EXECUTIVE SUMMARY

Science and Technology have always been an integral part of Indian culture. Natural philosophy, as it was termed in those ancient times, was pursued vigorously at institutions of higher learning. The Indian Renaissance, which coincided with our independence struggle, at the dawn of 1900s witnessed great strides made by Indian scientists. This innate ability to perform creatively in science came to be backed with an institutional setup and strong state support after the country's independence in 1947. Since then, the Government of India has spared no effort to establish a modern S&T infrastructure in the country. One mode of making this investment is by providing funding support to S&T research. A large number of scientific agencies/departments/ministries of the central government provide funding support to S&T research in the form of extramural or sponsored R&D projects, with the aim of building research capability and S&T infrastructure in the country.

The Department of Science and Technology plays a pivotal role in promotion of science and technology in the country. National Science & Technology Management Information System (NSTMIS) division of Department of Science & Technology (DST), GoI has been continuoesly compiling the outcome of extramural research to assess and disseminate the output of these projects supported by various public funding agencies. The division is compiling information on extramural R&D projects annually and also published a 5-year analysis of the funding pattern to study the trend and understanding the dynamic S&T landscape of extramural R&D. With the cooperation of all the R&D funding agencies/departments/organizations, NSTMIS division has already published six reports on the funding pattern of the sponsored research by scientific agencies for the periods 1985-90, 1990-95, 1995-2000, 2000-2005, 2005-2010 and 2010-15. The division has also analysed the outcome of R&D projects funded during 1995-2000, 2000-2005, & 2005-2010 and published the reports. Taking it further, the present study analyses outcome of the extramural R&D projects funded during the period 2010-2015.

The study has analysed the information received from all the R&D projects, funding agency-wise, subject area-wise, year-wise, types of institute-wise, state-wise, city-wise, project cost-wise, PIs age-wise, and PIs gender-wise. The analysis is described in two parts namely-

- Support to extramural R&D projects by S&T agencies

- Outcome of extramural R&D projects

Support to extramural R&D projects:

The support to extramural R&D projects is based upon the information collected from the annual EMR directories published for the five years period. During the period 2010-2015, total amount of Rs. 10,504.27 crore was approved for funding of 27900 projects sanctioned by 21 central government departments and agencies.

During this period, major sponsors of R&D projects were DST (9808), UGC (8175), DBT (2921), ICMR (1913) and CSIR (1778), accounting for more than 88% of the total number of projects sanctioned. In terms of funding support, DST was at top (Rs. 3591.53 crore), followed by DBT (Rs. 2671.79 crore), MOCIT (Rs. 1188.55 crore) and ICMR (Rs. 658.92 crore). These four scientific agencies accounted for 77% of the total extramural R&D funding. An interesting pattern was emerged from these data – in case of UGC, number of projects sanctioned was second largest but in funding support, it was at fifth place while in case of MOCIT, it was at tenth place in number of project but got third place in funding support. This was attributed to high cost per project in MOCIT and low cost per project in UGC.

Among the various subject areas, biological sciences received the maximum support by way of number of projects (29.95%), followed by engineering and technology (18.88%), chemical sciences (14.55%) and medical sciences (14.46%). These subject areas together accounted for 78% of total number of projects sanctioned.

Year-wise analysis of projects supported has **interesting to note that number of project and amount sanctioned are both declining from 2010-11 to 2012-13 with slight increase in after that.** A total of 5855 projects were supported in 2010-11 which were higest in all the five-year period.

The outreach of extramural R&D support confined mainly to the academic sector comprising of universities, colleges and institutes of national importance (80%) while national laboratories had 7% projects and remaining 13% went to others category.

Although colleges & universities awarded maximum number of projects from funding agencies, the average cost per project was only Rs. 20 lakh, while in case of other institutions it was Rs. 70 lakh, national laboratories Rs. 68 lakh, deemed universities Rs. 73 lakh and institutes of national importance Rs.51 lakh.

About 71.66% of the projects were sanctioned to the institutions located in eight states viz. Andhra Pradesh, Delhi, Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh and West Bengal. These states also received 73% of total funding during the reporting period.

During the reporting period, 630 cities/towns were covered under EMR projects. Among these locations, institutions based in six metro cities received 29% of total projects. 107 cities had 50 or more projects.

The maximum number of projects approved (10748) were in the middle cost range while minimum (868) projects approved were in ultra high-cost range category. **As the cost-range increased, the number of R&D projects decreased**.

Gender-wise analysis of PIs who undertook these R&D projects indicated that the number of R&D projects with women PIs was small as compared to projects carried out by male PIs. 7813 projects had women PIs while 20046 projects had male PIs.

Outcome of extramural R&D projects:

The analysis of outcome of extramural R&D projects is based on the response to the questionnaires received from the 10950 (39.3%) projects out of total 27900 projects sanctioned during the period 2010-2015.

Department/funding agency-wise analysis reveals that 21 scientific department/agencies under central government supported these extramural R&D projects. The highest response rate of around 54% was of projects supported by Department of AYUSH followed by AICTE (46%), MoSJE (44%) and MoCIT (41%). In absolute terms, the highest response was received from the DST-funded projects (3791), followed by UGC-funded (3354), DBT-funded (1084) and ICMR-funded (760) projects. These four funding agencies accounted for nearly 82% of the responded projects under analysis.

The highest number of research papers were published from the projects funded by DST. Among different funding agencies, the share of DST is highest (around 37%) in the total publications/presentations of research papers, followed by UGC (27%), DBT (10%), ICMR (7%) and CSIR (6% papers) funded projects.

The significant revelation from the analysis is that the PIs of the sponsored projects published more papers in foreign journals (25043) than in Indian journals (7596) - almost 3.1 times. This shows that the PIs sent a greater number of quality research papers for publication in foreign journals which were accepted and published by them.

The analysis of 10950 R&D projects shows that these projects resulted in the development of 6358 new products, 2410 new processes, 990 new prototypes, 553 new instruments, 1085 new leads and 728 new principles/theories.

DST leads in almost all fields like new products, new processes, new prototypes developed, intellectual property rights (IPR's) registered, patents filed, patents sealed, new theories and new instruments developed.

A total of 789 patents were filed and 164 patents were obtained. In filing and sealing of patents, the DST-funded projects were on the top with 334 patents filing (283 in India and 51 in foreign countries), and 77 patents sealed (43 in India and 34 in foreign countries) during the period 2011-2015. It was followed by UGC with filing of 168 patents (113 in India and 55 in foreign countries) and CSIR-funded projects with 37 patents granted (9 in India and 28 in foreign countries). **The DST-funded projects obtained highest number (100) of copyrights.**

The specialised manpower generated from all the analysed R&D projects included 6522 PhD, 8 DSc, 869 MPhil, 33 MD and 2826 MTech. The share of DST-funded projects was maximum in almost all categories of manpower generation with 2361 PhD, 1225 MTech and 314 Mphil while ICMR funded projects was at top with 12 MD produced. The second highest number of PhDs were produced by projects funded by UGC (1679) followed by DBT (738) and ICMR (458).

A total of 21786 personnel were employed in different categories by all the projects analysed. The scientific staff (16974) included JRFs (5316), followed by SRFs (1826), RAs (1283), Engineers/Doctors (2125) and other scientific staff (6424). Agency-wise analysis shows that DST-funded projects employed highest number of scientific personnel (8808), followed by UGC (3004), DBT (1362), ICMR (886) and CSIR (794) funded projects.

Among the subject areas, biological sciences (8433 projects), engineering & technology (5240 projects) & chemical sciences (4309 projects) were main recipients of projects as well as funding while mathematics with 1214 projects was at bottom in both number of projects and funding. Although

engineering & technology has lesser number of responses than biological sciences it had more new processes (641), new prototypes (342) and new intruments (178) developed to its credit. **The highest numbers of Patents filed and sealed were in the area of engineering & technology followed by biological sciences and chemical sciences.** As far as research papers are concerned, maximum number of papers were published in the area of biological sciences (17009) followed by engineering & technology (10580), chemical sciences (8401) and physical sciences (7195).

The analysis of Institute-wise outcome revealed that the outreach of the R&D support was confined mainly to the academic sector. As colleges & universities were awarded maximum number of projects by the funding agencies, the outcome has also reflected similar patterns in publication/presentation of research papers, development of new products, processes, instruments, prototypes, principles/theories, varieties, filing & sealing of patents, producing PhDs, employing JRF, SRF & RA etc.

The PIs age-wise analysis of sponsored R&D projects gives an interesting finding that PIs above 55 years of age have outperformed on most of the outcome parameters. This category of PIs gave maximum response to questionnaires (21%), published second highest research papers (11887) and developed highest number of new processes (503), new and new varieties (222).

A look at the cost range-wise analysis indicates that the highest number of JRF (2099) SRF (733), RA (521) and number of engineers & doctors (1600) were employed in middle cost range projects. Employment of scientific personnel was found to be inversely proportional to the cost range of projects. In other words, **as the cost-range of EMR projects increased, number of personnel employed in projects decreased. When very high and ultra high costing projects were further analysed, it was found that infrastructure support (scientific equipments) was major component in these projects which lead to increase in their cost and not the manpower.** In the high-cost range, very high-cost range and ultra high-cost range, the number of persons employed gradually decreased with the increase in the cost range of the projects.

Out of total 789 patents filed and 164 patents obtained at national and foreign levels, the very high-cost range projects (50 lakh to less than 1 crore) obtained 2 patents out of 70 patents filed. The middle cost range projects (10 lakh to 25 lakh) could obtain 93 patents while filed 380 patents.

The gender-wise analysis of R&D projects and their performance is a novel aspect of the report. It is seen that the share of women as PIs in extramural R&D projects was small, only 22.64%. In terms of outcome, the women PIs published 8818 papers in journals (6667 in foreign and 2151 in Indian). They also participated in Indian and foreign conferences and presented 6159 papers. **The performance of female PIs in terms of development of new products, processes, prototypes, varieties, etc. per project has been found quite good and comparable with male PIs. In terms of number of manpower generated per project, the number is comparable in each category of degree/diploma with male PIs**. Thus, projects with women as PIs are in no way behind the men as PIs in terms of performance.

Number of problems were faced by the PIs in carrying out EMR projects and some common one was: **delay in approving the project, curtailment of budget for equipment, delay in the releasing of next instalment of grant, lack of infrastructure facilities, resignation of project staff at crucial time, lack of motivation among students for research** etc. These should be looked into by the funding agencies.

Based on the study, few conclusions and recommendations are made. Prominent among them are **need for central repository of Project Completion Reports (PCRs) in every funding department/agency**, **need for uniformity in project completion report (PCR) of all funding agencies**, **more use of IT in data collection, women participation in extramural R&D needs to be encouraged by funding agencies** and **increasing awareness of R&D schemes in all states to maintain regional balance.**