Accommodating outliers in Indian science

While the Indian Institutes of Technology (IITs) have combined research and undergraduate engineering education for decades, it is only recently that a small but not insignificant number of institutions have begun housing undergraduate science students in a research environment. Recent examples of this trend include the Chennai Mathematical Institute (CMI), the Indian Institutes of Science Education and Research (IISERs), the University of Hyderabad (UoH) and the Indian Institute of Science (IISc).

However, none of these institutions cater to students talented in just one subject. Such students often have a single-minded focus that makes them likely to engage in high-impact scientific research, but also unable (or just unwilling) to pass the usual examinations that test them across subjects. It would be nice to see elite institutions (elite as measured by quantum of funding) address the challenge of accommodating this class of students. J. B. S. Haldane is reported to have remarked that Srinivasa Ramanujan would not have been admitted to any of our institutions of higher learning. The Olympiads, conducted by the Homi Bhabha Centre for Science Education play a role in encouraging such students, but offer no career incentives (admissions/scholarships).

High-school students with stellar performances in any one subject in the standard admissions examinations (an area that independently needs radical reforms), should qualify for an interview at a research institution. For example, a student with 100 percentile in the mathematics paper of the IIT–JEE examination, but poor scores in the other papers, should be interviewed for a B Sc Honors in mathematics specially created for the purpose at an IISER. The IISER would constitute a panel of experts to interview students in each discipline for the proposed B Sc Honors programme. Large numbers always pose a problem in India, but spread across institutions and their faculty, this interview process of the top percentile in each subject will be manageable.

A second positive move would be to drastically increase the number of seats for research-related undergraduate degrees in India. Every research institute, whether under the DAE, CSIR or MHRD umbrellas, ought to start a small undergraduate programme in its thrust area. For example, the National Chemical Laboratory (NCL) has the resources to offer a B Sc Honors in chemistry of unparalleled breadth. While this will involve a lot of thought, planning and work, such programmes will inevitably attract bright high-school students. Issues regarding the teaching of humanities and ancillary courses must be addressed, perhaps by reaching a mutually beneficial arrangement with neighbouring institutions. A realistic target is for each research institute to admit 30 undergraduate students every year.

Indian science can only benefit from an influx of bright, enthusiastic and uncluttered young minds.

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Pros and cons of food-based interventions to overcome malnutrition

Population explosion combined with reduction in cultivable land due to urbanization and industrialization are considered as the biggest threat for food and nutritional security in developing countries like India. Though the green revolution made our country self-sufficient in food grain production, a sizable population (mostly poor) is suffering from malnutrition and people are already talking of the ever-green revolution to feed the ever-increasing population with more emphasis on nutritional security. Among nutrients, micronutrients like zinc and iron are of greater importance in addition to vitamin A and iodine from human nutrition perspective and deficiency of these micronutrients is detected across more than one-half of the world's population[1]. Malnutrition is rampant in our country, resulting in chronic diseases and often reported deaths. Therefore, while biofortification is considered a long-term sustainable intervention, food-based interventions are the most appropriate measures to tackle this dreadful problem.

The major short-term interventions to overcome malnutrition are dietary diversification, food fortification and supplementation. A diverse diet that includes cereals, pulses, millets, animal products and a variety of fruits and vegetables is the ideal solution to alleviate malnutrition. However, people mostly in developing countries, can only afford staple foods like rice, wheat and maize for their dietary needs, because of lack of purchasing capacity. Further, rising food prices makes it harder to reach out to the target population through this approach[2].

Food fortification is a process where addition of nutrients to staple food is considered as an effective immediate strategy. Iodine fortification of salt is one of the success stories of the 20th century, helping to eliminate iodine deficiency disorders in India as well as across the globe. Unlike iodine, fortification of other nutrients is not very successful and the causes are many. For example, iron fortification can be technically challenging, because iron compounds that are easily absorbed by the gut tend to leach easily and also change the taste of food, whereas those with less impact on taste are the most difficult to absorb. However, this approach also demands cheaper fortification techniques, distribution infrastructure to reach out to people living in remote and rural areas, and compliance monitoring[3].

Supplementation is the best short-term intervention involving the distribution of pills or mineral solutions for immediate consumption. Recently, the Government of India has started distribution of iron pills to school children during midday meals and pregnant women at primary health centres to overcome anaemia, a

common disorder among women. Similar supplementation is highly recommended to complement the diet of the entire population. But it is unsustainable, because when pills of high concentration are consumed, there will be antagonistic effects of one element over the other. For example, zinc pills can affect absorption of calcium in the human gut. Besides, supplementation being an expensive intervention, this approach heavily relies on adequate and sustained funding and efficient distribution mechanisms[3].

Biofortification is a process of enhancing essential nutrient content and its bioavailability in crop plants. Biofortification of food grains can be achieved by either enhancing the nutrient content or by reducing the antinutritional factors like phytate in food grains[4]. To biofortify grains, agricultural scientists employ different approaches like conventional breeding, molecular breeding and transgenic approach. A well-framed breeding approach is essential for biofortification, and often it takes 6–8 years to develop a cultivar with improved nutritional status. By adopting conventional breeding approach in 2013, the International Centre for Research in Semi-Arid Tropics has released pearl millet variety with increased iron. In a multi-institutional harvest-plus programme, rice and wheat varieties rich in zinc and iron have been developed. Though, biofortification is a time-consuming process, it is considered as the most cost-effective and sustainable approach. Realizing its importance and need, several transgenic[5] and molecular breeding programmes were initiated at national and international centres to hasten the process to develop biofortified crop cultivars. The bigger task ahead of us now is popularization and bringing awareness among farm communities to accept these biofortified crops over the elite crop varieties under cultivation. 'Health comes from the farm, not the pharmacy.'

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Better health: an approach

Being astonished by the fact, known to me through personal sources, that the health care bills just for buying medicine might be as high as 70–90% of the income of some retired and middle-class families, I was convinced that we need better health. Ill-health reduces income, opportunities and happiness, and wrings out every penny in our private and public finance. But no one can wish away the problem. This realization might have prompted Kalam[1] to formulate his mission to 'go to all parts of the country, particularly beyond cities, remove the pain of mind and body' (see Table 1 for more facts).

Table 1. Some facts[1]

Overall GDP (in billion US$) of Indians would be 436.4 and 2140.5 for the years 2000 and 2020 respectively.
Projected household demand of food grains (in million metric tonnes) is 208.6 in 2000 and 343.0 in 2020 respectively.
Projected mortality rates (per 100,000) of all causes in India are 846 for male and 745 for female for the year 2015, of which infectious diseases claim 152 (male) and 175 (female) lives.
Projected incidences of cancer are 851,904 (male) and 705,896 (female) in 2021.

Emerging technology for growth generates hopes for individual income, concern for overconsumption of natural resources, changes in lifestyle, and may lead to increased life-expectancy. Complexities of life lead to degenerative diseases, mental illnesses and stress-related physical symptoms in addition to all other diseases our ancestors lived with in the villages.

In addition to Allopathy, Homeopathy and traditional Ayurvedic medicines are followed by some. Homeopaths have now raised the controversy as to whether their products are 'nanocrystalloids'. Ayurvedic bhasmas of metals, after shodhana and marana procedures, were believed to have rendered metals non-toxic. Indian nanoscience is well developed[2], and nano-medicines might open another avenue for new medicine.

As every new technology enters our life, it confronts us every day with many simple, mundane questions: Are we at the losers' end? Are we losing our careers, privileges, income, property, or culture and heritage? Nanotechnology and biotechnology are no exceptions. While the concerns are genuine, one cannot be paranoiac, xenophobic iconoclast. One has to test every new technology in improving one's lifestyle with regard to reducing cost, cure of disease, and use of local knowledge skills and material.

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