70 per cent of R&D manpower with higher academic qualifications.

Time taken to Reach Present Pay Scale from the Level of Category B:

The time taken to reach the present scale of pay from the category B fluctuated widely across the institutions. On an average more than half of the researchers (54.4%) took more than 10 years to reach the present scale, while only 24.5% of the qualified manpower was lucky enough to reach the present scale within 5 to 10 years. This is the situation irrespective of the gender.

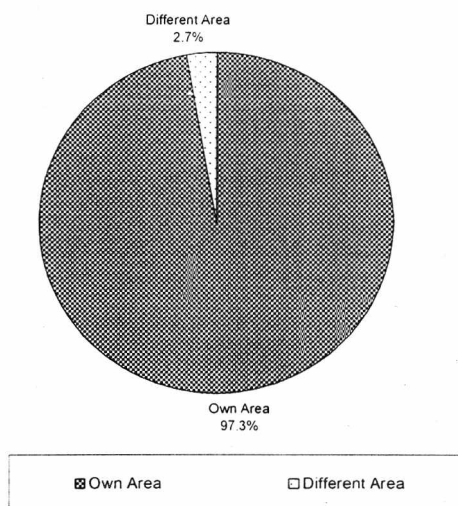
Deployment of Scientific Manpower Vis-a-vis their area of specialization:

In the institutions under the ambit of the Socio-Economic Ministries, it was observed that the scientists were engaged in research areas intimately linked with their qualifications. This may probably be assigned to recruitment of scientific manpower in limited number that too for the specific research conducted by the institutions in areas of R&D activities of specific applications. The S&T persons are invariably attached to the R&D cells of their respective institutions. This explains the overwhelming percentage (97.3%) of the manpower to have been gainfully employed in their areas of qualification/ specialization:

Deployment of Scientists Vs Areas of Specialization

	Number	Percent
Own Areas	2,389	97.30
Different Areas	66	2.70

Deployment of Scientists of Category B and above



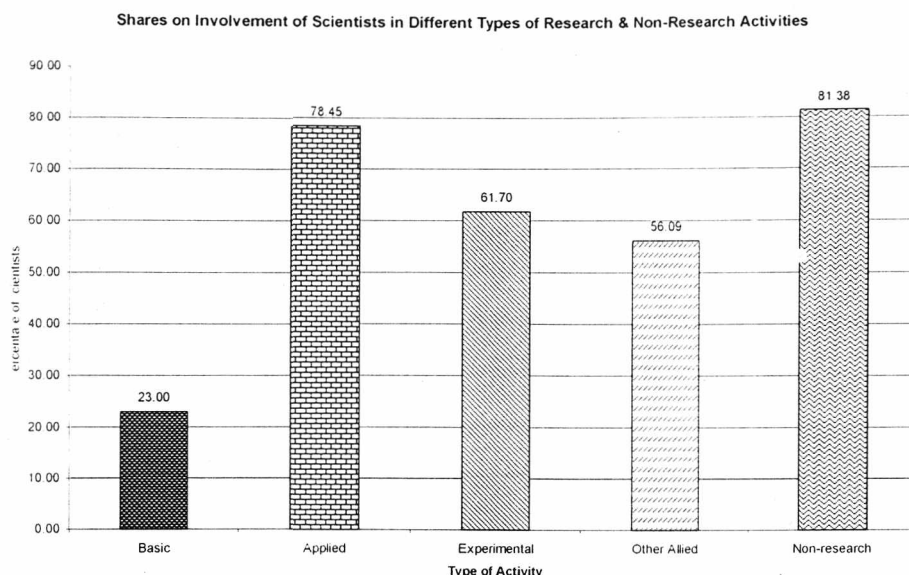
Activity-wise Time Allocation by the Scientists:

The scientists in the institutions spend their time in:

- Different types of research ,
- Research support to the scientists of higher ranks as member of team,
- Technology transfer and
- Administration-cum-management

The parameters such as ratios of R&D manpower engaged in different types of research and other activities, allocation of times in different stratification of research activities, the time dedicated to research by scientists of different age groups, grades and academic attainments etc influence the research outputs and productivity of scientists.

The following data give the level of involvement in basic, applied and experimental research in the institutions whose scientists responded to this massive information seeking exercise:



**No. of Scientists with Zero Involvement in Research
(By types of research activity)**

Type of research	No. of Scientists	Per cent
Basic	1891	77
Applied	529	21.55
Experimental	940	38.30
Other allied research	1078	43.91
Non-research activity	457	18.62

The data manifest that 77 per cent of scientists had no involvement in basic research while maximum involvement of the scientists (78.45% of the total number) was in the applied research. This indicates that research of applied nature had the maximum acceptance and operation in research institutions under the Socio-Economic Ministries. The next in preference (practiced by 61.2 per cent) was the experimental research followed by the other research activities (accounting for 56 per cent of involvement of scientists)

It is also discernible that 81.50 of the scientists were involved in non-research activities in some way or the other; the average duration of involvement during the year, of course, varied within a wide range.

In respect of applied and experimental types of research activities, the involvement of researchers of grade 4 to grade 7 provided the much-needed matured thrust:

**Grade-wise involvement of scientists in Applied & Experimental Research
(In months/ year during the years 1995-96 and 1996-97)**

Number of Scientists						
Grade	Applied Research			Experimental Research		
	Months			Months		
	>=1&<=3	>3&<=6	>6&<=9	>=1&<=3	>3&<=6	>6&<=9
4	105	117	38	88	50	41
	30.52	34.02	11.05	25.56	14.53	11.92
5	47	70	28	47	25	16
	26.10	38.89	15.55	26.11	13.90	8.90
6	43	47	12	30	16	0
	32.09	35.07	8.96	22.39	11.94	0
7	38	37	12	20	17	3
	35.85	34.91	8.96	18.87	16.00	2.83

Note: Percentages represent the share of the total scientists of all grades who were involved in various types of the research activities.

There is corresponding higher level of involvement in non-research activities with the increase in grade presumably due to higher incidence of administrative- cum- management as the rank enhances:

**Involvement in Non-research Activity Vis-a- vis the Grade
(In months /year)**

Grade		Months		
		>1&<=3	>3&<=5	>6&<=9
1	No.	272	132	24
	Percent	23.4	13.92	2.53
2	No.	179	128	32
	Percent	29.66	21.25	3.65
3	No.	61	25	10
	Percent	46.56	19.08	7.63
4	No.	117	100	35
	Percent	34.01	29.07	10.17
5	No.	53	64	10
	Percent	29.44	35.55	5.55
6	No.	37	47	14
	Percent	27.61	35.07	10.45
7	No.	21	45	18
	Percent	19.81	42.45	16.98

Gender-wise Involvement in R&D activities:

Non-involvement in different types of research activities is not gender specific but is practically of equal relevance to both the genders. Instead, as stated earlier, it is basically a function of policy options of the institutions and their commercial priorities.

Gender- wise Non- involvement of Researchers in Different Types of Research Activities

Gender	Basic	Applied	Experimental	Allied research	Non-reasearch
Male	67.76%	21.13%	32.85%	43.53%	32.02%
Female	74.25%	24.25%	43.11%	45.81%	32.34%

The percentage of non-involvement of both the genders run more or less parallel to each other.

Duration of projects, Efficiency of Execution and Future Expectations:

The annex 5.12 gives the details of efficiency of execution of projects sponsored by different agencies. These details are summarized in Table 5.1

Table 5.1
Duration of Projects and Efficiency of Execution

Duration of Projects in Months	Just Commen ced	Half way	Just Completed	Total	Per cent
1 to 6	34	33	26	93	5.9
>6&<=12	140	308	49	497	31.7
>12 &<=24	114	201	32	347	22.1
>24&<=36	85	187	21	293	18.7
>36	55	230	53	338	21.6
Total	428	959	181	1568	100.0
Per cent	27.3	61.2	11.5		

More than 60 per cent of the sponsored projects were stated to be in half way of completion while completed projects comprised just little 10 per cent of the total jobs.

Projects of 12 months duration and below constituted 37.6 per cent of the sponsored projects while projects of longer duration (over 36 months) formed more than one-fifths of the jobs in hand. And balance more than one-fifth jobs were of medium duration(12 to 24 months).

As stated earlier, bulk of the projects in hand (75 per cent in respect response at the individual scientist level) were self – sponsored ones.

But the scientists exhibited quite a confidence in execution of the job in time. The future estimates of completion of jobs were reflected through the following prognostication:

**Completion of the project in time
(per cent of response)**

Completion on Time	64.6
Can not be completed in time	2.8
Can not be assessed	32.6

CHAPTER 6

RESEARCH PROJECTS HANDLED

(Average of 1995-96 and 1996-97)

The composition of the level of flow of funds from various donors is in direct proportion to the number of research projects sponsored by them. The intensity of research projects, their durations and over and above their number have price tags commensurate with these variables. The data on the number of projects undertaken and their sponsors are furnished in Annex 6.1 to Annex 6.7. The details are summarized in Table 6.1

Table 6.1

Details of projects sponsored by Different Agencies
(Average of 1995-96 and 1996-97)

Ministry/ Department	Govt.	Public Sector	Private Sector	Internat ional Agency	Self- sponsored	Others	Total
Dept of Agriculture & Cooperation (3 units)	3	2	-	2	-	-	7
Dept. Animal Husbandry & dairying (19units)	3	-	9	-	-	-	12
Dept. of Chemicals & petrochemicals (1 unit)	2	1	-	-	-	-	3
Dept. of Civil aviation (1 unit)		-	-	-	-	-	-
Ministry of Civil Supplies, Con. Affairs & Public Distribution (5 units)	69	-	-	-	-	-	69
Ministry of Commerce (4 units)	-	3	-	-	-	-	3
Ministry of Food (1 unit)		3	-	-	-	-	3
Dept. of Health (17Units)	136	2	1	6	5	11	161
Dept. of family Welfare (1 unit)	3	3	-	-	-	-	6

Dept. of Indian System of Medicines & Homeopathy (9 units)	86	-	-	1	-	-	87
Ministry of Home affairs (6 units)	10	-	-	-	1	-	11
Dept. of Culture (2 Units)	2	-	-	-	-	-	2
Dept. of Industrial Development (2 units)	40	8	109	-	24	-	181
Dept. of Ind. Policy & Development (1 unit)	7	99	99	4	-	8	217
Dept. of Small Scale Ind., Agro & Rural Industries (3 units)	22	-	-	1	-	6	29
Ministry of Information broadcasting (1 unit)	10	-	-	-	-	-	10
Ministry of Labour (one unit)	3	-	1	-	-	-	4
Ministry of Surface Transport (2 units)	-	-	-	1	-	-	1
Ministry of Textiles (4 units)	5	-	-	-	-	-	5
Ministry of Urban Development (2 units)	18	1	1	2	-	-	22
Ministry of Water Resources (1 Unit)	-	-	-	-	-	-	-
Ministry of Welfare (4 units)	-	-	-	2	2	-	4
Ministry of Food Processing (1 Unit)	7	-	-	-	-	-	7
Total	426	122	220	19	32	25	844

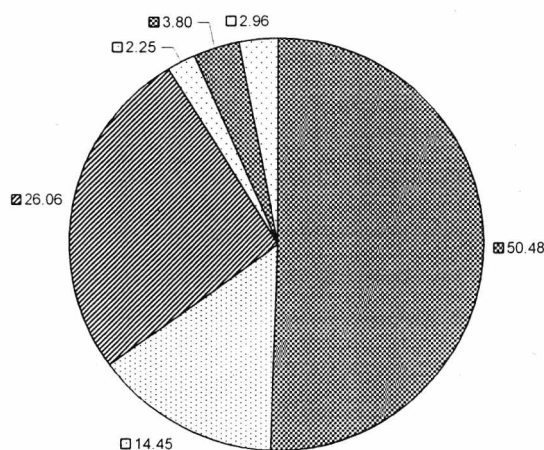
Note : the information is based on availability of data in Institutional Schedules received from the institutions surveyed. The details of projects undertaken-institution-wise and source-wise are furnished in Annex 6.1 to Annex 6.7

As expected, the number of research projects awarded by the Government accounted for more than 50 per cent of the projects sanctioned and if the projects undertaken at the behest of all the three government agencies viz. Govt., public sector and self-sponsored by the institutions are taken into consideration, their contribution rises to 68.73 per cent. The number of projects financed by the industry exceeded 40 per cent: out of which 26 per cent was the share of private sector.

Share of Projects sponsored by the Various Agencies

Agency	Number	Percent
Controlling Ministry/Department and Other Central Ministries/Departments	426	50.48
Public Sector	122	14.45
Private Sector	220	26.06
International Agencies	19	2.25
Self-sponsored by the Institution	32	3.80
Others	25	2.96
Total	844	100.00

Share of Projects Sponsored by Various Agencies



Central & Other Ministries/Departments Public Sector Private Sector International Agencies Self Sponsored Oth

Projects Handled pay scale-wise and rank-wise :

Projects in the institutions are handled usually by a team headed by a leader who is a senior researcher and expected to steer the study to its final result. He is supposed to inspire and guide the members of the team in day to day monitoring of research study and is responsible higher officers of the organization.

Annex 6.8 furnishes the details of researchers involved in studies sponsored by the agencies defined above. The information is based on the response received from the

researchers in the form of filled-in Scientist Questionnaires. These are summarized as under :

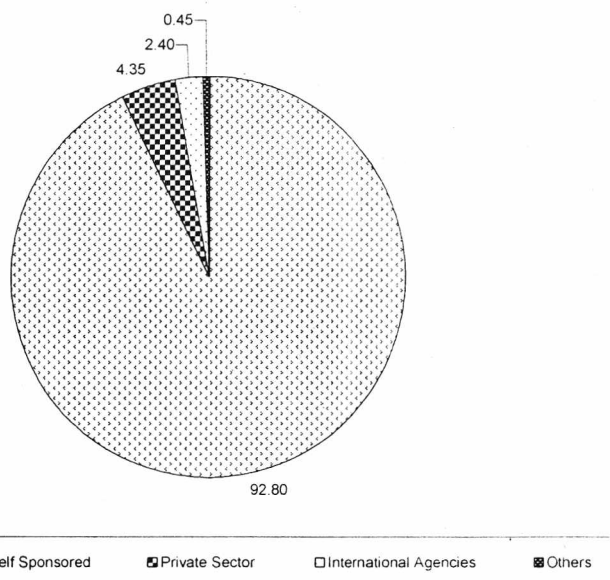
Sources of Projects and Involvement of Manpower

Source of Projects	Number of Scientists involved	Per cent
Controlling Ministry/ Deptt. & Other Central Ministries / Departments	147	6.00
Public Sector	94	3.93
Private Sector	107	4.35
International Agencies	59	2.40
Self-sponsored	2037	82.87
Others	11	0.45
Total	2455	100.00

Source: Response from Researchers in Scientists schedules

It is peculiar that the Controlling Ministry/Department and other Central Ministries/Departments are stated to have sponsored more than 50 per cent of projects, but the involvement of R&D manpower was only 6 per cent. Later on it was revealed that the projects sponsored by the all the government agencies were clubbed under self-sponsored projects and this explains very high share (82.87 per cent) of engagements of scientists in self-sponsored projects.

Sources of projects and Involvement of Manpower



Chapter 7

RESEARCH OUTPUT (Average of years 1995-96 and 1996-97)

The research output is governed by a number of factors such as:

- Whether the institution has an import-led base, or
- Whether its base is governed by domestic demand stemming mainly from import substitution.

It is the commercial inclination adequately supported by financial inputs and the required infrastructure, which acts as catalyst in accelerating the output of both applied and experimental researches.

Since the basic research is intended initially for theoretical work undertaken primarily for acquiring new knowledge, it has in view a long-term perspective or application and extends invariably over a longer duration. It is sometimes terminated without leaving any yardstick to measure its tangible results. Basic research as observed in earlier chapters is not of any interest to the research institutions under the Central Socio-economic Ministries/ Departments.

Moreover, the nature of research conducted by some of the institutions is such that their output can not be expressed in acceptable measurable terms. At the same time, the research conducted by a few institutions such as under the Ministry of Defence is of strategic significance and output is kept as closely guarded secret. Due to these reasons, the aggregate picture of research output expressed in measurable terms may not be truly representative of the research efforts of the institutions under the Socio-economic Ministries/ Departments, which responded to the field survey undertaken by TES. It is, therefore, suggested to deal with the institutions under each of the Ministry/ Department separately in respect of both tangible and non-tangible outcome.

The research projects of longer duration launched in a particular year do not result in availability of findings of commercial value in that year but only after a lapse of time needed for completion of the project. Sometimes, it is difficult to apportion the achievements credited to that project in that particular year. It is but natural that the output of research as mentioned in this chapter may perhaps be the outcome of the research activity carried out over the years.

Research output Ministry/Department-wise

The analysis presented in this chapter is based on the response received from the institutions under various Ministries/ Departments through filled-in Institutional Questionnaires. The data received have been clubbed together to represent the research output of the controlling Ministry /Department. In the interest of better understanding, these have been segregated under the following heads:

New Products / New Process / New Design / Modification of Design / Process / Technology / Consultancy services / Import Substitution and Others—Completed / In-progress and Transferred:

The development of a new product, new process and or new design and their subsequent commercialization is the real test of research related competence of an organization and relevance of its output. The data linked with the output are presented in Table 7.1. These data presented to the extent these are relevant and are applicable to the type of the output of the institutions surveyed. The product here signifies the outcome of the R&D activities in the areas for which the institution has been specifically created.

Import substitution is also one of the objectives of the scientific pursuits of the institutions created under the ambit of the Central Socio-Economic Ministries / Departments.

The designs developed /modified during research is usually the precursor of the application for registration of patents, which gives the research activity of an institution the much acclaimed market- orientation.

Table 7.1

New Products/Process/Design/Modification of Design/Process/Technology/ Consultancy Services etc Completed/In-progress and Transferred

Organization	Stage	New product	New Process	New Design	Modification of Product /Process /Design	Consultancy service rendered	Import Substitution	Others
Dept. of Agriculture & Cooperation	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Dept. of Animal Husbandry & Dairying	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Dept. of Chemicals & Petro-Chemicals	A	5	3	-	-	29	-	-
	B	1	9	-	-	-	-	-
	C	-	-	-	-	-	-	-
Dept. of Civil aviation	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Civil Supplies & Consumer Affairs	A	99	1	3	2	-	-	23
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Commerce	A	5	5	15	186	1	1	-
	B	16	15	1	-	-	-	-
	C	1	6	-	-	-	-	-
Ministry of Food	A	-	-	13	7	75	-	-
	B	-	-	10	8	15	-	-
	C	-	-	13	7	-	-	-
Dept. of Health	A	1	29	1	26	3	-	51
	B	1	9	-	5	-	-	-

	C	-	25	-	25	-	-	-
Dept. of Family Welfare	A	7	2	7	-	4	-	-
	B	4	1	-	-	4	-	-
	C	4	1	-	-	1	-	-
Dept. of Indian System of Medicine & Homeop.	A	15	20	-	-	-	-	-
	B	43	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Home Affairs	A	-	-	-	-	-	-	10
	B	-	6	-	-	-	-	-
	C	-	-	-	-	-	-	-
Dept. of Culture	A	-	-	-	-	-	-	15
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Dept. of Ind. Development	A	6	6	4	4	53	2	99
	B	-	-	-	-	47	-	-
	C	6	5	4	4	5	2	99
Dept. of Ind. Policy & Promotion	A	99	99	7	1	25	-	33
	B	26	33	6	-	6	-	9
	C	-	-	-	-	-	-	-
Dept. of Small Scale Industries	A	3	3	4	-	6	-	-
	B	1	-	1	-	50	-	-
	C	1	-	1	-	-	-	-
Ministry of I&B	A	2	-	-	3	2	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Labour	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Power	A	2	4	-	-	58	-	-
	B	-	-	-	-	58	-	-
	C	2	-	-	-	-	-	-
Ministry of Surface Transport	A	2	-	-	-	1	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Textiles	A	16	5	-	1	99	-	-
	B	16	3	1	-	-	-	-
	C	15	1	-	-	5	-	-
Ministry of Urban Development	A	-	2	1	1	3	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Water resources	A	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Welfare	A	1	-	-	-	-	-	-
	B	1	-	-	-	-	-	-
	C	-	-	-	-	-	-	-
Ministry of Food Processing	A	-	-	2	-	-	-	-
	B	2	2	1	-	-	-	-

	C	-	-	1	-	-	-	-
Total	A	263	179	57	231	358	3	231
	B	111	78	20	13	72	0	9
	C	29	38	19	36	119	2	99

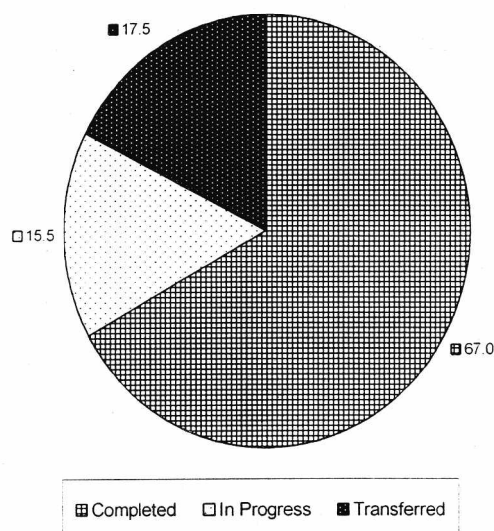
Note: A= Completed , B= In progress, C= Transferred

	Number	Percent
A	1322	67.0
B	303	15.5
C	342	17.5
Total	1967	100.0

From the above statement it is obvious that the assignments completed constituted about 65% of the total jobs assigned to the institutions while the projects in progress (15.5%) and the assignments transferred (17.5%) constituted the balance.

The research assignments related with the development of new products and new processes in addition to consultancy service formed the core of scientific base of the institutions. These combined together alone accounted for 63.5% of the total assignments.

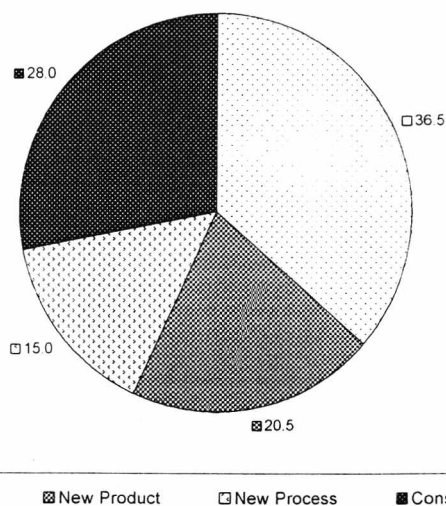
Status of Research Output



	Number	Percent
New products	403	20.5
New processes	295	15.0
New Design	96	4.8
Modifications	280	14.2
Consultancy Services	549	28.0
Import Substitution	5	0.3
Others	339	17.2
Total	1967	100.0

Thanks to the liberalisation of economy in 1991, import substitution occupies the lowest priority of research pursuits. This is amply manifested by a very low level of involvement in this sub segment of research activity. Otherwise, once import substitution was the main thrust of the R&D activities.

Share of Various Types of Research Assignments



Patents Obtained and Patents Applied for:

The research output in terms of number of patents applied for or number of patents obtained is not a true measurement of output of S&T activities of an institution. Instead how many of research outputs have led to products of value, could be of real interest.

None-the – less the number of patents applied for and obtained provide credibility to an institution in having brought in the market oriented acceptable research. Of the total research output listed in Table 7.1, the output thought to be worthy of being patented is of limited nature and is summarized in Table 7.2

Table 7.2

**Patents Applied for and Patents Obtained
(Average of the years 1995-96 and 1996-97)**

Organization	Stage	Patents obtained	Patents Applied for
Ministry of Commerce	A	1	-
	B	-	-
	C	-	-
Ministry of Food	A	4	-
	B	1	-
	C	1	-
Ministry of Industrial Development	A	3	1
	B	-	1
	C	-	-

The number related with patents is very small as compared with the other outputs of research activities and a few organizations had the distinction.

Research Output Scientist- wise (in the institutions surveyed):

The research output expected from the scientist at his/her level is dictated by a number of factors such as:

- individual scientist's interest and drive ,
- encouragement available to him/her from the senior scientists .
- credit and rewards given to him/her for the output ,
- the research atmosphere prevailing in the institution that the scientist is attached with .
- the proportion of time the scientist is called upon to dedicate to activities other than research.

Left to himself / herself, the scientist would wish to do his/her best unless restricted by the constraints and limitations discussed in Chapter 9. The difficulties identified at the level of scientist impinge on his/her productivity the most.

Table 7.2

Research output by R&D Personnel of Category B and above
(Average of the year 1995-96 and 1996-97)

Output	Output per scientist reporting the specified output (in number)
Product/ process developed	1.9 (0.3)
Patents obtained	1.9 (0.019)
Patent applied for	1.75 (0.029)
Awards/merits earned	1.25 (0.094)
Articles published in Indian journals	3.8 (0.74)
Articles published in foreign journals	3.23 (0.55)
Books published	1.56 (0. 14)

Note: the data are derived from the filled- in scientist questionnaires from 2455 scientists of category B and above. The figures in parentheses represent the average of overall response. These are the average figures irrespective of gender.

Further segregated information (pay scale-wise) is furnished in Annex 7.5. It is discernible from the data presented therein that the output achieved is through the active involvement of scientists at all the levels of pay scale.

Articles / books published by R&D personnel:

Published articles/ books disseminate the scientific attainments at the national and international levels. These publications project the image of the institutions to the industrial sector in respect of what may be the anticipated research out come in the future, which the industry may look forward to commercialize. This also provides the insight into

the research activities of the institutions under the purview of the Socio- economic Ministries/ Departments by the Industrialised Countries having interest in the dissemination of information on research findings/ outputs. The articles / books brought out by the government scientists provide a general accountability to the public at large in a democratic set up as that of India.

As expected research outcome in terms of published materials which may be credited to the research activities carried out by the scientists during their stint with the institution is comparatively very high in contrast to other outputs. It magnifies 8 to 10 folds. The pursuit of personal recognition through the media of published works is undoubtedly a path of least resistance but rewarding. Every scientist aspires to follow this path.

Number of Awards/ Merits Earned:

In research activities, the carrot is more effective than the stick in producing the desired results. It is a fair combination of both the professional and mental satisfaction, which sustains the interest of the scientist in maintaining his/her research productivity levels. The role and significance of incentives in the form of awards/ merits need no emphasis.

The number of awards/merits made available to responding scientists crosses unity mark, which is the average of two years. This may be treated as reasonable taking into consideration the limited opportunities available at the national level.

Note; the detailed information related with the chapter is furnished in Annex 7.1 to Annex 7.5.

Chapter 8

Details of R&D Related Activities at National Levels (average of the years 1995-96 and 1996-97)

The research output as quantified in Chapter 7 provides the yardstick of the depth of involvement in the result oriented R&D activities. Besides, the research institutions have obligation towards the society at large as well as incumbent scientists employed by the institution.

Arrangement of Seminars/ Conferences/Training programmes by the research Institutions:

Such programmes organized by the institutions benefit not only the external participants but also the internal scientists as well. The opportunities to participate in seminars for presentation of technical papers or otherwise and or training programmes are a few because of:

- Limited number of seminars / training programmes held primarily due to the paucity of funds and
- Restrictions indirectly imposed by hierarchy.

The seminars / training programmes operated in-house by the institution overcome the above constraints. The details of such promotional activities linked with R&D conducted by the institutions surveyed, are furnished in details in Annex 8.1 to Annex 8.2 and summarized in Table 8.1

Table 8.1

Seminars and Training Programmes Organized by Institutions

Department/ Ministry	Status	Seminars	Confere nces	Training	Fellow ship	Exhibi tion	Others
Dept. of Agriculture & co- operation	A	2	1	5	-	4	-
	B	22	8	97	-	35	-
	C	1	11	4	-	5	-
Dept. of Animal Husbandry & Dairying	A	-	1	26	-	2	-
	B	-	30	338	-	2	-
	C	-	-	14	-	1	-
Dept. of Chem. & Petrochemicals	A	3	-	-	-	-	-
	B	100	-	-	-	-	-
	C	-	-	-	-	-	-
Dept. of Civil Aviation	A	-	-	-	-	-	-
	B	-	-	-	-	-	-
	C	-	-	-	-	-	-
Ministry of Civil Supplies, Cons.	A	7	99	90	-	6	-
	B	20	-	1597	-	-	-

Affairs & public Distribution.	C	-	-	-	-	-	-
Ministry of Commerce	A	75	4	8	-	5	-
	B	556	1005	1083	-	10	-
	C	73	13	20	-	1	-
Ministry of Food	A	1	-	13	-	1	-
	B	100	-	121	-	-	-
	C	1	-	1	-	-	-
Dept of Health	A	43	30	83	30	3	30
	B	1494	992	1507	30	301	-
	C	311	117	98	11	-	-
Dept. of Family Welfare	A	3	-	1	51	11	-
	B	203	-	10	-	999	-
	C	-	-	-	-	-	-
Dept. of Indian System of Medicines & Homeopathy	A	5	-	3	-	3	2
	B	346	-	8	-	45	20
	C	10	-	1	-	6	2
Ministry of Home Affairs	A	10	8	70	1	-	-
	B	15	23	1039	1	-	-
	C	-	1	3	-	-	-
Ministry of Culture	A	8	-	3	23	7	-
	B	-	-	28	-	100	-
	C	-	-	-	6	-	40
Dept. of Industrial Development	A	1	-	58	-	4	-
	B	110	-	1079	-	100	-
	C	1	-	10	-	2	-
Dept. of Industrial Policy & Promotion	A	4	-	44	-	-	-
	B	108	-	539	-	-	-
	C	1	-	45	-	-	-
Dept. of SS Industries	A	1	-	14	-	-	-
	B	41	-	794	-	-	-
	C	-	-	4	-	-	-
Ministry of I&B	A	-	-	-	-	2	2
	B	-	-	-	-	2	2
	C	-	-	-	-	2	2
Ministry of Labour	A	14	-	18	-	-	-
	B	39	-	29	-	-	-
	C	-	-	-	-	-	-
Ministry of Power	A	6	-	4	-	2	-
	B	300	-	100	-	500	-
	C	4	-	2	-	1	-
Ministry of Surface Transport	A	20	-	22	-	-	-
	B	339	-	129	-	-	-
	C	4	-	2	-	-	-
Ministry of Textiles	A	3	7	27	1	8	-
	B	382	224	1177	1	999	-
	C	6	4	37	1	24	-
Ministry of Urban	A	-	4	-	-	-	-

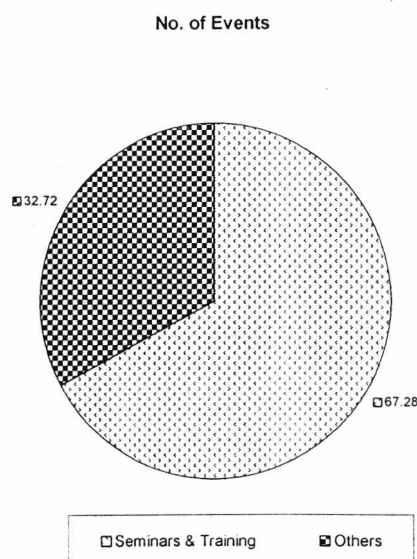
Development	B	-	70	-	-	-	-
	C	-	20	-	-	-	-
Ministry of Water Resources	A	-	-	-	-	-	-
	B	-	-	-	-	-	-
	C	-	-	-	-	-	-
Ministry of Welfare	A	49	4	8	-	2	-
	B	1758	150	187	-	-	-
	C	31	2	1	-	26	-
Ministry of Food Processing	A	5	-	2	-	2	10
	B	225	-	200	-	200	250
	C	-	-	-	-	-	-
Total	A	260	158	499	106	62	44
	B	6158	2502	10024	32	3293	272
	C	443	168	242	18	68	44

Note : A- No. of events
 B- No. of participants
 C- Expenditure incurred in Rs. Lakhs.

The seminars and training engaged more than 2/3rd of the events that took place.

Events	Number	Percent
Seminars	260	23.03
Conferences	158	14.00
Trainings	499	44.20
Fellowships	106	9.40
Exhibitions	62	5.49
Others	44	3.88
Total	1129	100.0

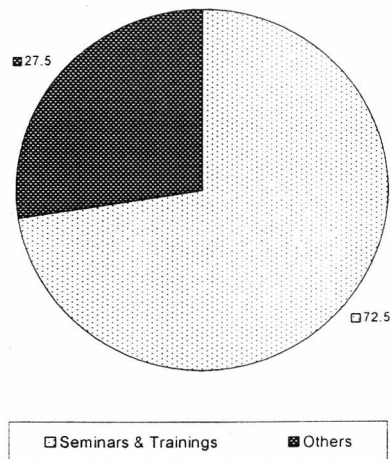
72.63% of the participants were also attracted towards seminars and trainings.



Events	Participants	Percent
Seminars	6158	27.64
Conferences	2502	11.23
Trainings	10024	44.99
Fellowships	32	0.14
Exhibitions	3293	14.78
Others	272	1.22
Total	22281	100.0

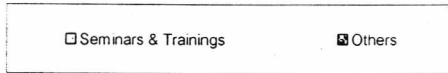
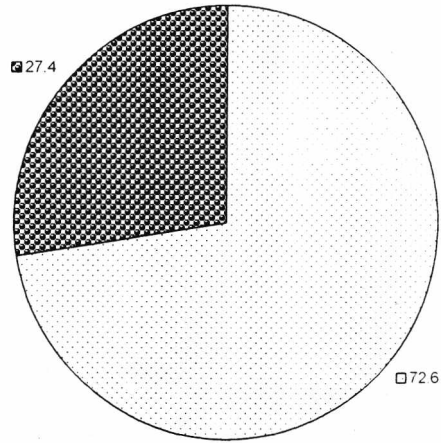
The expenditure incurred on events mentioned above was also commensurate with the events. The percent share of expenditure on seminars and trainings was 69.6% coincidentally at par with the percentage of participants.

Share of Participants



Events	Expenditure (Rs.Lakhs)	Percent
Seminars	443	47.0
Conferences	168	17.8
Trainings	241	25.6
Fellowships	18	1.9
Exhibitions	68	7.2
Others	4	0.5
Total	942	100.0

Percentage Share of Expenditure



CHAPTER 9

Constraints Influencing R&D Activities of Institutions (average of the years 1995-96 and 1996-97)

The fieldwork was conducted to elicit the opinions of the head of the institution with respect to the parameters impinging on the efficiency and research output of the institutions. These qualitative opinions constituted a section of the Institutional Questionnaire canvassed during the field investigations.

The details of the opinion survey are furnished in Annex 9.1 and summarized in Table 9.1.

Table 9.1

Constraints Against Achievement of Full Research Potentials of Institutions

Department	Status	Inadequate Funds	Late receipt of funds	Less R & D staff	Less supporting staff	Poor quality of R & D Staff	Exodus of R&D personnel	Non-congenial work atmosphere	Administrative Problems	Others
Dept. of Agriculture & Cooperation	Yes	1	-	1	1	-	-	-	-	1
	No	2	3	2	2	3	3	3	3	2
Dept. Of Animal husbandry & dairying	Yes	4	2	8	12	1	-	-	3	1
	No	15	17	11	7	18	19	19	16	18
Dept. Of Chemicals and petrochemicals	Yes	-	-	-	-	-	-	-	-	-
	No	1	1	1	1	1	1	1	1	1
Dept. of Civil aviation	Yes	1	1	1	1	-	-	-	-	-
	No	-	-	-	-	1	1	1	1	1
Dept. of Civil supplies, Cons. Affairs & Pub. Distribution	Yes	2	-	2	3	2	-	-	2	-
	No	3	5	3	2	3	5	5	3	5
Ministry of Commerce	Yes	2	2	2	1	1	1	1	1	-
	No	2	2	2	3	3	3	3	3	4
Ministry of Food	Yes	-	1	1	-	-	-	-	-	-
	No	1	-	-	1	1	1	1	1	1
Dept. Of Health	Yes	3	5	9	7	3	3	3	6	1
	No	14	12	8	12	14	14	14	11	16

Dept. Of Family Welfare	Yes No	- 1	- 1	1 -	1 -	- -	- 1	- 1	- 1	- 1	- 1
Dept. Of Indian System of Medicine & Homeopathy	Yes No	5 4	7 2	2 7	2 7	- 9	- 9	- 9	1 8	1 8	1 8
Ministry of Home affairs	Yes No	1 5	1 5	6 -	5 1	4 2	1 5	3 3	4 2	4 2	4 2
Dept. Of Culture	Yes No	1 1	- 2	1 1	1 1	- 2	- 2	- 2	1 1	- 2	- 2
Dept. Of Industrial Dev.	Yes No	2 -	1 1	1 1	1 1	1 1	- 2	- 2	- 2	- 2	- 2
Dept. Of Industrial P&P	Yes No	1 -	1 -	- 1	1 -	- 1	- 1	- 1	- 1	- 1	1 -
Dept. Of Small Scale Industries	Yes No	3 -	2 1	3 -	3 -	- 3	- 3	2 1	2 1	2 1	- 3
Ministry of I&B	Yes No	1 -	- 1	- 1	- 1	- 1	- 1	- 1	1 -	- 1	- 1
Ministry of Labour	Yes No	- 1	- 1	1 -	1 -	- 1	- 1	- 1	1 -	- 1	- 1
Ministry of Power	Yes No	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1
Ministry of Surface Transport	Yes No	- 2	- 2	1 1	- 2	- 2	- 2	- 2	- 2	- 2	- 2
Ministry of Textiles	Yes No	1 3	- 4	- 4	- 4	- 4	- 4	- 4	- 4	- 4	- 4
Ministry of Urban Development	Yes No	- 2	- 2	1 1	- 2	- 2	- 2	- 2	- 2	- 2	- 2
Ministry of Water Resources	Yes No	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1
Ministry of Welfare	Yes No	- 4	- 4	- 4	- 4	- 4	- 4	- 4	- 4	- 4	- 4
Ministry of Food Processing	Yes No	- 1	- 1	1 -	- 1	- 1	- 1	- 1	- 1	- 1	1 -
Total	Yes No	28 64	23 69	42 50	38 54	12 80	5 87	9 83	22 70	9 83	9 83

In respect of 64 units and above (over 70%) some of the constraints listed above did not exit at all. The inadequacy of R&D staff and supporting staff was expressed by 42 units (45%) and 38 units (41%) respectively. Non-the-less it is felt that the overall

impact of these constraints did not prove too heavy to pull down the overall R&D output of the organisations under study.

Problems stemming from the existence of vacant posts:

The situation arising out of inadequacy of R&D manpower owes much to the posts lying vacant in the institutions of various Ministries. This leads to the institutions being deprived of the manpower to exploit its full potential of more involvement in R & D activities. The posts left vacant as such impinge on the research output of the institutions.

The institution wise details of vacant posts are furnished in Annexure 9.2. But in respect of certain institutions, such vacant posts are supposedly very conspicuous in their impact. These institutions are:

Department of Health:

In the department of Health there were in all 518 vacant posts during the period under consideration with the grade wise dispersion as depicted in Annex. 9.2. It is noteworthy that more than 30 percent of the vacant positions belong to grade-7. Such a wide void at such a high level undoubtedly influenced the level of guidance expected from the scientists of such a seniority.

Department of Indian System of Medicine & Homeopathy:

The vacant posts in ISM&H were 41 but were mainly concentrated at grade-1.

Department of Industrial Policy & Promotion:

Even though a single unit under the Department of Industrial Policy and Promotion, the vacant post existing during the period were 98. But the bulk of the concentration was at the lowest four rungs of hierarchy.

Ministry of Information & Broadcasting:

This Ministry had the distinction of keeping 34 vacancies in grade-1 scientists thus being deprived of services of the scientists at the initial stage of scientific activities.

Ministry of Home Affairs:

The six research institutions under the ambit of this Ministry conducting research related with detection of crimes, had about 60 vacant jobs under their jurisdiction. Such a large number of vacancies had a dilution effect on R & D activities.

CHAPTER 10

Work Culture, Job Satisfaction, Problems & Prospects

The chapter is based on response to the scientist schedules by the R&D manpower of category B and above related with the institutions surveyed. As stated earlier, 2455 scientists responded to the questionnaire. The percentage of scientists that reported satisfactory perception of the work culture (defined by a set of parameters) prevailing in their respective institutions varied within a close range of 80 to 90 per cent. These variations are captured in the Table 10.1

Table 10.1

Perception of Work Culture in the Institutions (In percentage response)

Item	Satisfactory	Not- satisfactory	No response
Area of Work	91.08	2.48	6.44
Present Project	80.69	2.57	16.74
Work atmosphere	83.42	5.50	11.08
Support from lower staff	84.44	7.45	8.11
Encouragement from seniors	84.81	4.60	10.59

Note: Details are provided in Annex 10.1

Job Satisfaction:

In all 85% of the scientists reported job satisfaction and about 5% of the scientists said that they do not have it. About 10 % did not respond at all.

The job satisfaction percolates from top ranks to bottom rank of the scientists and there are not much of the variations in the levels of job satisfaction at different rungs of the ladder. This is manifested by the data presented in Annex 10.2 and summarized in Table 10.2

Table 10.2

Job Satisfaction – Grade wise (Per cent of scientists response)

Pay Scale	Satisfied	Not satisfied	Non-response
Grade 1	85.55	4.01	10.44
Grade 2	82.42	5.14	12.44
Grade 3	85.50	6.12	8.40
Grade 4	84.59	5.23	10.17
Grade 5	86.67	3.33	10.00
Grade 6	89.55	4.48	5.97

Grade 7	93.40	1.89	4.72
Grade 8	87.50	-	12.50
Grade 9	100.00	-	-
All grades	85.30	4.4	10.20

Suggestions at the Institutional Levels:

The problems encountered by the scientists in research activities have their origin in their respective institutions. These problems and their solutions have been stratified into 8 segments. Some of the problems are of severe nature while others are of only moderate significance. During the survey, it was quite evident that in almost every institution the problems related with infrastructure, lack of funds and shortage of technical manpower were quite severe. Other problems varied across institutions.

The institutional heads were requested to give some suggestions to improve the research worthiness of the institutions. But unfortunately, the response to this suggestions- seeking exercise was not very encouraging. A few opted to furnish suggestions. Their reactions are summarized as under:

A. Placement of full sanctioned strength of R&D scientists and supporting staff of different cadres should be ensured. The institute and various divisions should not be left headless for a very long time. The staff should be recruited after full scrutiny of their caliber.
Number of Responding Units = 3
B. The Institute should identify the areas of research well before the beginning of every financial year. Duplication of research conducted by the institution elsewhere in the country should be avoided to the extent possible. A close liaison between the institutions should be maintained.
Number of Responding Units = 3
C. With the overlapping areas of R&D activities should be encouraged and maintained.
Number of Responding Units = 1
D. Development of expertise in the specific areas of R&D activities of the Institute should be attempted as far as possible. This can be achieved through the exposure of scientists to various skills and knowledge up -gradation programmes such as training in India and abroad, active participation in seminars and workshops, availability of latest literature in the library on various areas of research etc.
Number of Responding Units = 1
E. Pay scales of scientists should be at par with those of other National Research Organizations for the comparable ranks. This will facilitate attracting the talented scientists and retaining them in the institute.
Number of Responding Units = 2
F. If the institute is located in remote areas, the basic facilities such as educational infrastructure for the children, medical and transport facilities etc should be adequately maintained to peg the talented scientists with the institute.
Number of Responding Units = 1
G. The institute should have a strong Personnel Policy in respect of promotion and rewards. Merit should be the only consideration at the time of recruitment of

scientists and research accomplishments and flair for R&D should be the criteria for recognition and reward and assessment should be unbiased by the seniors.
Number of Responding Units = 3
H. The researchers should have an upper hand in the day to day working of the institution and this will impart to them the feelings of recognition. The administrative division should be treated as supporting wing of the institution and provide the necessary inputs needed for R&D activities without much of the time consuming administrative formalities.
Number of Responding Units = 4
I. Cent percent self- generation of revenue and capital expenditure needed for R&D activities is expected from the R&D institute as against 3 decades of standing with full financial support hitherto from the government. This target is considered difficult to be achieved. At best this may be slashed to 50% of the revenue expenditure incurred annually by the institute on R&D activities. There should be adequate financial support for R&D activities whatever might be the sources of funds.
Number of Responding Units = 4

Suggestions of Scientists for Improvement of Research Competence of Institutions and R&D Manpower:

Similarly suggestions were solicited from the R&D personnel in the Scientist Schedule for betterment of research output of the individual scientists and ultimately the productivity of the institutions.

Number of scientists reported problems faced by them in carrying out research work in their respective institutions. For the purpose of analysis, these problems and their solutions have been grouped into 9 broad categories. The most common problems faced by the scientists are caused by inadequate infrastructure facilities such as ill-equipped laboratory facilities, insufficient space, interrupted supply of power etc.

Financial constraints facing the institutions were reported the most. Besides causing stagnation in promotional avenues, these constraints prevented the scientists from attending international seminars, symposia and training programmes. This restricted their exposures to the latest developments in fields of science and technology. There were also reports of shortages of auxiliary and technical staff in carrying out research activities followed by the scientists who complained about not receiving timely delivery of chemicals, raw materials and other inputs needed for continuance of research work.

Only 1117 scientists (45.5%) furnished their comments/suggestions. These are multiple in numbers.

Response

The response is summarized as under:

A. The project for research should be related with demand. There should a close interaction with the industry, academic institutions and other research institutions conducting research in similar areas to explore the possibilities of

<p>collaborative work. This will lead to optimal utilization of infrastructural facilities available in the country. Proper accountability and time frame be prepared for the various projects to avoid time over runs. Research should preferably be handled by a team headed by a competent project leader. Besides development of high-tech products based on orders from customers: some products may be first developed in- house and marketed commercially. Potential fields for diversification should be constantly explored.</p>
<p>Responding Number of Scientists = 354</p>
<p>B. Proper training in specified fields of research activities should be arranged in India and abroad. Scientists should be encouraged to participate in seminars/ workshops and collaborative scientific activities in India and abroad to update their scientific skill. The library should be adequately equipped with the latest literature on all the subjects of research normally dealt by the institution. There should normally be no resource constrains for updating library.</p>
<p>Responding Number of Scientists = 559</p>
<p>C. A congenial atmosphere to encourage research in the institution should prevail and this should be authenticated by the availability of resources and adequate incentives and improvement of pay scales and related benefits. There should be recognition of genuine research talent without any bias through institution of awards. Besides recognition, project allotment should be done based on previous experience and area(s) of expertise.</p>
<p>Responding Number of Scientists = 474</p>
<p>D. Administrative procedures should be simplified and revamped. Rules should be framed and interpreted in the best interest of research work. The administration should be treated as a supporting infrastructure of the institute and it should not waste time in avoidable paper work which in certain cases leads to time over in procurement of the essential inputs.</p>
<p>Responding Number of Scientists = 175</p>
<p>E. There should be involvement of all the related scientists of the team at the planning stage of the new project. There should be an active involvement of high-ranking scientists at all the stages of the project who should inspire all round indigenous development of technology and products.</p>
<p>Responding Number of Scientists = 143</p>
<p>F. There should be adequate availability of supporting staff of various cadres for smooth conduct of research assignments. New scientists should be made aware of function of all the supporting staff and the other divisions and should be encouraged to avail of their help in their research activities. At the selection stage, the R&D personnel should be scrutinized for their high qualifications and inclination for research work. The staff in research institutions should be non-transferable to ensure continuity and local maturing of expertise.</p>
<p>Responding Number of Scientists = 197</p>
<p>G. All scientists involved in R&D projects should be encouraged to present brief account of their research activities and findings periodically for a healthy over view of their work and appreciation. The senior should listen to their difficulties sympathetically and try to solve their problems within the framework of various constraints.</p>
<p>Responding Number of Scientists = 141</p>
<p>H. Infrastructure facilities like computer network, laboratory, library facilities with the latest relevant literature, gadgets/ implements, adequate qualified support</p>

staff etc should be available and updated. Adequate funds should be set apart every year to improve the infrastructure as the need arises.
Responding Number of Scientists = 636
I. R&D activities of an institute should be separate from its production functions and should have higher level of autonomy. There has to be higher element of flexibility in the functioning of R&D cell of a production unit Revenue generation be detached to extent of 50% of the total funds needed for R&D or R&D units are allowed to have 80% production oriented activities. But allotment of R&D projects should be independent of sales objectives.
Responding Number of Scientists = 200

Only 1117 (45.50%) of the total scientists contacted. furnished their comments and these comments are multiple in nature.

