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EDITORIAL

Science in India: Signs of Stagnation

Ranking individuals, institutions or nations is a dangerous pastime. The parameters which permit differentiation and classification must be carefully defined. In sport, rankings are easily achieved. Competition, with clearly defined objectives, permits an unambiguous conclusion. Even as the results from the Commonwealth Games in Manchester pour in, it is clear that India might finish third or fourth in the medals tally, a result that will undoubtedly gladden the hearts of all Indian sports lovers. But, there are other lists. In the FIFA rankings, the Indian football team is listed at a lowly 124th position in a collection that includes 203 teams, including those from tiny countries and islands, a few of which may be unknown to many readers. In football India is outclassed by Libya, Estonia, Cyprus and Iceland among others. Brazil, the newly crowned champion, tops the list and the Republic of Korea which did so well is, as high as, 22nd on the list. In this season of lists, the United Nations Development Program (UNDP) has released a ranking of countries based on the human development index (HDI). The HDI is calculated using a complex formula, which factors in parameters like life expectancy at birth, adult literacy rate, GDP per capita and an education index. And, in the HDI ranking for 2001, India appears unhappily, at the 115th position among 162 countries. Predictably, there have already been critical comments in the press on the manner in which the HDI is calculated. There is, however, some cheering news. Bangalore, home to this journal, ties for the 4th position with four other cities, among the 46 top technology hubs; Silicon Valley in the US, of course, heads the list. On an index for technology achievement, India occupies the 63rd position, with China at 45, Brazil at 43 and Korea at 5.

In thinking about ranking and lists, I must turn inevitably, to science. In assessing scientific productivity quantitatively, the simplest index is the total count of published papers. The database that is most widely used is the *Science Citation Index* (*SCI*), produced by the Institute for Scientific Information, Philadelphia. Although the *SCI* is necessarily selective in covering Third World journals, it still includes all scientific periodicals above an acceptable threshold of quality and frequency. Counting papers and ranking nations is, thus, a common activity amongst scientometrists. Nearly six years ago in a letter entitled 'India's declining ranking', N. Raghuram and Y. Madhavi pointed out that the country slid from 8th position in 1980 to the 13th position in 1995, in a list that ordered countries based on their output of published papers (*Nature*, 1996, **383**, 572). In commenting on the apparent decline of India's world ranking in science, the authors noted that 'lack of motivation, a feudal work culture and absence of dynamic and inspiring leadership' may be contributory factors. They also pertinently noted that 'what is most striking is the total lack of monitoring of Indian science publishing trends as an input to policy and planning'. After a brief outcry at the 'negativism' implicit in the Raghuram–Madhavi analysis, the matter was conveniently forgotten. More recently the ghosts have come back to haunt us. In a letter entitled 'Is science in India on the decline?', published in this journal, S. Arunachalam has returned to the arena of scientific ranking, armed with data for two decades, 1980–2000 (*Curr. Sci.*, 2002, **83**, 107). India is now at position 15, while China and South Korea occupy the 9th and 16th ranks respectively. But, the statistics are telling. In 1980, India accounted for 14,983 papers in the *SCI*. By 2000, the number had fallen to 12,127. China moved upwards from 924 in 1980 to 22,061 in 2000. In the same period South Korea jumped from 175 to 12,013, Brazil from 2215 to 9565 and Israel from 5733 to 9292. Although the share of the developing countries in the world's scientific output is still very poor, there are clear signs that some countries are moving forward at a fast pace. Korea and Brazil appear to have focused on improving both their soccer and their science. India, on the other hand, appears to have reached an uncomfortable, equilibrium position. If the published output remains stagnant or declines over the next few years, there is little doubt that we will slip further down these rankings.

Is the number of papers published annually an adequate index of the health of the country's scientific enterprise? Many would argue that few conclusions can be drawn from such numbers, which probably hide more than they reveal. But how do we assess an individual scientist, a

department or an institution? More often than not, such evaluations are based on the number of published papers as an index of performance. When the numbers are small more detailed analyses, which introduce a 'quality criterion', are possible. It is here that the journal impact factor begins to rear its head. But, at the level of nations a total count may be a moderately reliable index. Why then is India struggling to improve its rate of scoring, while others seem to be accelerating rapidly? The very premise that science in India is in a rut will be strongly contested. Are there not many signs of visible, technological progress? The successful nuclear explosions, the satellite launches and the production of indigenous missiles are a tribute to the organized arms of strategic research and development. Well-defined 'missions' can undoubtedly be accomplished in chosen areas of technology development. But, when published papers are counted we are really assessing academic science; traditionally research carried out in universities and national laboratories, which are not part of a grand strategic design.

For over three decades after independence academic science remained a low-key activity, attracting little by way of major support from government. The winds of change were evident in the late 1970s, when the National Committee for Science and Technology began to function. The early 1980s saw an intensification of support for academic science by the Department of Science and Technology (DST), following the Baroda (now Vadodara) seminars, which formulated the 'Thrust Area' programs. Subsequently, government funding for science increased steadily, levelling a little in the late 1990s. Ironically, the decline of scientific productivity coincides with enhanced inputs into scientific research. This apparently paradoxical situation merits analysis. One possibility is that the universities, which used to contribute substantially to published output, have been declining alarmingly. While many new, and sometimes embarrassingly well-endowed, national institutions have been created since the mid-1970s, the academic science departments in most universities have been rapidly plunging downhill. The major academic centres of the 1950s and 1960s, the universities at Calcutta (now Kolkata), Madras (now Chennai), Delhi, Allahabad and Banaras are no longer the foci of academic science. Plagued by problems of political interference, diminishing resources, declining faculty quality and a rapid deterioration of the academic ambience, the contribution of Indian universities to the country's scientific output is undoubtedly falling. With the exception of a couple of Central universities, the status of science in university departments is hardly encouraging. There are no solutions on the horizon, which will address the inexorable decline of our universities. On the contrary, several national laboratories and central institutions now have excellent research facilities, increasing numbers of Ph D students and appear to have significantly enhanced the quantity and quality of their published scientific output. However, the national institutions have been buffetted by the winds of change. Their research is gradually being driven, by the carrot of large funding, into areas of apparently applicable research, with the focus shifting to areas of 'national priority', 'networked projects' and 'missions' of various kinds. While considerable financial inputs are generally provided for these enterprises, publications are often not the expected outcome of these projects. In many cases the output of these researches is hard to measure. The camouflage of patents and protection of 'intellectual property rights' is often used to mask the fact that many major 'research projects' have yielded far fewer interesting results than promised. A new breed of scientist is now emerging; the 'managerial scientist', whose success is determined by the ability to accumulate funds and facilities, with a diminishing emphasis on published output.

While mere numbers of papers may not tell the whole story, it is worth recalling that one of the first analyses of Third World science output, using the 1973 *SCI*, put India at the 8th position, preceded only by the US, UK, USSR, West Germany, France, Japan and Canada (E. Garfield, *Science and Public Policy*, 1983, **10**, 112). Interestingly, in the period for which Arunachalam has produced statistics (1980–2000), the number of universities and deemed universities has grown from 128 to 231. R&D expenditure has risen in this period from Rs 760.5 crores to about Rs 13,000 crores; figures adjusted for the falling value of the rupee. From 1985–86 to 1998–99, the R&D expenditure has hovered around 0.8% of the Gross National Product (*Research and Development Statistics*, Department of Science and Technology, May 2002). It does not require a great feat of interpretation to conclude that all indicators suggest that scientific output is on the decline. An uncomfortable facet of counting numbers of papers is that quantity is no guarantor of quality. A few years ago an analysis of the *impact* of papers published between 1992 and 1996 was carried out, using the ISI's databases. Nations were ranked by citations per paper. Switzerland topped the list, with the US coming second. Brazil appeared at position 30, Argentina at 26, while China and India were conspicuously absent (*Science Watch*, 1997, **8**, 1). Here, we must remember that a large number of poorly cited papers reduce the citation frequency. Scientometric analysis, carefully done and conservatively interpreted, can be valuable in establishing the status of academic science in institutions and countries. A hard look at incontrovertible facts may help policy makers. The tools for assessment exist and they must be cautiously used. We must also pay attention to the problem of evaluating scientific projects which do not seem to yield publications. However much one would like to disbelieve statistics, the writing is on the wall. Science in India is in danger of stagnating.

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