There are several issues connected with biodiversity, rural peoples' medical knowledge, plant genetic resources, farmers' variety and GI. Traditional Knowledge is a point to prove that it is prior knowledge or common knowledge and the element of invention or discovery or novelty is not there in cases with neem, turmeric, ginger, etc. and hence patent applications making a claim of originality needs careful examination. Considerable effort has gone in, during the last decade or so to document the traditional wisdom on these issues available in various Indian languages. India must straighten out these issues in the various international negotiations and press the need for considering before a patent is granted to a product in the convention countries. India should develop a system to grant community rights to the TK similar to what PPV&FR Authority is granting for farmers' variety.

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S. Nagarajan is with Protection of Plant Varieties and Farmers' Rights Authority, NASC Complex, Opposite Todapur Village, DPS Marg, New Delhi 110 012, India
e-mail: snagarajan@flashmail.com

OPINION

Whither science in India

B. K. Sen

C. N. R. Rao has sounded an alarm apprehending the bleak future of science in India[1]. Why the situation has come to such a pass possibly demands a thorough probe to unearth the underlying causes and then take remedial measures. I feel, if we look back a little, it will not be too difficult to identify some of the root causes.

Jawaharlal Nehru, the great visionary for shaping India's destiny, was of the firm conviction that it is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and of deadening custom and tradition, of vast resources running to waste, or a rich country inhabited by starving poor[2]. Guided by this conviction he went ahead and during his regime (1947–1964) came up with around 25 research institutions under the Council of Scientific and Industrial Research; dozens of laboratories, research centres, stations and substations under Indian Council of Agricultural Research, and a few laboratories under Indian Council of Medical Research. The Defence Research and Development Organization was constituted and a large number of laboratories devoted to aeronautics, armaments, electronics, etc. started functioning. The Atomic Energy Act was passed in 1948, and the decision to create Atomic Energy Establishment, Trombay (now Bhabha Atomic Research Centre) was taken in 1954; it was formally inaugurated by Nehru in 1957. Five Indian Institutes of Technology came up in quick succession at Kharagpur, Bombay, Delhi, Kanpur and Madras. Similarly, in the sphere of medicine sprang up the All India Institute of Medical Sciences at New Delhi, Jawaharlal Institute of Postgraduate Education and Research at Pondicherry, Institute of Postgraduate Medical Education and Research at Calcutta, and Postgraduate Institute of Medical Education and Research at Chandigarh. Nehru envisioned an all-round S&T development in the country. Hence, it did not take long for the first agricultural university of India to take root at Pantnagar as UP Agricultural University in 1960 followed by Orissa University of Agriculture and Technology and Punjab Agricultural University[3]. The launching of *Sputnik* by Soviet Union on 4 October 1957 heralded simultaneously the onset of the space age as well as the space race. Just in a few years time the enormous potential space technology was holding, became evident. India could not afford to lag behind. Hence, Indian National Committee for Space Research (INCOSPAR) was formed by the Department of Atomic Energy in 1962 and work started on the establishment of Thumba Equatorial Rocket Launching Station (TERLS)[4]. On 21 November 1963, the first sounding rocket of India was launched from TELRS[4]. The list does not end here and can be lengthened a great deal further.

Nehru's attachment to science was so great that he religiously attended the Indian Science Congress every year and delivered his inspiring address. During his tenure of 17 years, Nehru tried to do everything possible to make India no less a superpower in science. Today, if we have joined the nuclear club, space club, have surplus food, and have raised India to the level of a developed country as far as science is concerned, it is because of those scientists who started flourishing unhindered during the Nehru era.

The infrastructure and environment that Nehru created for the rapid development of science in India paid rich dividends. A study conducted by American Institute of Physics in 1964 showed that India ranked ninth in the world in the field of physics in terms of journal papers, next only to USA, USSR, UK, Japan, France, Germany, the Netherlands, and Italy[5]. In 1998, India's position in the field of chemistry was ninth, next only to USA, Japan, Germany, France, UK, Russia, China and Italy. In 2004, the ranking underwent a radical change, pro-

pelling China to the second position, next only to USA, while India struggled to attain the eighth position, with USA, China, Japan, Germany, France, UK and Russia ranking ahead of India[6].

Eugene Garfield, who formulated the *Science Citation Index* (*SCI*), conducted a study with 1973 *SCI* data for mapping of science in the Third World[7]. The study revealed the position of India in terms of scientific productivity as eighth, next only to USA, UK, USSR, Federal Republic of Germany, France, Japan and Canada. In the same article, Garfield showed that India's contribution was about 50% of the entire Third World contribution. India's decline from eighth to 13th position[8] was recorded in 1995. Even today the position has remained unchanged[9], with India's ranking being 13th in 2006 in its ten-year country ranking.

China's cultural revolution spanning from 1966 to 1976, led to the closure of all scientific and technological periodicals, including those continuing for more than hundred years. This brought down China's substantial scientific productivity prior to 1966 almost to zero. Around 1965, I was to compile a bibliography of S&T periodicals emanating from China. I was astonished to find that around 1400 (as far as I remember) S&T periodicals were emanating from China at that time compared to India's less than 500. In 1980, only 924 papers from China were noticed in Western bibliographical sources[8]. Under the dynamic and pragmatic leadership of Deng Xiaoping, China started progressing in S&T not with trots but with canters, and today China ranks fifth in the world next only to USA, Japan, Germany and UK.

The above figures bear infallible evidence as to India's steady decline in S&T and China's meteoric rise.

When Indira Gandhi became the Prime Minister of India, she, also a visionary like Nehru, decided to advance the field of S&T. She realized that the development of science in India will not be sustained until and unless there is a department exclusively devoted to science and technology. Thus came up the Department of Science and Technology (DST) in May 1971 for the first time in the history of science in India to promote research in promising areas of S&T and play a key role in coordinating and organizing S&T activities in the country.

Research in key areas of science received an adequate to inordinate boost. Agricultural universities sprang up one after another. India's first atomic device was imploded in Pokhran on 18 May 1974. Installation of TV transmitters all over the country went ahead with stormy speed and in 1982, our national television network became a reality. In space science and technology, India started setting up one milestone after another. Satellite Communication Earth Station was set up at Ahmedabad in 1967, the Indian Space Research Organization (ISRO) in 1969, Department of Space as well as Space Commission in 1972, and the first Indian satellite, *Aryabhata* went into space on 19 April 1975. The momentum thus built up allowed India to forge ahead in space science and technology in the years to come.

Indira Gandhi knew that the non-replenishable mineral resources of our country were depleting fast. Alternate sources will have to be found and they may be available in the ocean along India's 7500 km coastline. Antarctica might be another choice. Hence, under the special initiative of Indira Gandhi, the Department of Ocean Development was created in July 1981 'as a nodal and independent department under the direct charge of the PM for organizing, coordinating and promoting ocean development activities'[10]. Antarctic Research Programme was also initiated in the same year. The very next year, our Ocean Policy Statement was brought out with one of its objectives being 'exploratory survey, assessment and sustainable utilization/ harnessing of the ocean resources, including living, non-living and renewable sources of ocean energy'[10].

When Rajiv Gandhi became the PM in 1984, he decided to go all out with computerization, and in 15 years we became one of the superpowers in software development in the world. This shows how a visionary can change the destiny of a nation practically in no time.

Factors contributing to decadence

Lure of money and power

Today, a first-class M Sc or a Ph D in science at the beginning of his career as a researcher earns around Rs 20,000 a month; an IT professional with a B Tech or equivalent degree joins an MNC with a package of about Rs 6 lakh a year or more; and an MBA from an IIM or any other top-ranking institute draws around Rs 50,000 to 100,000 per month at the beginning of his career. An IAS draws more or less the same salary as that of a researcher at the beginning of his career; but the administrative power he wields, the enviable VIP status he enjoys, the respect of the masses he commands, the avenues for promotion he holds, and the post-retirement opportunities he foresees are some of the factors that allure the brilliant students to join the service. Since the beginning of our independence till early 1990s, the disparity in salaries in our country was not so much as it is today. Even in China, the US or other developed countries, the disparity in salaries is not so discouraging for scientists as it is in India. The question then arises as to why a brilliant student of our country should aspire for a career in scientific research? There might be a few brilliant students who had chosen or would like to choose a research career setting aside all allurements. Obviously, only a few brilliant scientists cannot propel a huge nation like India to a better destiny.

Age

In bureaucratic, commercial, industrial and many other set-ups, a professional with the advancement of age becomes mature, experienced, and possibly contributes more to the development as well as productivity of an organization. In the case of scientific research, unfortunately, it is not so. Here age seems to play a major role. Srinivasa Ramanujan breathed his last at the age of only 33 leaving behind his prodigious mathematical contributions. M. N. Saha's most outstanding contribution on astrophysics appeared when he was hardly 25. Albert Einstein was only 26 when he published his four epoch-making scientific papers. S. N. Bose published his paper that gave rise to Bose–Einstein statistics at the age of 32. A study has shown that the mean age of scientists when they did their Nobel Prize-winning work has been 37.8 for chemistry, 36.0 for physics, and 39.0 for medicine and physiology[11]. From this it may be tentatively concluded that as a scientist ages his inventive, innovative and creative capacities decrease.

Continuous flow of young blood in scientific research paves the way for outstanding discoveries, productive innovations, and promising inventions. Unfortu-

nately for India, the long-standing embargo on recruitment in the past few decades has interrupted the flow of young blood a great deal.

Inadequate funding

We spend less than 1% of the GDP in our R&D activities, whereas developed countries like Japan and USA spend around 3%. Undeniably, this is also an important factor adding to the decline of science in India.

Few questions

Is our scientific pursuit having a predetermined goal? In five years' time or so, a litre of petrol may cost Rs 100.00, if not, more. As the petroleum reserves of the world dwindle, the cost of this product will sky-rocket. Are our scientists concerned about this? How much have we done to extract automobile fuel from wood or by using solar energy for driving motor cars?

In August 2006, major parts of Delhi experienced on average about 6 h of load-shedding per day. The situation was not this bad 30 or 40 years ago. The shortage of power supply is more or less an all-India phenomenon. With the rapid development in the country, the demand for power supply is also rising. How are we going to cope with the situation in the coming years? Are we doing enough to popularize the utilization of solar energy for cooking, generating power, etc. using the mass communication media like newspaper, radio or TV? Are we seriously doing any research to enhance the efficiency of solar cells?

We are exporting valuable iron ore to earn foreign exchange. In about a hundred years from now, we will have to import the same at the cost of gold from countries preserving it now. Mineral resources of the world are getting exhausted at a rapid rate. The time is not very far when we will have to think of lunar mining or soft landing of the potentially hazardous asteroids that are threatening to hit the earth any time in future to extract invaluable mineral resources. It may sound like science fiction. We have seen in the past that many scientific fictions have become stark realities with the passage of time. It may not be different in these cases as well. Are our scientists thinking about these?

It is more or less agreed that our national expenditure on science being less than 1%, our performance in science is poor. Suppose, in the next Five Year Plan it is decided to raise the expenditure on science to around 2%. Are our scientists equipped enough to pinpoint the areas where the extra amount would be spent?

Future

Viewed from its present situation, the future of science in India does not look good. China is going to occupy the second position in terms of scientific productivity next only to USA in the foreseeable future, since China, being a communist country, can exercise its option to divert all its best brains to scientific research, which India cannot. Tremendous efforts will be needed to bring India back to within the first ten positions. Tempting the best brains to opt for scientific research and dissuading them from the number of allurements described above is no mean job. Motivation for scientific research among students should start from schools. If Einstein, instead of Bill Gates, becomes the role model of a sizable number of brilliant students in India, then we can definitely expect a better future for our scientific pursuit.

By and large it is accepted that scientists are meek social beings. To press their demands they cannot go on strike, form a trade union, or go on a fast unto death. Neither can we have visionaries like Nehru, Indira Gandhi or Rajiv Gandhi at all times. In such a situation, ways and means will have to be found whereby science can progress unhindered and India can attain the position of a superpower in the years to come. It is to be remembered that the economic development of a nation can be well sustained if it goes hand in hand with scientific development.

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B. K. Sen lives at No. 80 Shivalik Apartments, Alaknanda, New Delhi 110 019, India. e-mail: bksen@airtelbroadband.in