

# **The Science, Technology and Innovation Policy**

***Government of India***

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## **Science in Shaping the Future of an Aspiring India**

Science, Technology and Innovation (STI) have emerged as the major drivers of socio- economic development globally. India of the 21<sup>st</sup> century is an aspiring country. Faster, sustainable and inclusive growth is her aspiration. Science, Technology and Innovation leading to applications of products of Research and Development will need to play defining roles. The large demographic dividend and talent pool of the country offer unique opportunities the National STI enterprise for earning for itself a central position in national development through its excellence, relevance and performance.

### **What is innovation?**

Scientific research converts money into knowledge and innovation converts knowledge into wealth. Innovation is more than mere conversion of knowledge into a workable technology. It implies an S&T-led solution that is successfully deployed in the economy or society. India has, hitherto accorded little importance to this aspect. There is now an urgent need to invigorate this aspect of the national STI enterprise.

### **Changing Phases of National Policies in S&T**

India's Scientific Policy Resolution (SPR) of 1958, a pace setter in the world, remains valid even today. The SPR resolved to "foster, promote and sustain" the "cultivation of science and scientific research in all its aspects". Technology was then assumed to flow from the country's established science infrastructure. The SPR also emphasized the use of the scientific approach in all activities of the nation. The Technology Policy Statement (TPS) of 1983, enunciated at a time of constraints on import of technology, emphasized the need to attain technological competence and self-reliance. Several of its statements were converted into action. The Science and Technology Policy (STP) of 2003 brought science and technology (S&T) together. It emphasized the need for investment into R&D to address national problems. It called for integrating programmes of socio-economic sectors with the national R&D system. It also articulated the need for technological innovation and creation of a national innovation system. The world has changed vastly since then in all spheres of human activity

## Why another policy?

Today innovation is no longer a mere appendage to science and technology but has assumed centre stage in the developmental goals of countries around the world. Vertical integration of all dimensions of STI into the socio-economic processes seems the way forward in the modern world. New paradigms of innovation have emerged and systems that foster innovation are not universal. They have become country and context specific. The Prime Minister of India, at the Indian Science Congress-2010 declared 2010-20 as the “Decade of Innovations” and formed the National Innovation Council. The Prime Minister and Minister of Science & Technology declared at the 99<sup>th</sup> Science Congress the bringing forth of a policy that develops the synergy between science, technology and innovation. The STI Policy 2013 is in furtherance of the declaration and aims to bring fresh perspectives to bear on innovation in the changing context. The policy thus seeks to *focus on both people for science and science for people* and combine the benefits of excellence and relevance.

## Policy for Science and Science Policy for Development: A New Paradigm

Science, research and innovation can exist separately on their own in disconnected spaces. But there are synergistic linkages. India’s global competitiveness will be determined by the extent to which the STI enterprise integrates vertically and is able to create social good and economic good through innovation. Innovative structural mechanisms and models will thus need to be evolved to balance the priorities and develop interconnections of the three sectors.

India’s STI system needs to deliver solutions to address the pressing national challenges of energy and food security, nutrition, affordable health care, environment, water and sanitation and above all employment. Thus discovery and solution dimensions of science and technology need to play major roles in shaping the future of the country. *“Science and technology for the people”* will be the new paradigm of the Indian STI enterprise. Indian society must emerge as the major stake holder for the national STI system.

India’s STI-led developmental efforts should thus aim at faster, inclusive and sustainable growth. While global competitiveness in trade would call for high-technology inputs, inclusive growth would need to ensure access, availability and affordability of solutions to as large a population as possible. India needs ‘inclusive innovation’. The policy will thus drive both investment in science and

investment of science-led technology and innovation in agriculture, manufacturing and services that lead to socio-economic benefits to a wide cross section of society. Emphasis will be laid on bridging the gaps between knowledge and the economic sectors. The STI policy would develop symbiotic relationship with economic and other policies.

### **Capturing aspirations**

The key elements of the STI policy will be:

- ❖ Promoting proliferation of scientific temper amongst all sections of society.
- ❖ Enhancing skill for applications of science among the young from all social strata
- ❖ Making careers in science, research and innovation attractive to the brightest.
- ❖ Establishing world class R&D infrastructure for gaining global leadership in some select frontier areas of science.
- ❖ Positioning India among the top five global scientific powers by 2020.
- ❖ Linking contributions of science, research and innovation system with inclusive economic growth agenda and combine priorities of excellence with relevance
- ❖ Migrating R&D outputs into commercial applications by replicating hitherto successful models as well as establishment of new structures.
- ❖ Facilitating S&T-based high-risk innovations. through new mechanisms
- ❖ Triggering changes in the mindset and value systems to recognize, respect and reward performances which create wealth from S&T derived knowledge.

### **Investment in Research and Development**

Global investments in science, technology and innovation are estimated at \$1.2 trillion as of 2009. India's R&D investment is less than 2.5% of the global investments. India's R&D investment has been under 1% of the GDP. Increasing Gross Expenditure in Research and Development (GERD) to 2% of the GDP has been a national goal for some time. Achieving this in the next five years is realizable provided the private sector matches India's public investment and the ratio of public to private sector investments in R&D changes from the current 3:1 to 1:1 within the next five years. This seems attainable as the industrial R&D investment grew by 250% while the sales growth was at 200% between 2005 and 2010. An environment conducive for enhancing private sector investment in R&D will be created.

Gross budgetary support for the science and technology sector has significantly increased during the last decade. Accrual of benefits of such increase in the GERD is becoming evident. India's global share of scientific publications has, for example, increased from 1.8% in 2001 to 3.5% in 2011. The Composite Annual Growth Rate (CAGR) of Indian publications during the last three years is around 12±1%. But the percentage of Indian publications in the top 1% impact making journals is only 2.5%. India should aim to increase its share of scientific publications from the current 3.5% to over 7% and quadruple the number of papers in top 1% journals from the current levels by 2020. Citation impact of Indian publications must improve and match at least the global averages. Initiatives under the new policy should enable this to exceed the global average by 2020.

India ranks ninth globally in the number of scientific publications and 12<sup>th</sup> in the number of patents filed. According to the Global Science Report of the UNESCO, India's current global ranking matches with its ranking with respect to the number of Full-Time Equivalent (FTE) of R&D personnel. In order to match the enhanced level of private sector investments in R&D and to maintain the tempo of public sector investments, it is imperative that within the next five years the total number of FTE of R&D personnel must increase by at least 66% of the present strength.

### **Nourishing the root of Science for promoting Excellence in Research**

Ensuring sustainable pipeline of talented youth for science is a challenge. India has mounted some significant initiatives for attracting talent to science and careers with research. Empowering stakeholders for local actions is a key element of these initiatives. The policy framework will further enable school science education through improvement of teaching methods and science curricula, motivating science teachers and schemes for early attraction of talent to science.

### **Combining Excellence and Relevance: Way Forward for Indian Science**

Basic research-led discoveries stimulate innovation in the long term. While Indian investment in basic research will be further enhanced by fostering excellence through global benchmarks and focusing on relevance for addressing national challenges.

The few inter-university centres set up earlier have proved the concept to be a successful and viable one. Such inter-university centres would be multiplied in different fields to enable a wide cross section of university researchers to access advanced research facilities and equipment which are otherwise not available in university environments. Grand challenge programmes, where resource deployment could bring tangible and intangible returns in the global setting, will be launched.

### **Participation in Creation of Large Global R&D Infrastructures and Big Science**

Modern science is increasingly becoming resource intensive. There is a current trend to create high-cost global infrastructures through international consortia models. Given India's global standing in science, invitation to participate in such projects is expected to increase. Indian participation in such consortia-led international projects will be encouraged and facilitated for improving access to facilities for advanced research in cutting edge areas of science.

### **Attracting Private Sector Investments in R&D**

Supply side interventions have hitherto been the main strategy for public investment in R&D. The situation requires changing; equal emphasis on both supply side interventions and demand based investments is needed. While public investments in R&D should maintain the current rates of growth, private investment has to increase significantly for translating R&D outputs into commercial outcomes.

Public funds for partnerships with the private sector for social and public good objectives will be earmarked as a new policy initiative. A National Science, Technology and Innovation Foundation will be established as a Public Private Partnership (PPP) initiative for investing critical levels of resources for innovative and ambitious projects.

The focus of the policy environment will be:

- ❖ Facilitating private sector investment in R&D centres in India and overseas.
- ❖ Permitting multi stakeholders participation in the Indian R&D system.
- ❖ Treating R&D in the private sector at par with public institutions for availing public funds.
- ❖ Bench marking of R&D funding mechanisms and patterns globally.
- ❖ Aligning Venture Capital and Inclusion Innovation Fund systems.
- ❖ Modifying IPR policy to provide for marching rights for social good when supported by public funds and for co-sharing IPRs generated under PPP.

- ❖ Exploring newer mechanisms for fostering Technology Business Incubators (TBIs) and science-led entrepreneurship.
- ❖ Providing incentives for commercialization of innovations with focus on green manufacturing.

### **Partnerships among Stake holders for Scaling Successes of R&D**

Special and innovative mechanisms for leveraging academia-research-industry partnerships will be devised. Success stories in S&T-based innovations from Indian experience would be replicated and scaled up. Regulatory and legal framework for sharing of IPRs between inventors and investors, and for closing gaps in the translation of new findings into the commercial space, would be put in place. Specifically the policy will focus on:

- ❖ Prioritizing critical R&D areas like agriculture, telecommunications, energy, water management, drug discovery, material science including nano technology, climate change and space technology and promoting interdisciplinary research,
- ❖ Promoting innovations through mechanisms including “Small Idea-Small Money” and “Risky Idea Fund” to support innovation incubators
- ❖ Supporting STI driven entrepreneurship with high scaling coefficients and viable business models,
- ❖ Investing in young innovators and entrepreneurs through education and training.

### **Gaining Global Competitiveness through Collaboration**

Open source discoveries for public and social good form interesting innovation systems. Knowledge commons is an emerging theme for managing IPRs created through multi-stake holder participation. The STI Policy will foster data sharing and access. Tapping global resources and especially Indian diaspora for accelerating the pace of technology-led development would be pursued. Multi-sectoral partnerships and alliances will be leveraged for upscaling national competitiveness in research and manufacturing. The new policy framework will enable strategic partnerships and alliances with other nations through both bilateral and multilateral cooperation in science, technology and innovation. Cooperation in areas like climate change and mitigating natural disasters are important and beneficial. Science diplomacy, technology synergy and technology

acquisition models should be judiciously deployed based on strategic relationships.

### **Performance-Reward Relationships**

Transparent systems for tracking individual research performers based on past and proven track record would be developed to enable grant based investments in such performers. A well-designed centrally implementable Performance Related Incentive Scheme (PRIS) for basic research leading to scientific publications would be put in place.

For R&D leading to technology development and knowledge services, the criteria would, however, be specific to the institution, the local conditions and the context. Incentives to public-funded R&D centres for outcomes leading to public and strategic goods could be introduced. Transparent performance-reward relationships and accountability for investments would form central theme of the policy.

### **Leveraging Innovation potentials for Social Inclusion**

Global innovations systems tend to bypass large sections of the community. The instruments of the STI policy will aim at increasing accessibility, availability and affordability of innovations. Establishment of a Fund for Innovations for Social Inclusion will be a step in this direction.

### **Delivery systems for STI outputs to stake holders and Society**

Migration of scientific outputs and technology interventions into the social systems is a multi-layered process. Direct delivery of scientific outputs through dissemination and public outreach by the scientific agencies and bodies is possible only in relatively smaller number of sectors. The entire delivery mechanism involves a large number of intermediaries from the public, non-governmental and private sectors. This requires strengthening of linkages between the scientific and socio-economic sectors. The STI policy will leverage the R&D allocations of socio-economic ministries through a shared vision on addressing developmental challenges, co-generation of values through partnerships, and co-investments, adoption of new delivery models and maximization of stakeholder value perceptions.

The state governments constitute important stake holders and measures will be taken to ensure that state-specific S&T vision and plans are informed by the new STI Policy.

### **Transition from perception to evidence-based approaches for investment decisions**

Sound measurement principles for STI indicators are necessary for evidence based policy actions. New and globally relevant indicators, which integrate measures of excellence with relevance as well as inventiveness with affordability, will be developed. Around 10 sectors of high impact potential, with commitment to deploy commensurate resources, will be identified for directed STI intervention. Enabling policy instruments that facilitate both research and enterprise to focus their efforts in these will be put in place.

Global competitiveness of manufacturing sector is closely related to the technology intensity of the sector, which in turn is a direct corollary of the vitality of the R&D system in providing technology inputs. India's share of global trade in high technology products is presently only around 8%. The aim is to double this share through innovations in high-technology products. Appropriate supporting instruments will be put in place to stimulate the development and deployment of high technology by industry.

### **Triggering Ecosystem changes for Science, Technology and Innovation**

A flexible approach that allows for fine tuning the Five Year Plan investments in R&D, technology and innovation in response to rapid changes in STI ecosystem would be put in place. Speed, scale and sustainability would be key governance parameters for the new approach. Internal processes of institutions need to build-in Trust as an integral principle in decision making. "Risks" are integral parts of a vibrant national innovation system and policies must provide for risk management strategies. Education is currently focused on understanding; it should now embrace emphasis on Applications as well. Venture capital systems need to adventure in risky innovations rather than to rely on incremental innovations, new financing mechanisms for investing in enterprises without fear of failure and options for foreclosing unsuccessful ventures are essential part of such an enabling innovation ecosystem. India's innovation machinery should aim to lead rather than to follow safe paths of discovery. Hence Trust, Risk, Application, Venture. Enterprise and Leadership should form new mantras of the new STI ecosystem.

## **Gender Parity in STI Sector**

Participation of women in STI activities is important. New and flexible schemes would be put in place to address the mobility challenges of employed women scientists and technologists. A broad scope for re-entry of women into R&D and new facilitation mechanisms with special career path in diverse areas will also be made feasible.

## **Public Awareness and Public Accountability of Indian STI sector**

Public understanding of science is an important dimension for introducing and reaching the benefits of modern science and technology to the people. Public and political understanding of science should be based on evidence and debates with open mind. The civilizational aspect of science or scientific temper needs to be promoted across all sections of the society systematically. People and decision makers must be made aware of the implications of emerging technologies, including their ethical, social and economic dimensions. Effective science communication methods, by using tools such as the National Knowledge Network, will be initiated. These will enable all the stakeholders of the civil society to discuss and present a collective perspective on such developments. Mechanisms for assessing the performance of the national STI system by all the stakeholders and reporting to the nation on a periodic basis will be established. The national science academies will be accorded a major role in this endeavour of public accountability.

## **Science, Technology and Innovation to serve National Agenda**

**Agriculture:** R&D policy for agriculture is articulated by the Indian Council of Agriculture Research (ICAR). Integration of the agriculture R&D policy with the national R&D system and STI policy will be brought about.

**Manufacturing:** STI inputs to manufacturing sector offer opportunities for enhanced employment generation. A strategic selection of sectors, where India can aspire for leadership, would be made for focused STI inputs. A special drive for stepping up R&D intensity in key manufacturing sectors with competitive advantage will be mounted. Small and Medium Enterprises (SME) generally have low R&D intensity. Special schemes to support R&D at the firm or collective level, will be devised and put in place.

**Services:** The R&D intensity of the service sector needs to be enhanced considerably and skill base also expanded significantly. Linkages between the services with educational sectors for establishing human capacities will be fostered through incentive mechanisms. For rapidly accomplishing the tasks of modernization of technology-led services, technology missions, aimed at achieving global leadership in some select areas in the services sector, will be identified. Deployment of technology-led services for increasing transparency in the Government machinery will also be supported.

**Climate Change:** Climate change is of global concern and India has articulated a National Action Plan for Climate Change (NAPCC). The S &T system will have to play an active role as a source of strategic knowledge for coping with the challenges of climate change as well as in meeting equity-based differentiated and shared responsibilities of India.

### **Policy Goal**

STI policy 2013 is focused on serving India by connecting performance with excellence and relevance. The policy goal of the Indian STI sector is to accelerate the pace of discovery and delivery of science-led solutions for serving the aspirational goals of India for faster, sustainable and inclusive growth. A strong and viable Science, Research and Innovation System for High Technology-led path for India (SRISHTI) is the goal of the new STI policy. Aspirations of India would be serviced by an equally aspiring Indian STI system.