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CORRESPONDENCE

Saving Indian science

The views expressed with concern by C. N. R. Rao (*Curr. Sci.*, 1992, **63**, 505) will certainly be shared by the Indian community of scientists. The reduction in Government funding for S&T at 0.9% of Indian GNP is all the more alarming as bulk of allocated funds go for space research and atomic energy sectors with hardly 25–30% being available to the rest of the areas. The National Laboratories have been suggested to look for external funds with market-oriented research and work with corporate culture. This appears to be an anomaly of sorts since our National Laboratories are not tuned to work on corporate norms thanks to the straight-jacketed bureaucracy and rules and regulations. There is more concern in spending money even of industry sponsored work carefully (slowly) by antiquated procedures than the speed to achieve the objectives set within a time frame. This was highlighted in the recent national conference on Inhouse R&D units in Industry and S&T held at Delhi. It is equally a paradox that industries are quite reluctant to fund R&D in institutions and wait for the outcome as they always look for ready-to-apply turnkey technologies with product or process guarantees. This then leads us to the egg-chicken situation. Often, the corporate sector tries to label the indigenous technologies as inefficient to justify importing obsolete technologies abandoned abroad since there is craze for foreign tie ups. The battle in this situation is unequal for Indian scientists to match. Corporate sectors should set apart a percentage of their turn over for supporting R&D voluntarily for national economic growth. This is imperative as they take away the 'creamy layer' of trained and competent personnel available in the country at no cost for their training.

If Japan has progressed and has become an industrial giant in a remarkably short time, it is due to contract research with the universities and the National Laboratories. Our universities never look for taking up the challenges of industries in R&D sectors and go for easy options of getting soft grants from governmental funding agencies. Indeed, it is sad that bulk of our scientists in universities and national laboratories lack serious commitment and determination to deliver goods and our research approach is too open-ended. There are too many escape routes in funded projects for not achieving the objectives due to want of infrastructural facilities, chemicals, etc., and delays attributed legitimately or otherwise to administrative inefficiency. Why should the universities do only blue-sky research and not application-oriented ones and get beyond bench level.

It is also a pathos that some premier institutions like IIT's, IISc and some previleged universities alone are regarded to have capability for high level research and get easier funding than the equally capable scientists in several less-known universities who have to struggle many fold to attract funding and recognition. This will make these institutions remain eternally backward in research.

Though Indian scientist is second to none in intellectual abilities, he fails in a team. Modern science warrants co-operative endeavour and multidisciplinary efforts. There is an urgent need for a change heart in our scientific fraternity. A serious introspection is needed by all to keep afloat in scientific research under the present dire circumstances.

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C. N. R. Rao has said that 'we need to invest adequately in Science Education' (*Curr. Sci.* 1992, **63**, 507). I think this investment must be much more than in money that one might think of. A good investment of time and efforts on the part of top scientists and good science educators is very essential. We have several small pockets of excellence in science and science education in the country. However the impact of these small pockets on the vast area of the country is insignificant. To achieve good results people in these pockets should be prepared to invest their time and efforts for those outside.

Two recent activities, one undertaken by an individual (G. Venkataraman, through his book series Vignettes in Physics) and another by a voluntary agency (Indian Association of Physics Teachers through their national examinations), have made a small but significant achievement. We need more such efforts in physics and in other sciences as well. The quality of science literature in the hands of our youth should be of good quality and the examinations they take should make them think. This has to be done at High School or even at lower levels. 'Catch them young' is very important especially if we want good scientists. Let us not forget in this context that the best of the brains at class XII level are 'lost' to technology because the students at that level are not strongly motivated towards pure science.

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The major points of the case for more funds for science may be summed up as:

1. Basic science is important for long term future of the nation; support at

least the frontier areas.
2 The budget for science in India is less than in other countries on GNP ratio basis and is now dropping. This needs to be increased.
3. The research costs in India are less than in other countries — the wages of scientists are less.

All the above are true and valid. But there are some other points not considered by many scientists. There are certain other requirements, before science can benefit the nation; without these science cannot deliver the goods. These are a skilled labour force; an industrial infrastructure, and a society that is at peace.

The support for science till now, came from the enlightened Nehru family, who had a unique combination of the best in the East and the West. That era is now over.

What will be the basis on which we should 'sell' the need for more basic science? The society at large does not understand science; it knows and appreciates technology. It therefore is proud of our rocket-launching, the missiles, and the satellites. It will also take pride in Nobel prizes or other very prestigious awards.

Like a family in bad times, our country is facing severe financial crisis. Like the members of a family, we have to sacrifice something so that the nation survives. Which activity should get priority? Poverty alleviation; literacy and primary education, water and food for the year 2000; removal of social tensions, or basic science research? It is a difficult decision for any government, particularly when non issues like the Mandir–Masjid shake up the whole society. If the society is backward-looking, we as citizens are also to blame; what have we done to spread the benefits of science to the rest?

If the disparity in the society is not checked, the social tensions increase and any thing could rouse passions and ignite. If an upheaval erupts, it will engulf all the scientists also.

I suggest the following as an approach for the science in India:

1. Science establishments should analyse their budgets and should bring noticeable austerity. I know scientists who gave up their own privileges to get facilities for the laboratories. They should not spend too much on buildings, gardens and auditoria, bring to the minimum the cost of meetings and seminars. Make austerity a way of life.
2. Frontier areas are created by scientists, by making a breakthrough in research. Pasteur served industry and founded a new science. Earlier, in India, malaria and cholera have proved excellent subjects for 'frontline' work. The basic science related to our problems should get more attention than 'frontier areas' not of immediate relevance. As Mashelkar has said in his article, in the same issue, why can't engineering science give India a frontline position in railways, roads irrigation, watershed developments, metallurgy, etc. This will bring immediate economic returns and more funds for science. This will give the society faith in science and prepare the ground for real basic research.
3. There should be a strategy for getting a long term foothold in basic science.

This may include:
i. Enlarging the catchment area where young scientists are attracted. At present it is about 5% or less, of the total population. This should be increased to 50% by improving quality and amount of school science.
ii. Remove the deadwood in the science teaching and research institutions. Those who go for masters degree should 'go through fire' to prove they love science. Higher education should not be subsidized but prospective students should be given opportunities to earn their fees and material costs, by working part or full time on the campus or in the laboratory. This will eliminate non scientific staff from the campus, and bring a better work culture and perhaps make the scientists more skilled generally in life.
iii. Instrumentation research, design, fabrication, repairs should get much wider and more intensive attention. This should be a 'frontier area' for us. I believe instrumentation is one of the major cost centres in today's basic research. We should follow Raman and J. C. Bose in this. Pioneers have necessarily to design and build their own instruments.

4. In the same issue, in the biography of J. B. S. Haldane, there is a mention of his suggesting research in animal behaviour, because it will cost less. I feel this is a good strategy. Should not the topics for research for universities be selected such that the research approach is taught without too high an expenditure. It may also teach the students how to measure when no ready instruments can be ordered. Such topics will encourage creativity, not only in research but also in instrumentation and techniques.

In this era of 'no subsidy' the scientists will have to sell their case to the society to earn a bigger budget for science and not depend on a Nehru. For this, they will have to give up something; what will they give up to prove their love for science? Science should not be just a career, but a life mission. Those who are not committed to science will go, when there is less money in science and in the long run it may help Indian science to become slim and agile.

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The articles (*Curr. Sci.*, 1992, **63**, 505–528, 541–542) emphasized the need of adequate funds for scientific research and its progress. I concur with the authors of these articles that research money is a key component for placing India in the science map of the world. The impoverishment of basic research will lead to losing even the present face-saving status of our country in the highly competitive international science.

I was surprised to note that none of these articles analysed the other factors which impede the growth of science. To begin with, the science education in the schools is monotonous and repels young minds away from science. Some bright students who overcome these and manage to get brighter are diverted to professional courses because of social pressure. At the tail end we manage to train hundreds of young scientists and they migrate abroad at their prime time.

We cannot compare all scientific institutions in India with one particular Institute which is perhaps close to what an ideal scientific institution should be. In such institutions, research money alone might have good effects on research progress. However, for each such institution there are numerous

institutions that have all maladies like bad bureaucracy and reduced dedication and sincerity among scientists. These factors prevent the effective utilization and distribution of meagre resources. In these places scientists start to build empires and monuments duplicating expensive equipments. Quite a few of our laboratories in India are more posh than several Japanese laboratories. In the affluent America, a large number of research laboratories are still using counters, spectrophotometers and ultra centrifuges bought quarter century ago. But what we do here—we scientists need a lot of introspection. Padmanaban in his article attributes the phenomenal progress in the West to 'corporate research where 40 post docs work round the clock for a single scientist'. While this may be true in some cases, in some other cases small groups consisting of a single Indian scientist and four post-doctorals and two technicians are doing wonders in USA. Each such small group publishes papers every year in top ten journals. No doubt we have the same calibre Indian scientists in India in a few institutions that are equipped even better. But can we compare the productivity of the two types of highly talented Indian brains? What is going wrong? Is it the competition and pressure for getting grants and accountability that make the comparable Indian brains to perform better? Can we shift all blame to bureaucracy which prevents doing fast science?

Indian science shows signs of distress in all directions. The academies and scientists should discuss these problems and evolve ways to solve these. The most important is introspection and scientists should remember that they are also obliged to the people. As Vijayan asks in his article whether there is 'a case for sustained effort to improve our credibility among ourselves and among others', the answer is, yes. Scientists should be dedicated, realistic, inspire students and create a world of high aspirations.

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S&T scenario

I wish to comment on the following on S&T scenario

(a) All nations enjoy or suffer from their own normalized levels of 'limits of growth/efficiency' and, naturally, India is no exception. We seem to be uniquely caught up with a situation where all development activities and also policies are essentially dictated by the 'limits of efficiency' set out by the generalist-permissive administrative structures and practices, yet seeking 'limits of growth' typical of technological societies. No wonder that the S&T sector also is affected by this inherent incongruency.

(b) Excepting for agencies such as DAE, ISRO and lately DRDO, Indian *civil* science has all along been a neglected sector, save some occasional bouts of governmental benevolence for selected narrow areas or institutions. Our declarations of intent for using S&T as 'engines of growth' have by and large been more rhetorical, if not theatrical, when taken from self-reliance point of view. In short, the cardinal trend for the past several decades has been to import all required knowledge (by way of technology, expert advices, and what not) from abroad, partly tied with strings and the rest for short-time commercial terms. And, unlike in many other LDCs, of course, the native science was always encouraged to co-exist and fulfil a marginal/advisory role. Be it in the public sector or the private one, import has been and continues to be the rule of the day, notwithstanding marginally greater component of self-reliance in the PSU's based on half-hearted technology absorption/adaptation practices.

(c) Having said so, it is crucial to realize the dangers from further marginalization of the indigenous science arising out of, may be, increased financial constraints of the Government on the one hand and free technology import on the other. I do not for one believe that Indian S&T at its *present* level can very significantly contribute to industrial development *as needed* today, thanks to decades of neglect. But this is the time, perhaps the last, to strengthen it very consciously and systematically so that along with 'imported modernization' our native S&T capabilities, at least in select sectors, will be augmented and such that by the turn of the century or so the two sectors would find the partnership more 'matching'. The S&T community shall take upon themselves the onerous task of convincing the political leadership, both ruling and the opposition, on the inevitability of such a strategy, failing which both would let down our future generations.

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Enzymatic activity of ribosomal RNA

This is with reference to the comments by D. Chatterji[1] in *Curr. Sci.*, 1992, **63**, 535. To set the record straight he has made some statements which need clarification. There is some confusion about Noller's work[2] and our work[3]. We demonstrated complete protein synthesis (polyphenylalanine synthesis) in *E. coli* but Noller demonstrated in a thermophilic organism, only the so-called fragment reaction which is an assay system for peptidyl transfer. Further, a limited number of proteins had to be added to our system not for structural purposes (as stated by Chatterji) but for translocation without which polyphenylalanine synthesis cannot take place. In our system two different conditions (high salt-high Mg^{++} and ethanol) were used to maintain the structure of ribosomal RNAs. It should also be remembered that Noller and his coworkers had about 5% protein left in their system.

It is also wrongly mentioned by Chatterji that we had *predicted* (italics mine) the biological activity of ribosomal RNA. Actually we had *demonstrated* that. Further, it is wrong to say that the ribosomal RNA *fragments* (italics mine) form a stoichiometric complex; actually intact ribosomal RNAs form the complex. It is gratifying to note that our work was widely quoted, (for example, Maniatis and Reed[4], Watson *et al.*[5], Cech and Bass[6]) long before Noller's achievement.