

REFORMS AND ACTION POINTS TO STRENGTHEN SCIENCE, TECHNOLOGY AND INNOVATION ECOSYSTEM IN INDIA



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INDIA of the 21st century is an emerging country with an aspiration of faster, sustainable and inclusive growth. As Science and Technology (S&T) emerges globally as one of the major drivers of socio-economic development, it has to play a major role in achieving the desired goals.

The country offers a unique opportunity in the form of the large demographic dividend and a huge talent pool for national development through its excellence, relevance and performance. In the fast-growing Indian economy, there is an increasing demand for scientific inputs for problems in a variety of socio-economic, industrial and strategic sectors. It is high time that India, as a fast-growing nation, converts those challenges into opportunities.

To achieve this, several S&T interventions are required. Some of the emerging challenges being faced by the S&T sector include low investment in R&D; inadequate linkages amongst the academia, the researchers and the

industry; weak innovation ecosystem to convert ideas into useful acceptable products and processes; poor coupling between technology and trade; low base of full-time equivalent scientists per million populations, etc.

The following reforms are needed to strengthen our science, technology and innovation ecosystem.

Reforms in S&T for Societal Development

Science & Technology/Research & Development must be geared up for solving national problems by providing clean and potable water, enhancing food productivity and nutritional values, providing affordable healthcare solutions, energy security, tackling climate change and National security through S&T interventions. Such measures are necessary, particularly because the mere development of technologies and technology solutions are not adequate to solve major national problems.

The delivery of R&D outputs and linkages with the user community are essential. End-to-End solutions, based on technologies, call for strong internal linkages amongst the Indian science sector as well as with relevant socio-economic ministries of both the central and the state governments.

Action Points

- A suitable oversight and monitoring mechanism may be formed to oversee the implementing sector-specific R&D mission programmes/projects.
- Six sector-specific Task Forces on R&D mission on water, agriculture, health, energy, climate change and National security may be constituted.

Reforms in S&T/R&D for Global Impact

India ranks at the 6th position in scientific publications and 10th in patents, which includes only resident applications.



The total number of patent applications filed by scientists and inventors in India increased to 61,788 in FY 2018-19 (up to December 2018) from 47,857 in the FY 2017-18. India ranks at the 12th position in the Nature Index in 2020 (<https://www.natureindex.com/annual-tables/2020/country/all>), based on counts of high-quality research outputs in natural sciences. India improved its rank on the Global Innovation Index for the second year consecutively. From being ranked at the 81st position in 2015, India improved its ranking to 52nd in 2019 and further to 48th in 2020. This shows that Indian R&D has the potential to make a global impact.

Action Points

- Increase public investment in R&D and encourage the private sector to invest in R&D.
- Double the present strength of the total number of full-time equivalent of R&D personnel.
- Focus R&D on emerging disruptive technologies like big data, automation, AI, IoT, Blockchain, Cyber Security, Micro-Electro-Mechanical Systems (MEMS), Nanotechnology, Biotechnology, Energy Storage, Genetics, 3-D printing, etc.
- Formulate mission-mode projects on National Mission on Interdisciplinary Cyber-physical Systems and National Mission on Quantum Technologies and Applications.
- Identify global issues and initiate global collaborative R&D leveraging mechanisms like Global Innovation and Technology Alliance, Department of Science and Technology.

Reforms in S&T/R&D for Breaking Silos, Infusing Team Spirit & Competitiveness

There is a need to work in the mission mode, as an integrated S&T community, and fill the translational gaps through definite goals. It has become imperative to bring in more synergy between the Government, the public and the private institutions also. It is envisaged that different departments/laboratories will work together on identified projects and ensure that not only is the technology developed, but it is also transformed to reach the targeted segment of the society.



Action Points

- Identify multi-agency S&T missions.
- Sign MoUs between S&T departments/labs/institutions and universities to facilitate collaborative and interdisciplinary R&D.
- Create mechanism for mobility of scientists from R&D labs/academic institutions to industry and vice versa.
- Create a common portal for facilities available in each lab and academic institutions for sharing them with the research community.
- Revive S&T Advisory Committees (STACs) in each Ministry and Inter-Sectoral S&T Advisory Committee (ISSTACs) of the Department of

Science and Technology (DST), Government of India, for identifying sectoral S&T interventions.

- User Ministries to contribute 1% of their budget to a non-lapsable fund operated by an Inter-Ministerial body for merit-based R&D funding of socially relevant technologies.
- Identify major areas of S&T interventions for addressing national priorities during the next 3-5 years.
- Identify futuristic S&T areas for international competitiveness.
- Pursue technology development in areas identified in the Technology Vision 2035 of the Technology Information, Forecasting and Assessment Council (TIFAC).

Reform in S&T/R&D for Commercialisation of Technologies Developed in Government Laboratories

Some institutions have in-house mechanisms for technology transfer. However, there is a need to set up a dedicated institution for technology transfer. This will take care of the sourcing, designing, packaging, consultancy, field verification, marketing, backup support and dissemination of technology, etc.

Action Points

- Ensure industry partnership right from the conceptualisation stage of technology development projects.
- Create a comprehensive National Technology Portal of indigenous technologies available for commercialisation. The National Innovation Foundation has recently launched the National Innovation Portal, which includes grassroots innovations which are ready for commercialisation. This portal can be scaled up and its focus may be elevated to include all the national innovations ready for technology translation.
- Create an empowered Technology Commercialisation Cell/Value Addition Centre in each lab, with an appropriate budget, for:
 - * up-scaling the technologies,



Reforms in S&T/R&D for Encouraging PPP in R&D

The competitiveness of the nation is determined by its ability to translate inventions into successful technologies. Such translation can be achieved only by cooperation and collaboration with the private sector. There is a need to evolve operating models of Public-Private Partnership (PPP) in R&D. The following are possible reasons for the PPP in R&D falling short of expectations:

- R&D programmes/projects are risky and the percentage of failure is high.
- Funding agency provides loans to private partners, but in case of failure, honest risk-takers are penalised.
- Funding agencies are hesitant to disburse loans to private industry because of fear of not being able to recover the fund invested.
- Present investment in PPP in R&D is very meagre.
- Excessive auditing.

Action Points

To attract industrial funds into applied research areas, following is suggested:

- *Contribution by a start-up company in PPP in R&D, at the demonstration stage, may be exempted from taxation.*
- *Loan provided to the industry shall carry much lesser rate of interest, compared to the market rate.*
- *An Innovation Development and Translation Board (IDTB) may be established to administer the fund for PPP in R&D.*
- *An umbrella fund, i.e. Innovation Development and Translation Fund (IDTF) may be created under the IDTB.*

- * *demonstrating industrial-scale pilot production,*
- * *coordinating with investors for incubation of entrepreneurs,*
- * *bridging the gap between industry and development team,*
- * *formal technology transfer,*
- * *commercialisation and marketing and*
- * *technology consultancy services.*

(TBIs) and 6 Research Parks have been approved by the National Expert Advisory Committee (NEAC). This is a joint initiative by the Department of Science and Technology and the Ministry of Human Resource Development under the Start-up India scheme.

Further, Patent Rules, 2003 and Trade Mark Rules, 2017, have been amended to streamline processes and make them more user-friendly. Start-ups Intellectual Property Protection (SIPP) scheme was launched to encourage innovation and creativity in start-ups. Under this scheme, 80% rebate for patent filing fees and 50% for trademark filing is provided to the start-ups. Support for International Patent Protection in Electronics and Information Technology (SIP-EIT) offers reimbursement of up to 50% of expenses incurred in patent filing on the actual expenditure, whichever is less.

Action Points

- *Government authorities can incentivise angel investments by, for instance, abolishing the angel tax or giving other kinds of tax benefits.*
- *Government should set-up a seed fund and give grants to start-ups as effective initiatives.*
- *More start-ups should be acquired by large, established companies so that it is easier for them to capture markets.*

Reforms in S&T/R&D for Strengthening Start-up Ecosystem

India has been ranked 20th among 100 countries, based on the strength of its start-up ecosystem in the year 2020 (<https://www.startupblink.com/startups/india>). To develop the Start-up culture, Government grants like Fund of Funds for Start-ups, India Aspiration Fund, Venture Capital Scheme and Multiplier Grants Scheme are currently operational.

Besides, 13 Atal Incubation Centers (AICs) are established by the NITI Aayog to foster 5,000-6,000 innovative Startups. 1500+ start-ups have been incubated in 13 AICs in the first phase, with close to 10% focusing on women empowerment. 5,415 schools have been selected till March 2019, and a target of 10,000 schools has been set for establishing Atal Tinkering Labs by the end of 2020. 13 Start-up Centres, 16 Technology Business Incubators



Atal Incubation Centers

- *Funds under PPP should be non-lapsable.*
- *Intellectual Property (IP) should be exclusively licensed to the industry, and the Industry concerned will commercialise the product within a specified time scale.*

Reforms in S&T/R&D Sector for Improving S&T Management System

It has to be recognized that scientific research flourishes in a more relaxed ambience when administrative and financial support system is more a facilitator than a controller. Autonomy, freedom for individual ideas, flexibility to carry forward promising ideas in a selective manner, in a framework driven by peers, liberal funding, a responsive engagement with academic, societal and industrial domains and sustained collaborative exchange with similar high-quality international research programmes, are key features of a conducive ecosystem for research. Development of technology, in addition, needs a more organised and coordinated effort by different groups across disciplines with a strategic vision to create conditions favourable for translation and growth of a specific innovation and technology.

Action Points

- *An Apex Body may be constituted which could perform the following functions:*
 - > *critical evaluation of the present state of S&T in India,*
 - > *S&T Policy planning,*
 - > *assessing future S&T needs,*
 - > *sociological study of the impact of S&T,*
 - > *funding R&D in priority, new and emerging areas*
- *Get rid of the “bureaucratic” mindset of unmindful control in a creative R&D environment and ensure meaningful public accountability and facilitating governance system.*

Increase R&D Investment

India’s R&D investment has shown a consistent growth trend over the years, but as a fraction of the true GDP, the public expenditure has been stagnant at

0.6% to 0.7% of GDP for the past two decades. India’s R&D expenditure, as a fraction of the GDP, is nominal as compared to countries such as the US (2.8%), China (2.1%), Israel (4.3%) and Korea (4.2%) (<http://psa.gov.in/sites/default/files/pdf/RD-book-for-WEB.pdf>). The R&D expenditure in India has mainly derived from the Central Government, with marginal contributions from the states and the private sector. This is one of the biggest hurdles for India, which is hampering returns from S&T in India.

Action Points

- *Increase R&D investment to at least 2% of GDP.*
- *Encourage private sector to contribute to R&D investment.*

Substantial Increase in Full-Time Researchers per Million

The UNESCO Institute of Statistics 2019 states that the number of researchers per million population in India stands at 156, which is considerably low as compared to US (~4200), China (~1200), Canada (4300) (<http://uis.unesco.org/en/news/rd-data-release>). The scarcity of researchers in India is a barrier to India’s R&D growth and could prove to be a major challenge, considering factors such as high-quality research opportunities abroad, limited incentives and dearth of high impact research in India.

Action Points

- *Provide researchers an Income Tax-free salary.*
- *Initiate scholarships and research grants for researchers.*
- *Provide career path for researchers.*

Reforms Required in Biotechnology Sector

Biotechnology is a sunrise industry having the potential to provide solutions to a variety of societal challenges. India’s bio-economy valued at \$ 62.5 Billion in FY 2019-20 (*Indian Bio-economy Report 2020*; ABLE) and expected to be \$128 Billion Industry by 2025 (https://birac.nic.in/webcontent/1594624763_india_

[bioeconomy_rep.pdf](#)). Therefore, the Biotech Sector can play an important role in pushing the economy on a high growth path for which the following reforms are required:

- *Improvement in research facilities and world-class Clinical Trial Infrastructure.*
- *Increase in Government spending on R&D and medical infrastructure.*
- *Fund Small and Medium Enterprises (SMEs) and start-ups in Biotechnology.*
- *Offer tax holidays for R&D-related income.*
- *Extend Tax breaks to cover R&D expenses of Indian companies outside India, as well as spending on the cost of patent filings, clinical development, drug discovery, and licensing.*
- *Extend R&D tax credits available to biopharmaceutical companies to contract research organisations and companies in other sectors of biotechnology.*
- *Appropriate steps need to be taken to minimise the go-to-market time for Biotech products by fast-tracking approval mechanism for testing and validating these bio-products in consultation with the Department of Biotechnology.*
- *Appoint more number of Patent examiners to reduce patent processing time and workload on existing examiners and also establish specialised courts or benches to address Intellectual Property-related matters.*
- *Incentivize the return of Indian students and professionals who are working abroad in the field of biotechnology.*



- Create a not-for-profit research organisation focusing on genomics R&D to better understand the biological characteristics and their variations for development of more accurate healthcare or other protection solutions.
- Establish an independent office for drug review process, which can serve as the single-point-of-contact for the process of drug review and guide companies through the process, and resolve their problems.
- Curtail the number of procedures required for starting a business and obtaining construction permits and make the process of land acquisition simpler.
- Promote mobility of researchers/scientists between industry and academia.
- Develop Indian standards and certifying products, which could instill faith in indigenous products, by ensuring the effectiveness and quality of the said product.
- Promote internships, apprenticeships, and other part-time opportunities for researchers by universities and research institutions to provide them the necessary industry exposure.
- Encourage Import substitution by creating local vendor network, policy drive for indigenous production of raw materials, reagents, components for achieving 100% Made in India value-added final products.
- Encourage MNCs to bring novel biotech products, future technologies to India by differentially incentivizing them over regular FDI for routine manufacturing.
- Upgrade testing labs to bring them at par with global standards to shun perceptions of low-quality goods.
- Continue to work on India-centric epidemic preparedness through the rapid development of vaccines, supporting the development of Indian vaccines in line with the Coalition for Innovation in Epidemic Preparedness (CEPI) global initiative.

- Industry, Academia and Government to work together towards military applications of synthetic biology and Genetic Engineering.

Reforms Required in IT Sector

India's IT industry contributed around 7.7 per cent to the country's GDP and is expected to contribute 10 per cent of India's GDP by 2025. The IT-BPM sector in India stood at US\$ 177 billion in 2019 witnessing a growth of 6.1 per cent year-on-year and is estimated that the size of the industry will grow to US\$ 350 billion by 2025.

India has become the digital capabilities hub of the world with around 75 per cent of global digital talent present in the country (<https://indiainvestmentgrid.gov.in/sectors/information-technology>). Indian IT & ITeS companies have set up over 1,000 global delivery centres in about 80 countries across the world. The computer software and hardware sector



in India attracted cumulative Foreign Direct Investment (FDI) inflows worth US\$ 39.47 billion between April 2000 and June 2019 and ranks second in inflow of FDI. Keeping in view the above, the IT sector has the potential to push the economy on high growth path for which the following reforms are required:

- Concerted R&D efforts towards new and emerging areas such as Artificial Intelligence (AI), analytics, automation, cloud, cybersecurity, mobile, etc.
- Create state-of-the-art cybersecurity and data protection frameworks.
- Prepare a roadmap to expand and upscale the infrastructure related to cybersecurity as well as multi-cloud computing for widespread adoption of work-from-home policy.

- Build capabilities for real-time data visualization and data analytics within India.
- Realise the vision of broadband for everyone and provide affordable high speed Internet to everyone by 2025.
- Scale up the Government e-Marketplace.
- Introduce technology-enabled remote healthcare in public and private health centres and hospitals.
- Build vibrant electronic device manufacturing ecosystems encompassing assembly, components, and design for smartphones, LED and LCD televisions and set-top boxes, LED lights, sensors, medical electronic devices, among other goods.
- Revitalize 'Make in India' policy to address the challenges in public procurement of indigenous technologies/products in order to strengthen India's manufacturing sector.

Reforms in S&T Sector for COVID-19 like Situation

In view of the recent situation where rapid transmission of COVID-19 brought about disruption in unimaginable ways, India needs to brace itself for stressful times ahead and bring necessary reforms to withstand the economic turmoil, which is widely expected in the coming months. The existence of S&T capabilities has never been so crucial for a nation. It has presented institutions with a great opportunity to work together for a common cause.

Organisations such as the Defence Research and Development Organization (DRDO), the Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research and Indian Institute of Technology have shown remarkable swiftness in responding to the critical situation, by continuously striving to bring scientific interventions. In the same light, the following measures may be taken in the S&T sector to leverage this situation for economic benefits:

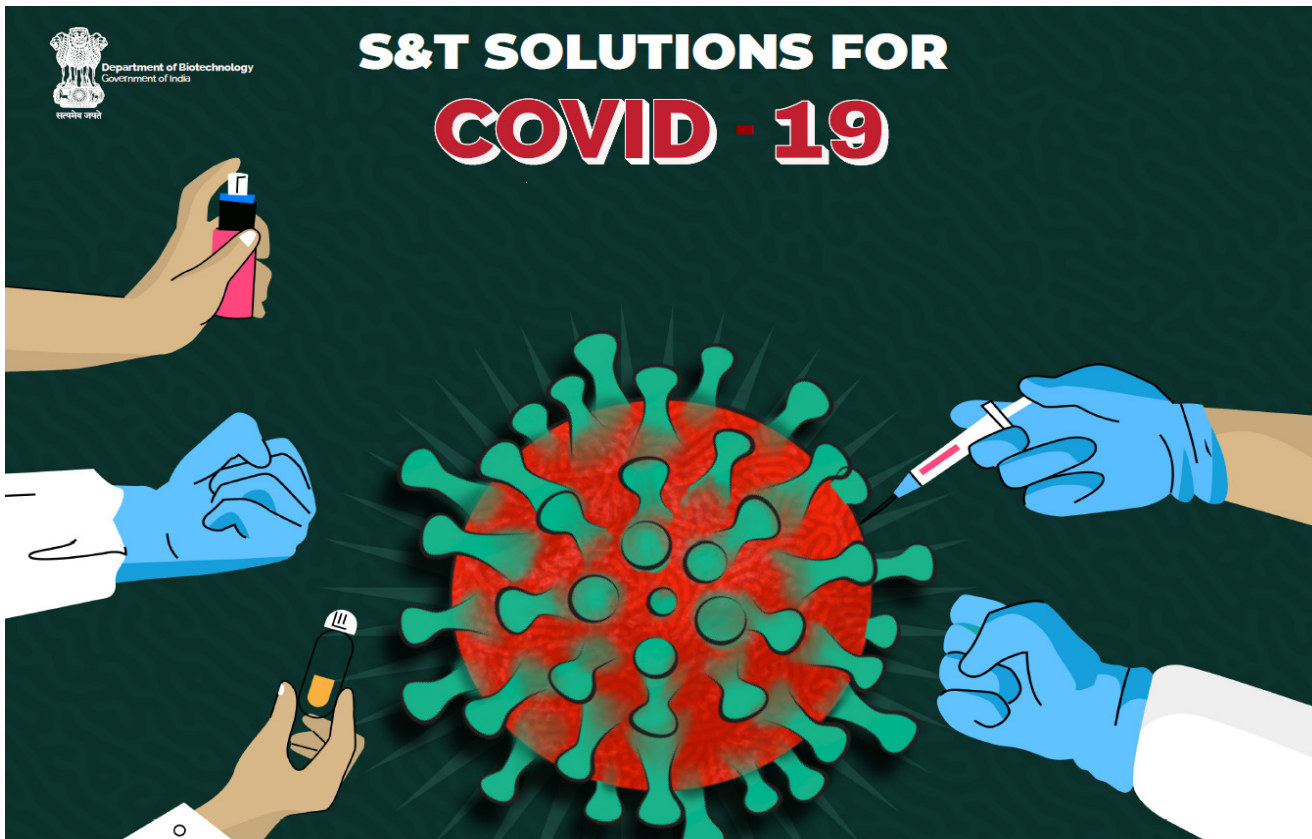


Image credit: DBT

- India has a great economic opportunity to leverage the existing infrastructure to manufacture Personal Protective Equipments (PPEs) and export PPEs for domestic and global consumption, which has evolved as a key concern across different countries in the present time. A dedicated program on manufacturing of PPEs in coordination with different line ministries such as the Ministry of Textile and Ministry of Health and Family Welfare may be initiated.
- Promoting R&D in Mission mode in potential areas such as alternative fabrics/materials/designs for PPEs, low-cost test kits, therapeutic drugs, medical devices etc. Specific public sector enterprises could be identified to manufacture these products in scale for indigenous adoption contributing to import substitutions.
- Appropriate mechanisms need to be developed to fast track prototyping, testing, validation and clinical trials of medical devices such as ventilators, splitters, etc. High-quality standards have to be ensured to enable acceptance from global markets. The Member (Health) and Member (S&T) who have been driving the efforts on promoting manufacturing of medical devices need to be continued.
- Appropriate management of medical waste is crucial. Manufacturing incinerators and development of alternative waste management disposal systems would not only ensure proper disposal of biomedical wastes related to COVID-19 in India, it could also reduce the cost of disposal of biomedical waste. It also presents an opportunity to serve the global demand for biomedical waste disposal systems.
- Recently ICMR has approved testing facilities in CSIR laboratories for COVID-19, to assist testing and containment of the novel coronavirus. As Laboratories/R&D Institutions under the S&T departments are located in almost all regions of India, measures like mandatory basic training to JRF/SRF to be given on handling equipments/procedures to support health emergencies like Covid-19.
- A Futuristic Technology Division may be set up under each R&D Institution to keep a vigil on probable issues/emergencies that might arise in the future and to address the same, in collaboration with various scientific/medical departments.
- Due impetus needs to be given to R&D and promotion of technical textiles which include protective clothing, sports gears, medical equipment and consumables, etc. Presently most technical textiles are imported. Indigenous manufacturing of these products will reduce India's dependency on imports while boosting production in India.

