Mediocrity in Indian science: Algorithm for a turnaround

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A lot has been written about the decline in the quality of Indian science[1–5]. During the last couple of years, a consensus has been arrived at that the vast majority of the scientific task force comes under the category of mediocre and the new science graduates, post-graduates or Ph Ds are, by and large, unemployable[6]. Such concerns on the sliding down of Indian science have been expressed by corporate doyens as well as policy makers[2,6]. N. R. Narayan Murthy, while delivering the D. V. Narasimha Rao Memorial Lecture[6] on the 'Indian software industry: Opportunities and challenges', quoted some glaring statistics. The number of patents per one million people is one in India and 289 in the US. Further, the number of researchers per one lakh population is 149 in India and 3805 in the US. He cited an example of the contribution of MIT (Massachusetts Institute of Technology): 'nearly 150 new companies come up each year through the efforts of the faculty and staff of MIT. There are nearly 4000 such companies in the US whose combined sales were worth $232 billion, which was nearly 40% of India's GDP. This means the productivity of every MIT graduate is equivalent to the productivity level of nearly one lakh Indians'. C. N. R. Rao in a letter to the Prime Minister mentioned that: 'In the last few years, our performance in basic sciences has come down markedly, not only in terms of the percentage of contribution to world science, but also in the percentage of high-quality research papers which get cited more. We are way below China, which contributes around 12% to world science (compared to our less than 3%). The decrease of high-impact papers from India (less than 1%) is of serious concern. Our universities are unable to perform and compete, their research contribution has come to an all-time low'[2]. Often the science managers feel handicapped by the lack of a critical/threshold level of personnel with intellectual and professional prowess to deliver the goods. The problem is further compounded by the increase in the average age of the scientific task force in various institutes and the universities.

A moot question is what is the root cause of reaching such a situation and as to what algorithm can be followed to be comparable with the best in the world in the shortest time-frame? Science teaching in schools is insipid. Students learn by rote and sometimes there is burn-out in the race for entering premier institutions, which are few for a population of billion plus. Here we can learn from the way USA is managing school education for science and igniting passion for science and mathematics[7]. During the last nearly three decades, there has been a substantial expansion in terms of opening new departments, splitting existing departments and opening many institutions. More recently, private players have also come into education, believing and rightly so, that it is the most lucrative business. While doing all this it was not realized that 'Science is not just about laboratories and fancy new institutions; it is about the people inside them too'[8]. In order to run new courses, institutions started taking in 'whatever was available', without realizing that an individual not meant for intellectual activity like doing and teaching science would be a liability and would ward-off generations away from science. Most of the new as well as old institutions fall short of even the bare minimum faculty[1]. In order to improve the financial health of institutions a knee-jerk reaction is the start of self-financing courses with sundry, usually contractual faculty. A common belief is gaining ground that a degree need not necessarily be earned, but can be purchased if you have enough money. This is vitiating the overall social milieu vis-à-vis respect for academics and science.

A key factor in training scientists and publishing international quality papers is the mentor. There are no quantitative norms for accreditation of mentors, except the length of service or the number of students the individual has guided. Both these criteria are essentially non-scientific and do not vouchsafe for the capability of the individual to be an effective mentor. Further, I believe no effective evaluation system is in place for the evaluation of mentors by the students. It is also common that the mentors rarely command respect of the students by virtue of their academic stature and are tormentors in terms of delays and overall callousness. A mentor ought to be a professional authority enjoying international recognition in the area of specialization and earn respect not by virtue of position, but by his/her worth.

Dispassionate diagnosis of the malady and action plan for immediate implementation is obviously the need of the hour. I would suggest that a survey be conducted at frequent intervals on the quality of mentorship, the quality of training research fellows get and overall quality of life in research laboratories in India. Such a survey (preferably on-line) has to be carefully calibrated so that the identity of the scholar is not revealed and it is ensured that the responses are candid. Such surveys are routinely conducted by AAAS and other fora in USA[9,10]. Richard Sykes has given a recipe for the UK, i.e. to emulate USA[11]. We too can emulate USA to create a world-class science base. It is not only the money and the facilities that are enabling the US to win over the best brains from all over the world[11], but the quality of life in the science institutions as well.

What is taking students away from doing basic sciences? An engineering or management student after 16–19 years education, starts earning essentially as much as a professor with 30 years of service. Thus doing science must be made attractive by keeping in view these ground realities by twofold action: (a) substantial enhancement in the value of scholarships plus improvement in the quality of life in research institutions and universities. If the word spreads that doing research is 'reasonably paying' and intellectually exciting, then a sizeable number of potential students would flock towards science. Mere seminars and expression of concern would not help. The responsibility for such an action lies with policy makers, science managers and mentors.

An institution is represented more by the quality, vision and international reputation of its faculty and not by the fanciful names of the departments and glossy pictures in advertisements. Once we have the right people for the job in place, the rest follows[12]. Here I do not talk of a few institutions of excellence which have in place the procedures and protocols comparable to the best institutions in the world. It is high time that adequate measures are put in place to adopt procedures for faculty hiring as in the US. Hiring of faculty should involve proper planning, search and day long exposure and interaction to provide opportunity to the candidates to know about the institution and the people working there and vice versa. A threshold level of criteria in terms of publications in international fora and cumulative impact factor is a must as the first step of screening[5,13]. This would automatically eliminate the frivolous candidates and those making an effort for back-door entry. It is time to remember what Winston Churchill said: 'The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to a close. In its place we are entering a period of consequences'. A silver lining has come in the form of an announcement about some sweeping measures by the honorable Prime Minister, which include a quantum jump in investment in science education and research, and a range of schemes to attract students and replenish the shrinking pool of scientific personnel[14]. Thus men and women in the laboratories can look forward to qualitative as well as quantitative changes in their lives, sooner than later.

1. Report of the Task Force for Basic Scientific Research in Universities, http://www.ugc.ac.in/more/bsrpdf/Report%20of%20BSR%20Task%20Force,%202005.pdf
2. *The Indian Express*, http://www.indian-express.com/story/8817.html
3. Padma. T. V., http://www.scidev.net/News/index.cfm?fuseaction=readNews&itemid=2383&language=1
4. Mehta, A., http://timesofindia.indiatimes.com/Opinion/Editorial/LEADER_ARTICLE_Science_In_The_Sick_Bay/rssarticleshow/2973153.cms
5. Sharma, O. P., *Curr. Sci.*, 2004, **87**, 1641.
6. *The Hindu*, http://www.hindu.com/2006/01/04/stories/2006010407060400.htm
7. www.regent.edu/publications/cl/pdfs/ss2008/math_science.pdf
8. Gibson, I., Science & Technology Committee Report No. 25 of Session 2004–05, 7 February 2005; http://www.parliament.uk/parliamentary_committees/science_and_technology_committee/scitech070205.cfm
9. Nally, T. L., 2002; http://nextwave.sciencemag.org/career_development/previous_issues/articles/1750/survey_of_surveys_ii_polling_postdocs_effectively
10. http://postdoc.sigmaxi.org/
11. Sykes, R., World Class Science Base: Emulate Uncle Sam; http://www.newtons-apple.org.uk/essays/essay1.htm
12. Dubos, R. J., *The Professor, the Institute and DNA*, The Rockefeller University Press, New York, 1976.
13. Sharma, O. P., *Curr. Sci.*, 2007, **93**, 5.
14. Jayaraman, K. S., *Nature*, 2008, **451**, 112; http://www.nature.com/news/2008/080109/full/451112b.html

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Bt resistance and monophagous pests: Handling with prudence

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Bacillus thuringiensis (*Bt*)-based insect pest-resistant transgenic crops have become a commercially successful and viable product in agricultural biotechnology globally. Both the area under *Bt* crops and demand for *Bt* crop seeds are increasing. In India, the area under *Bt* cotton, the first ever commercial transgenic crop, has shot up from nearly 30,000 ha in 2002 to 9.5 mha in 2007, constituting nearly 66% of the total cotton area with an expected output of 31 million bales. From a mere three *Bt* cotton hybrids in 2002, nearly 135 *Bt* cotton hybrids are under consideration for commercialization with a projection hinting further expansion in area and productivity. In cotton, *Bt* toxin is directed against the cotton bollworm, *Helicoverpa armigera* (Hubner). This and many other pests are polyphagous (attacking multiple crops) and have more than one host crop. For example, *H. armigera* has more than 200 host plants on which it can feed, lay eggs, complete its life cycle and multiply. Various tactical methods are deployed for delaying the development of resistance to *Bt* in insect pest populations (Table 1). However, certain issues still remain to be answered. If the cotton is *Bt* transgenic, the pest has options of invading non-*Bt* cotton and other crops. Not all pests are polyphagous. Pests like the cabbage diamondback moth (*Plutella xylostella* L.; Plutellidae, Lepidoptera), rice stem borer (*Scirpophaga incertulas*) (Walker; Pyralidae, Lepidoptera) and the brinjal shoot and fruit borer (*Leucinodes orbonalis*; Guenee; Pyralidae, Lepidoptera) are monophagous and do not have alternate host crops. So far, all the research and field experiences with regard to *Bt* technology and possible emergence of resistance to *Bt* in pests have concentrated on polyphagous pests, especially *H. armigera*[1,2]. The stochastic model '*Bt*-Adapt' developed at the Central Institute of Cotton Research, Nagpur, to understand and predict the rate of resistance development of *H. armigera* to *Cry1Ac*-based *Bt* cotton is definitely not applicable per se to monophagous pests[3]. Besides, unfortunately, there are hardly any studies with regard to *Bt* rice–*S. incertulas* and *Bt* brinjal–*L. orbonalis* systems. How are monophagous pests different from their polyphagous counterparts with respect to emergence of resistance to *Bt*, selection pressure and genetic dynamics of alleles in their populations and management of resistant types? How stringently are they monophagous? What are the molecular and physiological mechanisms that drive the development of resistance? How effective are the deployment tactics in reality? These and other questions need a thorough generation, analysis and interpretation of data, as a forewarning step, to ensure that Indian agriculture will be prepared to face in the imminent possibility of emergence of *Bt* resistant pests, polyphagous or monophagous, due obviously to the recent spontaneous changes we are all witnessing, of the dominating demography of cultivation of GM crops. The exigency of the problem is hastened by the recent observations of *Bt* cotton