

CHAPTER I

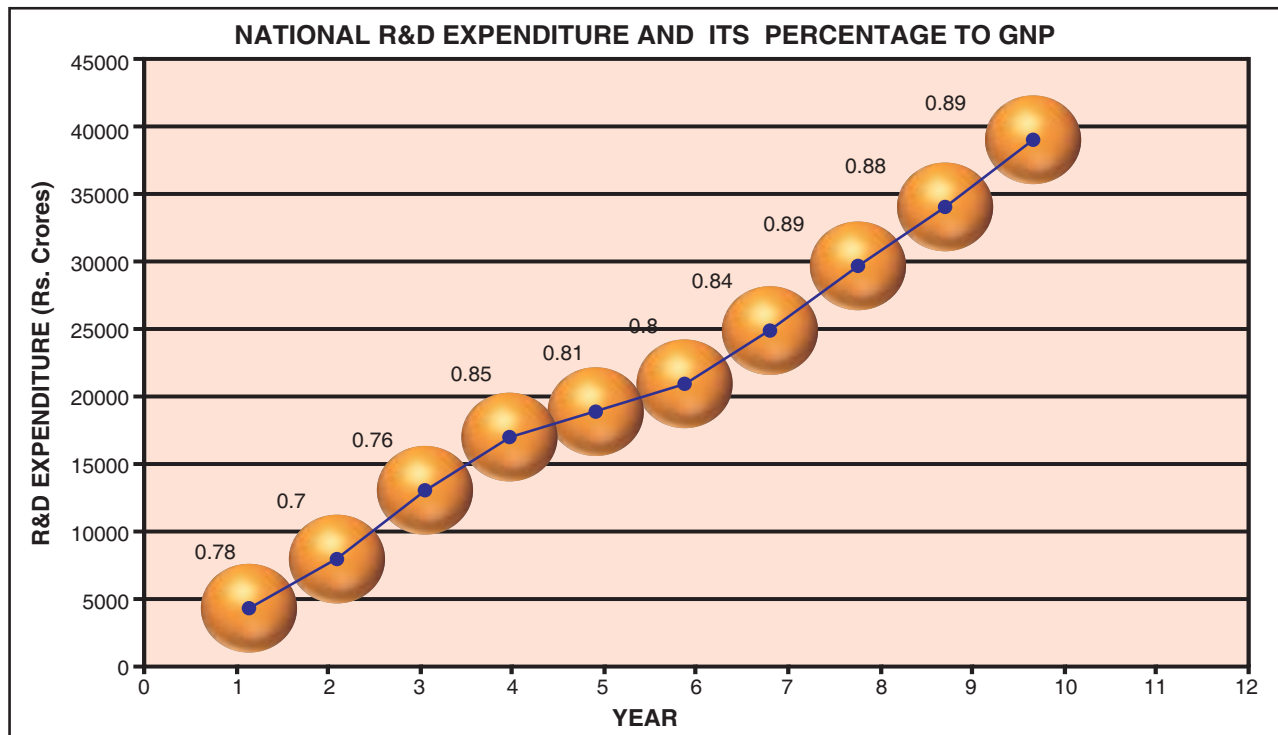
CHAPTER I

NATIONAL RESOURCES FOR RESEARCH AND DEVELOPMENT

The Indian R&D system can be grouped by way of a variety of performers and funding sources. The performers include the national laboratories, universities, in-house R&D laboratories and non-profit organisations. The funding sources include the Central Government, State Governments and the industry. In the Central Government, scientific research is carried out under both these groups. R&D performing bodies inter-alia included Department of Atomic Energy (DAE), Department of Space (DOS), Defence Research & Development Organisation (DRDO), Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR). In the R&D funding group fall the Department of Science & Technology (DST), Department of Bio-Technology (DBT), Ministry of Earth Sciences (MES) among others.

Although the primary role of R&D performing group is to undertake R&D by themselves, they also sponsor some amount of extramural research in the areas of their interest. On the other hand, the R&D funding group is primarily engaged in its major role of promoting scientific research in extramural mode. Research carried out by the Public Sector, Private Sector and Non-Governmental Organisations is supported mainly with their own sources. Whereas, Academic Sector performs R&D through both intramural as well as extramural sources.

It may not be out of place to mention that under this survey the scope and coverage of data on R&D expenditure and human resources has been revised and substantially enlarged to include multi-national companies and companies not covered by the



- Note:
1. The figure shown against the bubble indicates percentage of R&D expenditure to Gross National Product (GNP)
 2. Line shown in the bubble indicates R&D expenditure in Rs. Crores.
 3. Year 1- 98-99, 2-99-00, 3=00-01, 4=01-02, 5=02-03, 6=03-04, 7=04-05, 8=05-06, 9=06-07, 10=07-08.
 4. Data for the years 06-07 and 07-08 has been estimated.

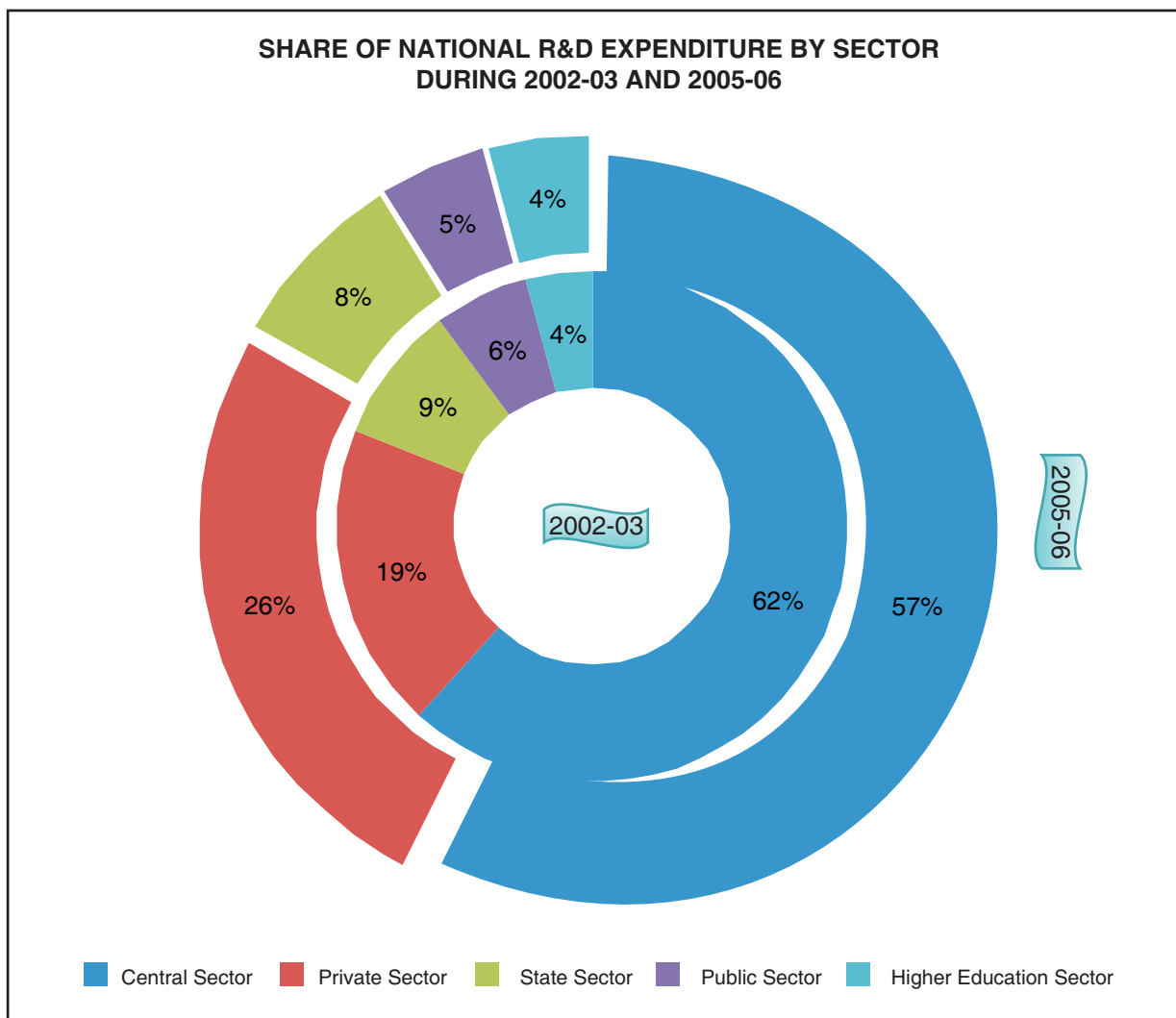
Department of Scientific and Industrial Research (DSIR) under its recognition scheme.

The National expenditure on Research and Development (R&D) has increased from Rs. 18088.16 Crores in 2002-03 to Rs. 20086.34 Crores in 2003-04. It further increased to Rs.24117.24 Crores and to Rs. 28776.65 Crores for the years 2004-05 and 2005-06 respectively. By applying the appropriate rates of growth for different sectors as observed from 2001-02 to 2005-06, the projected National R&D expenditure would attain a level of Rs. 32941.64 Crores in 2006-07 and Rs. 37777.90 Crores in 2007-08.

The compound annual rate of growth of R&D expenditure at current prices for the period 2002-03 to 2005-06 works out to be 16.7% and the rate of

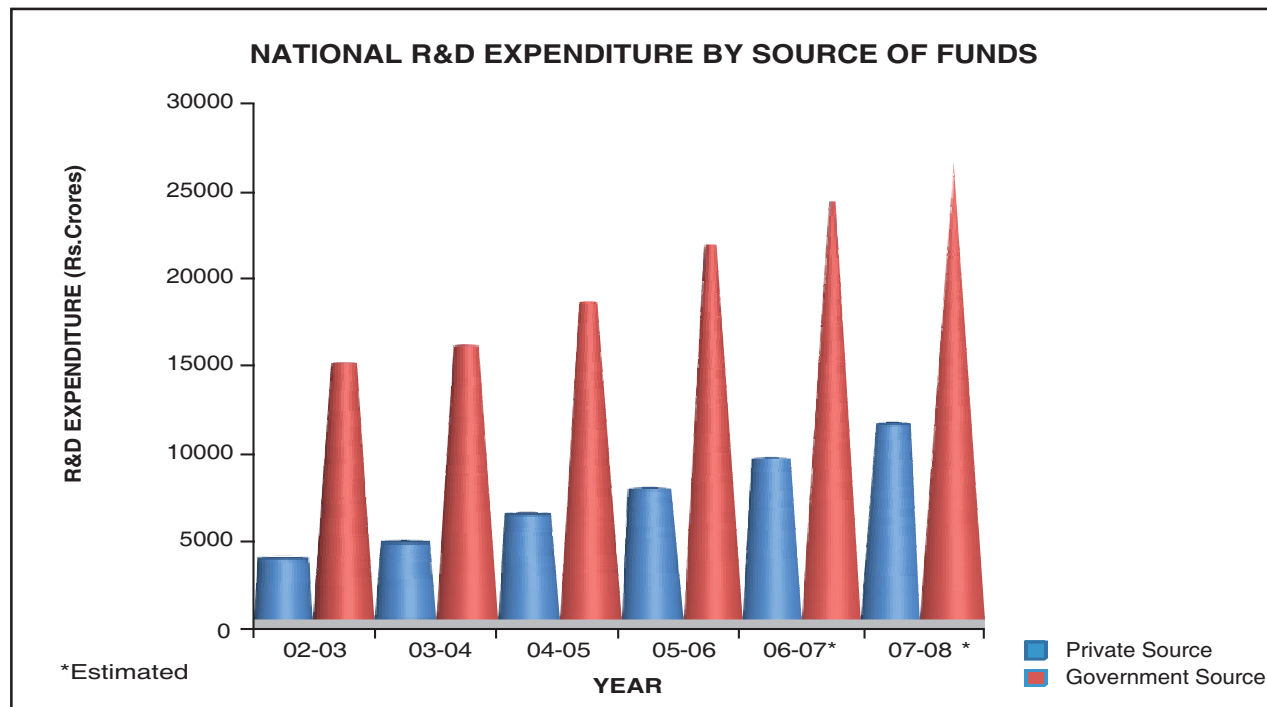
growth of R&D expenditure at constant prices for the same period is 12.0%. R&D expenditure at constant prices (base: 1999-00) has increased from Rs. 16353.72 Crores in 2002-03 to Rs. 17575.41 Crores in 2003-04 to Rs.19991.64 Crores in 2004-05 and further to Rs. 22963.91 Crores in 2005-06. R&D expenditure at constant prices has been worked out by using GNP price deflators as per Economic Survey 2007-08.

In the total R&D expenditure for the year 2005-06, the Central Government including Public Sector industries contributed 62.0%, Private Sector 25.9%, State Governments 7.7% and Higher Education Sector 4.4%. If one considers Industrial Sector as a whole comprising both Public and Private Sector, the share of Industrial Sector in the total National R&D expenditure increased from 25.3% in 2002-03 to 30.4% in 2005-06. The increase in the share of R&D



expenditure of Industrial Sector in the total R&D expenditure is mainly due to sharp increase in the share of Private Sector industrial R&D expenditure which has more than doubled from Rs. 3498.30 Crores in 2002-03 to Rs. 7444.21 Crores in 2005-06. The annual compound rate of growth for Private Sector R&D

that during this period the annual growth rate of GNP at current prices was higher (9.8%) compared to the annual growth rate of R&D expenditure at current prices (7.4%). The random variation in the value of R&D expenditure as percentage of GNP can be attributed to the random variation in the rate of growth



expenditure in this period was 28.6%, whereas, for Public Sector this was 6.6%.

Analyses have shown that 69.6% of the R&D expenditure was incurred by the Institutional Sector comprising of Central, State and Academic Sector and 30.4% was incurred by the Industrial Sector (both Public and Private) industries during the year 2005-06. Nearly three fourth of total R&D expenditure was met from Government sources during 2005-06. This is contrary to what one observes in the developed countries where the share of industrial sector in the national R&D expenditure is usually more than 50%.

R&D expenditure as percentage of GNP in 2005-06 was 0.89% as compared to 0.70% in 1995-96. Though in absolute terms the R&D expenditure has shown an increasing trend, the R&D expenditure as percentage of GNP has no fixed trend. The R&D expenditure as percentage of GNP has declined during the period 2000-01 to 2003-04 from 0.85% to 0.80% and then started increasing. Analyses have shown

of GNP as well as of R&D expenditure. The annual compound rate of growth of R&D expenditure at current prices for the period 1995-96 to 2005-06 was 14.4% whereas the growth rate of GNP at current prices was 11.8% for the same period.

As per Economic Survey 2007-08, GNP and GDP data has been revised and updated for all the past years shifting the base year to 1999-00. Accordingly, the R&D expenditure figures at constant prices and the ratio of R&D expenditure to GNP/GDP have also been revised.

R&D expenditure has been classified into 13 objectives based on UNESCO classification. Ideally, the R&D expenditure should be apportioned amongst the 13 objectives based on project wise expenditure. But such an exercise being not feasible, each R&D institution has been assigned to a specific objective depending upon its predominant activity. On this basis, the share of R&D expenditure by different objectives is given in Table 1.1.

Table 1.1

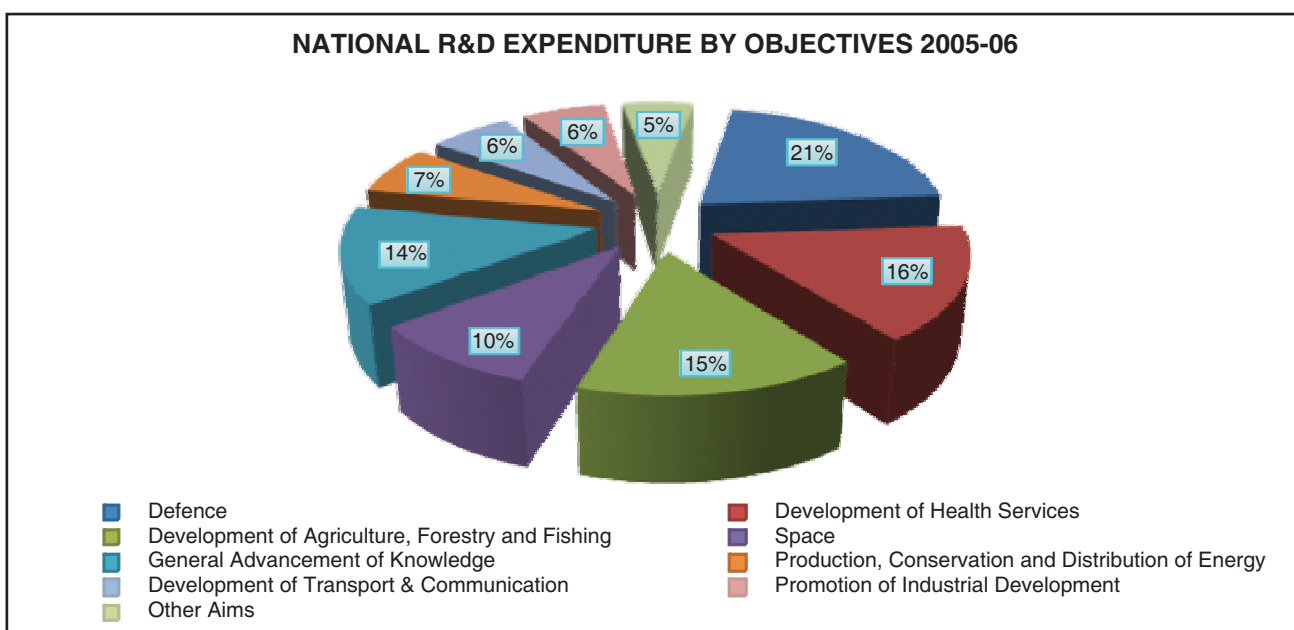
**PERCENTAGE SHARE OF NATIONAL RESEARCH AND DEVELOPMENT
EXPENDITURE BY OBJECTIVES, 2005-06**

Objective	Percentage
Defence	21.1
Development of Health Services	15.8
Development of Agriculture, Forestry and Fishing	15.3
General Advancement of Knowledge	13.5
Space	9.7
Production, Conservation and Distribution of Energy	6.8
Development of Transport & Communication	6.3
Promotion of Industrial Development	6.3
Exploration and Assessment of Earth, Seas, and Atmosphere	1.9
Other Aims	1.8
Protection of the Environment	0.9
Social Development and other Socio-Economic Services	0.6
Urban and Rural Planning	0.1
Total	100.0

More than three-fourth of total R&D expenditure was accounted for by five objectives-Defence, Development of Health Services, Development of Agriculture, Forestry and Fishing, General Advancement of Knowledge and Space in decreasing order.

The expenditure for S&T activities has been classified by type of work based on the estimates provided by the R&D institutions in the central and

state governments excluding higher education. Such a classification of expenditure by type of work is not available for the industrial sector. During the year 2005-06, the percentage share of Basic Research was 26.0, Applied Research 36.3, Experimental Development 31.8 and the related supporting activities was 5.9. Table 1.2 gives the break-up of S&T expenditure by type of work for the year 2005-06.



The share of R&D expenditure as percentage of total expenditure incurred by the Central Government in decreasing order among the major scientific agencies is presented in Table 1.3.

Table 1.2
PERCENTAGE SHARE OF NATIONAL S&T EXPENDITURE BY TYPE OF WORK, 2005-06

Type	Percentage
Applied Research	36.3
Experimental Development	31.8
Basic Research	26.0
Other Activities	5.9

These agencies accounted for a share of 86% of the total Central Government R&D expenditure including the expenditure incurred by Public Sector in-house R&D units and 53.3% of the National R&D expenditure.

Table 1.3
PERCENTAGE SHARE OF R&D EXPENDITURE BY MAJOR SCIENTIFIC AGENCIES, 2005-06

Scientific Agency	Percentage
Defence Research and Development Organisation (DRDO)	34.4
Department of Space (DOS)	17.4
Department of Atomic Energy (DAE)	11.4
Indian Council of Agricultural Research (ICAR)	11.4
Council of Scientific & Industrial Research (CSIR)	9.3
Department of Science and Technology (DST)	7.7
Indian Council of Medical Research (ICMR)	2.2
Department of Biotechnology (DBT)	2.0
Ministry of Ocean Development (MOD)	1.5
Ministry of Environment & Forest (MEF)	1.5
Ministry of Communication & Information Technology (MIT)	1.0
Ministry of New & Renewable Energy (MNRE)	0.1
Total	100.0

It may be seen from Table 1.3 that five major scientific agencies - DRDO, DOS, DAE, ICAR and CSIR account for 83.9% of the total R&D expenditure

incurred by the major scientific agencies. DRDO alone accounts for a share of 34.4%.

Industrial Sector R&D expenditure, comprising both Public and Private Sector, has increased from Rs. 4576.37 Crores in 2002-03 to Rs. 5562.30 Crores in 2003-04. It has further increased to Rs. 7296.84 Crores and to Rs. 8748.47 Crores in 2004-05 & 2005-06 respectively. The share of Private Sector investment on R&D in the Industrial Sector has increased from 76.4% in 2002-03 to 85.1% in 2005-06, whereas, the share of Public Sector during this period has decreased from 23.6% to 14.9%. It may be mentioned here that the investment on R&D by private industries has more than doubled from Rs. 3498.30 Crores in 2002-03 to Rs. 7444.21 Crores in 2005-06 and the same is expected to reach the level of Rs. 11192.86 Crores in 2007-08. Private Sector has large number of R&D units compared to Public Sector, however, in terms of size of the firm the Public Sector R&D units are larger when compared to Private Sector.

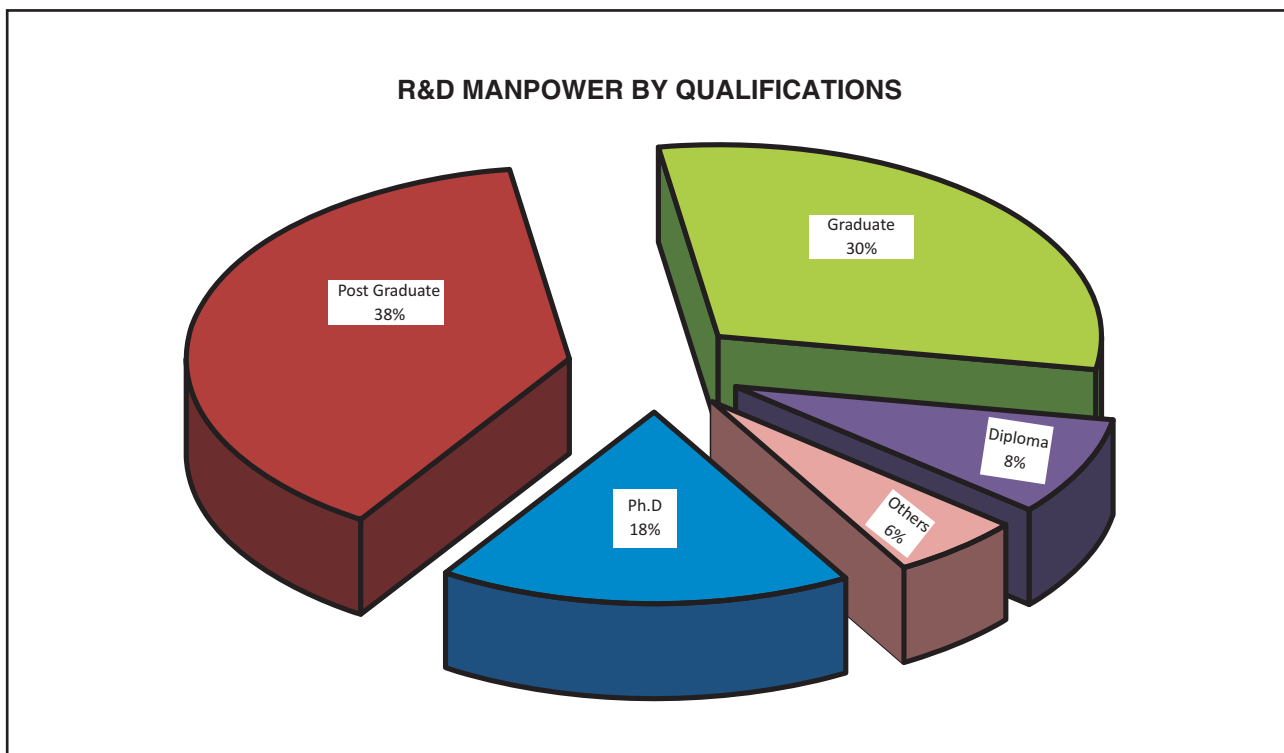
While more detailed analyses on personnel employed in R&D establishments is provided in the chapter on "Scientific and Technical Manpower", some highlights on quantity and qualification of R&D personnel are discussed below.

As on 1st April, 2005, 3,91,149 personnel were employed in the R&D sector. About 77.7% of them were employed by the Institutional Sector and 22.3% by the Industrial Sector. Out of the total, 39.6% of the personnel were engaged primarily on R&D work, 27.0% were performing auxiliary (technical support) activities and 33.4% were doing administrative and other non-technical activities. It can be assumed that those directly engaged in R&D activities and those extending technical support (that is auxiliary personnel) are by and large qualified as S&T personnel. With this assumption, it may be estimated that 2,60,635 S&T personnel were deployed in R&D sector as on 1st April, 2005. Out of this number, 1,54,827 were employed directly on creating new knowledge. This works out to be 3.2% of the total estimated stock of S&T personnel for the year 2001.

Out of 1,54,827 personnel engaged primarily in R&D work, information regarding field of specialization and educational qualification was available for 1,16,175

R&D personnel. The analyses of this data showed that 47.6% of total R&D personnel had specialization in Engineering/Technology, 29.8% in Natural Sciences, 12.1% in Agricultural Sciences, 8.1% in Medical Sciences and rest 2.4% in Social Sciences. In the Institutional Sector comprising of Central Government, State Governments and Higher Education the deployment of R&D personnel by major disciplines has shown that 42.0%, 32.0% and 19.6% were respectively from Engineering/Technology, Natural Sciences and Agricultural Sciences while in Industrial Sector comprising of Public and Private Sector industries, 53.4%, 27.5% and 12.5% were respectively from Engineering/Technology, Natural Sciences and

There were 19,707 females directly engaged in R&D activities (female R&D personnel) which form only 12.7% of the total R&D personnel engaged in R&D work. Information related to field of specialization and qualifications were available for 14,375 candidates engaged in R&D activities. The analyses of this data showed that Engineering & Technology shared 39.0%, Natural Science 29.9%, Medical Sciences 14.8%, Agricultural Sciences 10.3% and Social Sciences 6.0%. By level of qualifications they were comprised of 18.7% Ph.Ds, 39.2% Post Graduates, 31.6% Graduates and 10.5% Diploma Holders and other qualifications. In case of Institutional Sector 73.9% of total females possessing



Medical Sciences disciplines. The composition of R&D personnel by level of qualifications has indicated that 17.5% were Ph.Ds, 38.2% were Post Graduates, 30.3% were Graduates, 14.0% were Diplomas and Others (not classified under the above level of qualifications). It may also be mentioned that 76.6% of total Ph.Ds and 55.0% of total Post Graduates were employed in the Institutional Sector. It appears from the above given analyses that Institutional Sector is employing more qualified personnel on R&D as compared to Industrial Sector.

Ph.Ds were deployed on R&D activities, whereas, for Industrial Sector this was 26.1%.

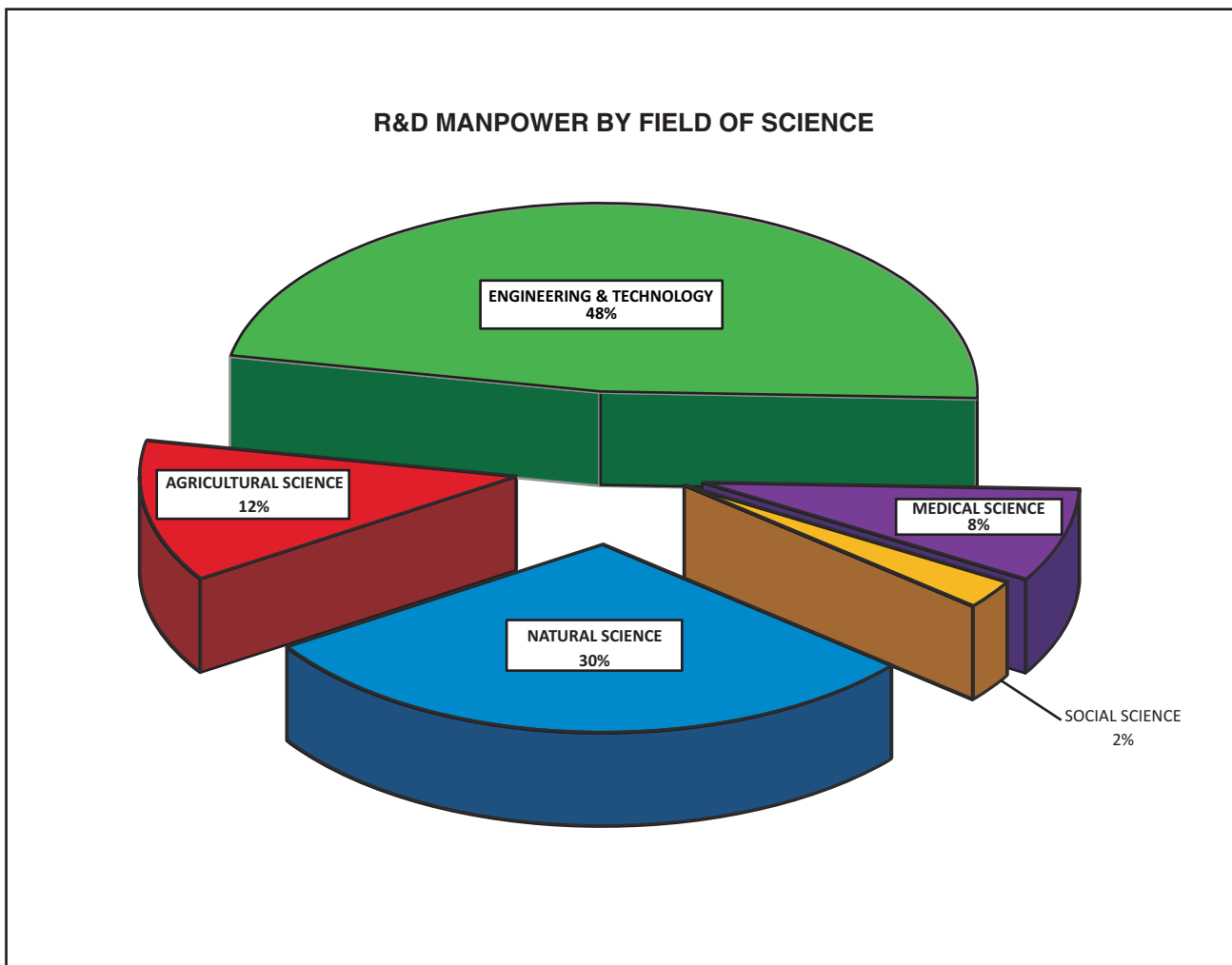
International comparison of R&D efforts provides an opportunity to understand the country's position in relation to other countries. Most of the developed countries spend over 2% of their GDP on R&D but developing countries spend around 0.5% with a few exceptions. R&D spending of 0.89% of GDP in India was, though no doubt higher than a number of developing countries, the country needs to enhance its R&D expenditure in order to attain the level of 2%.

India has 140 researchers per thousand population whereas the same for Sweden, Japan, Denmark and U.S.A. was 6139, 5546, 5277 and 4651 respectively. However, in terms of total researchers, USA tops the list with 13.90 lakhs researchers followed by China and Japan with 12.15 lakhs and 7.10 lakhs researchers respectively.

Questions are often asked whether the output of R&D is commensurate with the level of investment made by the country. No precise model has so far been evolved to evaluate the output of R&D. In the absence of such rigorous indicators, an attempt is made to look at some of the parameters even if they are only indirect efficiency indicators. Patent statistics is considered to be one such indicator. If one looks at the data for the period 1976-2006, the number of applications filed for granting patents every year varied between 2,870 and 28,940. It was highest for the year

2006-07. The number of patents granted varied between 780 to 7,539 during 1976-2006 and it was highest in 2006-07. The number of patents in force as of 2006-07 was 17,066. The state-wise distribution of number of patent applications filed by Indians shows that about 73.4% were from Maharashtra, Delhi, Karnataka and Andhra Pradesh during 2006-07. As is well known, many foreign nationals take patents in countries other than their own with a view to tap the potential of their products there.

The number of patents sealed in the name of foreigners was almost two to three times those sealed in the name of Indians. During the year 2006-07 the number of patents in force in the name of foreigners in India was 79.6%. The number of foreign patents in force has declined from 19,780 in 1976-77 to 13,593 in 2006-07. USA accounted for 8,389 out of 23,626 total foreign applications made during 2006-07.



To sum up, the salient features are as follows:

- ❖ The National R&D expenditure has increased from Rs. 18088.16 Crores in 2002-03 to Rs. 24117.24 Crores in 2004-05 and further to Rs. 28776.65 Crores in 2005-06.
- ❖ The share of R&D expenditure of the Central Government including Public Sector industry was 62.0% during 2005-06.
- ❖ R&D expenditure by Institutional Sector was 69.6% of the total National R&D expenditure and the rest 30.4% was incurred by Industrial Sector comprising both Public and Private Sector industry during 2005-06.
- ❖ India has spent only 0.89% of her GNP on R&D during 2005-06 as compared to 0.70% in 1995-96.
- ❖ Major scientific agencies accounted for 86.0% of the total R&D expenditure of the Central Government including Public Sector in-house

R&D units. At national level, major scientific agencies have shared 53.3% of total R&D expenditure.

- ❖ 83.9% of total R&D expenditure of the major scientific agencies under the central government including public sector was accounted for by five agencies - DRDO, DOS, DAE, ICAR and CSIR in that order with DRDO accounting for a major share of 34.4%.
- ❖ As on 1st April, 2005, there were 3,91,149 personnel employed in the R&D sector. Out of these, 1,54,827 personnel were employed directly on R&D work.
- ❖ Information regarding field of specialization and educational qualifications was available for 1,16,175 R&D personnel. About 48.0% of this had specialization in Engineering & Technology and 29.8% in Natural Sciences.
- ❖ Institutional Sector employed 76.6% of total Ph.Ds and 55.0% of total Post-Graduates.