SWOT analysis on Indian scientific research

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Manmohan Singh, the honourable Prime Minister of our country, while inaugurating the 95th Indian Science Congress on 3 January 2008 at Andhra University, Visakhapatnam, announced that the Government proposed in the 11th Plan to establish 30 new Central Universities, 5 Indian Institutes of Science Education and Research, and 8 new Indian Institutes of Technology. With an aim to promote scientific spirit, he also proposed science innovation scholarships to 10,000 students, as an incentive for those entering the science degree courses. This is a welcome change towards promotion of quality in scientific research in the country.

India has emerged as one of the leading nations in scientific research during the last six decades. Among the developing nations, India ranks first in terms of not only the number of scientific organizations, both universities and institutes, but also in the number of science graduates. The most remarkable achievements are in the fields of space science, nuclear science, communication, medical and agricultural sciences. For the sake of convenience and also because of their inseparable nature, the 'technologies' are also included as 'science and technology'. This implies that both the theoretical and applied aspects are relevant while discussing the overall achievements in scientific research in the country. In this context, the fast developing fields are biotechnology, computer and information technologies, which have revolutionized the utility value of research in terms of knowledge explosion, more importantly in reaching the common public. Establishment of ATMs by several banks for easy and quick money accessibility, cell-phones for rapid communication and on-line reservations for various purposes have impacted the general public with tremendous success.

Emerging sciences

India is surging ahead in biotechnology/bioinformatics research, be it in plant or agriculture (transgenics, resistance to diseases and pests) or in medical research (stem cells, cancer, diabetes, etc.). Nano-technology is the most recent emerging field which in the next five years is expected to facilitate the society in a big way. All the above are possible because of modern infrastructure facilities and the advanced training imparted to scientists in India or because they are deputed to reputed foreign laboratories to acquire latest knowledge. The Government provided substantial funds in the Five-Year Plans to different ministries associated with scientific research.

Growth

Let us have a cursory glance at the growth of science in India from pre-independence period to the present (six decades). For this, the number of universities and research institutes are taken into consideration. From a modest about ten traditional universities in the 1950s, the number has now reached over 240, which includes about eight Central Universities. Some of the leading centres of excellence in scientific research have also received the status of deemed universities. To provide thrust to agricultural education, research and extension, the Government had started State Agricultural Universities (SAUs) at Pantnagar in the mid-sixties and later at Coimbatore, but now there are 39 SAUs in almost all states, with Maharashtra alone having five of them. Five Universities for Animal Sciences and Fisheries have also been introduced to take care of the livestock and fisheries sectors. Recently, exclusive Medical and Health Universities have also been established to strengthen health research.

Besides, the Government established different scientific councils and departments as apex bodies to enhance research potential, like the Council of Scientific and Industrial Research, Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research, Department of Atomic Energy, Department of Biotechnology, Indian Space Research Organization, etc. Under each council/department there are a large number of institutes. For instance, the ICAR has 93 institutes, National Research Centres, Directorates and 74 All-India Coordinated Centres. In addition, there are world-recognized organizations like the Bhabha Atomic Research Centre, Indian Institute of Science, Tata Institute of Fundamental Research and seven Indian Institutes of Technology. The State Governments have established research institutes to address local problems. India has also renowned science academies like the Indian National Science Academy, Indian Academy of Sciences, National Academy of Sciences, National Academy of Agriculture Sciences (NAAS), Indian Medical Association and Indian Medical Council. Almost all disciplines of science have their own societies to promote exchange of research findings through conferences and seminars and publications in their journals. Thus, the country is endowed with vast scientific manpower, physical resources and financial investments.

SWOT analysis

The time is now ripe to make a critical analysis of scientific research in the country. The best way to do this is perhaps to undertake SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) of Indian scientific research as a whole. Although not a quantitative approach, SWOT definitely helps in assessing the real status of a given situation, as successfully employed in many international and national projects. It must be admitted that all the points listed under SWOT may not be complete, but the information provides an opportunity for in-depth study.

Strengths

- Largest number of qualified scientific manpower.
- Availability of topmost expertise in many research areas.
- Infrastructure facilities built to desired levels.
- Vast scope for encouraging young scientists to pursue research in advanced fields.
- Funds fairly adequate both from Government and private sectors.
- Large number of scientific academies, councils, societies, etc.
- High-quality library facilities with modern communication technologies.
- Publication of a large number of scientific journals.

- Commendable achievements, laurels, recognition.

Weaknesses

- Under-utilized scientific manpower.
- Imbalance in research priorities.
- Inadequate facilities in some institutes and poor linkages.
- Lack of incentives and rewards to back-up excellence.
- Low priority for standard of research output.
- Scientific journals of poor quality.
- Lack of awareness on quality research journals and impact factor analysis, citation index/frequency, etc.

Opportunities

- Scope for reorganizing scientific manpower vis-à-vis organizations.
- Reorientation of research priorities on a national basis.
- Providing opportunities for achieving excellence.
- Promotion of team spirit with scientific temper.
- Accelerating inter- or multidisciplinary research.
- According incentives/rewards for quality work.
- Counselling on quality of publications.
- Deputation to advanced centres for acquiring latest knowledge and encouraging exchange with other centres.

Threats

- Exodus of brilliant brains to other countries.
- Personality clashes affecting progress of research.
- Enhanced level of mediocrity.
- Improper utilization of enormous funds.
- Lack of scientific auditing – accountability/responsibility.

From the forgoing one may feel proud of the 'strengths', especially in scientific manpower, facilities and achievements in space, information and biotechnology research. However, there are glaring 'weaknesses' that cause great concern to policy planners and managers of research. Inadequacy of scientific posts in some organizations, lack of direction on focused research priorities and overall mediocrity, barring a few institutes and universities and duplication of research activities are all areas which ultimately affect the growth of science. Nevertheless, there are ample 'opportunities' to achieve excellence, as exemplified in space research and information technologies. It was an exemplary team spirit among scientists, engineers and technicians that brought glory to space research and it has served as a role model for other institutes. In spite of good work and generation of valuable data, the quality of publication in reputed journals needs to be strengthened. Awareness among scientists on the scoring of journals, citation index and impact factor seems to be lacking, which requires immediate attention. If appropriate actions are not taken to revitalize scientific research, then the 'threats' are bound to lower the image, which the country can hardly afford, especially when the 'strengths' and 'opportunities' are positive indicators for further enhancement of scientific efficiencies. Thus, SWOT reveals that the enormous potential available in the country should be geared up to achieve excellence.

Quality of research

Although we may pat ourselves over the accomplishments in the last six decades, there are some areas which require serious attention. The first and foremost is the quality of research in comparison with international standards. We cannot be satisfied by simply counting the thousands of science graduates rolled out by the universities year after year. Even after postgraduation in science, many do not pursue a research career, which means that the percentage of scientific manpower is less compared to the total number of graduates. Even those science postgraduates who opt for the teaching profession do not undertake research, either due to lack of facilities in their colleges or due to lack of interest or both. Among the 'professional' scientists also, the quality of output is rather poor and is not commensurate with the huge investments made for scientific research. Various reasons are attributed for poor-quality work. One of the yardsticks to assess the standard of a scientist and his analytical brain is the publication of research findings in specialist journals. Despite the large number of scientific journals published by various Indian scientific societies, more than 70% is found to be medium to low standard on the international scale of score/impact factor.

In an earlier publication[1] it was revealed that none of the Indian journals in the agriculture field achieved the highest score of 4.0, while only less than 15% had a score of 3.5–3.0; as much as 48% of the journals had the lowest score of 0.5. Almost all the SAU journals had a score of 0.5. This analysis was based on the score allotted to 1460 journals, both national and international, by NAAS. Analysis of research publications in agriculture is difficult, since the coverage in *Science Citation Index* (*SCI*) is rather poor[2]. It is not uncommon to sometimes find low impact publications being cited more than publications made in high impact journals[3], reflecting on the complexity of the situation. What would be the trend in other disciplines of science is anybody's guess. It was also found that few eminent scientists from India serve on the editorial boards of reputed international journals. Many Indian science journals do not find a place in the *SCI*. The national academies, councils and societies in India should debate on this rather poor show of scientific research, objectively and dispassionately.

Conclusion

The SWOT analysis has brought out some salient points on the Indian scientific research scenario. It is flexible inasmuch as some points may not apply or some need to be added to make it more realistic for a given institute/organization. The author does not claim that the analysis is foolproof. There is no second opinion that Indian scientists are shining both in India and abroad, but their number is in a microscopic minority. It may be possible to produce high-quality scientific brains if the analysis is considered for further improvement to make India the most scientifically advanced nation. Lastly, the Prime Minister's dream to provide more opportunities for scientific research must become a reality. Also, the passionate appeal by A. P. J. Abdul Kalam, the former President of India, to make India the most developed nation by 2020, implies that scientific research is the backbone for societal growth and prosperity.

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