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EDITORIAL

Investment in science, technology and development

The Principal Scientific Adviser to the Government of India has highlighted recently some of the items of relevance in the Union Budget 2021 for science, technology and innovation in the country. India has taken a bold step of setting up a National Research Foundation with a budget of Rs 50,000 crores over a period of five years. Hopefully, this is in addition to the allocation for the existing science departments such as the Department of Science and Technology (Rs 6071 crores), Department of Scientific and Industrial Research (Rs 5241 crores), Department of Biotechnology (Rs 3502 crores), etc. for the current financial year. It will have implications for fundamental research on topics ranging from atoms to astronomy, including history and social sciences. There are plans afoot for Deep Ocean Mission (akin to space mission) and Hydrogen Mission. The former would pave the way for our understanding of the ocean surrounding us and thence in harvesting the rich resources lying deep within. The latter would have an even larger scope, utilizing the abundantly available solar energy (and water) for producing hydrogen. No need to go into the details here of the use of hydrogen in various applications, from running cars to producing fertilizers as they are common knowledge. The underlying theme of such endeavours is clearly sustainable development and technology development. There are plans to make available clean (potable) water to all. Attention would be paid to processing the mounting waste of various kinds and safeguarding the society and at the same time, derive wealth from waste. A key to sustainable development is the individual health of the citizens as well as collective public health.

One of the lessons that we have learnt from the COVID-19 pandemic is the need for an expanded health infrastructure to tackle the crisis and to control the pandemic. Underlying all such undertakings is the fundamental research encompassing all aspects of science as well as history of science including social science. While the public is interested in health care, the private sector (understandably) looks at the profitability. This is where it becomes essential for the government to make investments in the way of setting up new institutes and laboratories and nurturing the existing ones. Government plans to set up four national institutes of virology and an

institute of public health. Ultimately, these public institutions along with the existing ones will produce new knowledge and trained manpower, which would be capable of studying, preventing and tackling any future epidemic outbreak.

Another thing that we have learnt from the recent pandemic is that, for reasons not fully understood yet, we as a nation seem to have had certain immunity that has protected us from disastrous outcomes in its first wave. Our death rate has remained the lowest among all developed and developing countries. This could be partly due to the strict lockdown imposed by the government early on, followed by social distancing, hand sanitization and serious use of masks by the public. Furthermore, but for social functions like marriages and family get-togethers, the 'partying' culture is much less prevalent in our society than in the West. It is of paramount importance to understand the biological as well as sociological science behind such a providence.

The return on investment for the public (government) is invariably in the long run. But the benefits of science, technology and innovation can always be taken to the public by the private in the short run. The development of vaccines by the Serum Institute of India, Pune and Bharath Biotech, Hyderabad are examples of private entities rising to the occasion. Underneath their success lies years of research carried out by the government institutions and manpower development over several decades. It is pertinent to note that letting in Bharath Biotech to join hands early on with the Indian Council of Medical Research (ICMR) and the Council of Scientific and Industrial Research (CSIR) was vital to the development of the vaccine in record time in India.

The Director General (DG) of CSIR has pointed out recently how the CSIR labs like the National Chemical Laboratory, Pune and Central Drug Research Institute, Lucknow have played a vital role in the development of drugs for various illnesses. Today, we are able to claim India as the Pharmacy of the World, because of the public investment in research and private companies taking the lead in producing goods of societal value.

David Leonhardt, in his column in *New York Times* (15 December 2020) portrays Uncle Sam as a successful

entrepreneur, pointing out the investments made by the United States (US) government over the decades and the participation of private companies in producing the vaccines. He goes on to point out how for more than half a century, the investment by the Defense department of the US government has led to the development of transistors, silicon chips, radars, jet aeroplanes, satellites, artificial limbs, etc. Similar sentiments are echoed in a recent interview of the Director General of CSIR, where he points out the role played by the National Aerospace Laboratories of CSIR towards the development of components of Tejas, the Light Combat Aircraft (LCA) for India. I remember discussing with a colleague in IIT Kanpur about the development of drones long before the term came into public parlance.

One can look back at the investments made in the domains of atomic energy, space mission and other national missions in India since independence. They have yielded results that make India proud. Time and again, technology had been denied to us by the western countries. That provided the impetus for us to develop technologies on our own and march ahead. From carrying a rocket on the back of a bicycle to launching of PSLVs and GSLVs, India has come a long way in its space mission. Putting our own satellites up in orbits around the earth has not only done the nation proud, but also contributed immensely to mass literacy, remote sensing, uncovering our natural resources and biodiversity, and improvement in weather forecast that is vital to our planning. Smart phones in the hands of almost every Indian have put knowledge and power in the hands of the citizens. From checking the weather outside before stepping out of the house, to checking the price of the consumer items in a competitive market, the internet and smart-phones have clearly kept us going with the change in times. The way forward is clear. It is going to be the influence of artificial intelligence and deep learning in all walks of our lives. We need to train manpower that would embrace the newer technologies and keep India abreast on the road to further development.

Basic research is the engine of creativity. It has to be kept running. Many ideas start in classroom discussions

and the laboratories of professors in academic institutions. The seed may germinate in the form of a Ph.D. thesis. The seedling must be protected and nurtured to let it become a tree to yield fruits. I come from a laboratory that had originally proposed the formation of infrared chemical lasers, which led to several applications. The chemical lasers paved the way for understanding the nature of intermolecular forces also and that was duly acknowledged by the Nobel committee in the year 1986. When Michael Faraday was asked about the use of producing electricity (through the application of dynamos), he seemed to have told the minister that one day he would tax it!

It is not realized often that behind every success lie perhaps hundred failures. Government funding provides the cushion for bearing the losses resulting from the failures. While the private sector is loath to risk taking, it can step in and take the (successful) development farther to public good in record time.

A learned science administrator points out four stages in the development of science and technology for common good: (i) pure (or basic) research that leads to discoveries and creation of new knowledge that may or may not be related to society immediately; (ii) applied research that takes ideas into something that is tangible; (iii) translational research in which the contours of applications become visible and (iv) development of deliverables, services and products. Investment by the government is vital for the first two stages. Public-private partnership could start in the third stage and the private entities will play a decisive role in the last step.

If only we could streamline the ease of doing basic research and development and facilitate translational research, India can march ahead and be among the top and be counted. The new initiative of the Government of India in setting up the National Science Foundation could foster such developments.

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