How safe are Indian laboratories?

Many students opt for science after their 10th standard examination and many of them study chemistry later. In case they fail to get into a professional course, they end up graduating in chemistry and even continue for their Masters and Doctoral degrees. How safe are the laboratories provided by the schools, colleges, Universities and research organizations (government and private) in India? One should not be surprised if the laboratories are located in dilapidated buildings, with paints peeling off and growth of fungi on the walls. A peep into many chemical laboratories would reveal any or all of the following:

Mandatory items like safety goggles, gloves and laboratory coats would normally be absent. In case these are present the experimenter, students and even the demonstrators themselves do not use them.

Auto pipettes and other safe devices for handling the chemicals are absent. (Do not be amazed if the experimenter is seen to suck harmful chemicals through pipettes!) No proper labelling of the chemicals, cautionary notes and a list of dos and don’ts can be seen in the laboratories. This is vital especially if the experimenter has a history of respiratory or other ailments. Gas cylinders may not be secured and at times could also be leaking.

Ventilation system is bad. Exhaust and ceiling fans are non-working or non-existent. Compounded to this would be scarcity of or non-functional fume hoods. Even if present, experiments would be performed outside them. Lack of first aid boxes, which if present would be found locked up and the key missing, have the essential items misplaced or the medicines would have crossed the expiry date. Improper storage, handling, transferring and transporting the chemical bottles and glass wares are common sights. No proper method of waste handling and disposal exists. Absence of emergency exists, sirens and smoke and fire detectors and extinguishers is more of a rule than exception. (It is not surprising to see experimenters smoking in the laboratories.) One can also observe leaking taps, plumbing problems and precariously located and over-hanging electrical wires.

The above is an open-ended list that could be suitably modified for a biology, biochemical, microbiology, physics or any other laboratory. Some of the laboratories could be time bombs ticking away slowly but surely. What needs to be done to make the work environment safer and user-friendly? The ensuing are a few suggestions. Probably these are adopted in some laboratories but they may be the exception rather than the rule.

Wherever and whenever possible, the laboratories should be designed keeping in mind the safety factors. Of course, budgetary constraints could be a hurdle but some ways (sponsorship?) should be evolved to overcome this problem. Furthermore, there should be scope for future modifications of the laboratories.

The creation of a laboratory safety group, consisting of 2–4 members, is important. The group would be responsible for regularly checking and updating the laboratory, training the users, documenting and putting up prominent cautionary notices. This group would need to have a checklist that pertains to the safety norms, have undergone first aid courses and be vested with powers for a ready redressal. The group should be ready to innovate and take quick remedial measures whenever required.

Since constant exposures to chemicals and other hazardous materials could have an adverse effect in the long run, there is an urgent need to look into and rectify the prevailing laboratory set-up in India. The well being of an experimenter could be at stake because of want of the minimum facility in the laboratory. It is not my intention to paint a bleak picture of the existing scenario but to bring to the fore the importance of safety in the laboratories. Although regulations pertaining to health and safety exist, how far these are implemented, in words, spirit and action, is anybody’s guess. Ironically we ‘celebrate’ a safety week but what about the remaining 358 days?

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Vivid signatures of water on Mars surface strengthen the debate of microbial life

I read with interest the recent exchange of correspondence between Fred Hoyle and Chandra Wickramasinghe (Curr. Sci., 2000, 78, 1057–1059) and Manoj Komath (Curr. Sci., 2000, 79, 266–269). The correspondence made a reference in passing to microbial life on extra-solar planets and on Mars, in our solar system. At present, we are not in a position to say anything with certainty about life on other planets in the solar system as argued by Hoyle and Wickramasinghe. However, it may be noted that there exists a belt around our Sun where life could flourish. Earth is in the middle of this belt. Venus is closer and Mars is farther from the Sun but both the planets lie within this life-supporting terrestrial belt. The extended exploration by Pioneer Venus Orbiter (PVO) continuously for over twelve years has ruled out any possibility for existence of life on Venus. Mars is not yet extensively studied and therefore possibility of some form of life is not yet ruled out. The scientific community is aware of the fast developments in space explora-

The list of publications being the linch pin in assessing the work of the academicians in the research institutes, universities and other places, has become the barometer for their selection and growth. Hence the correct assessment of the list of publications has become the cry of the day. The selections/assessments are always done through the ‘peer review’ by a team of learned experts. Since the learned experts for selection/assessment have neither the inclination nor the time for an informed and just judgement, the judgements are mostly subjective, prejudiced and accordingly, honest, objective, open, impersonal criteria free from limitations has become mandatory for the correct and just assessment.

Eugene Garfield, the father of ‘science watching’ has introduced the concept of ‘citation counts’ and the ‘impact factors’ in the 1970s. These concepts have been found to be adequately suitable in a digital age, particularly when we are travelling into the information super highway. Garfield’s idea is simple. It means simply to look through the reference list in the papers and catalogue the number of times each paper is cited and the addition of these citations refers to the citation counts of the individual paper of the concerned author. Citation count being objective, impersonal and broad based (not confined to any narrow discipline) has become the acid test for the assessment of the quality of publications. Further, in order to assess the quality of a journal objectively, basing on the concept of citation counts, a derived concept like ‘impact factor’ has been introduced and is defined as:

(Total number of current citation of articles published in a specific journal in a two years period)/(Total number of articles published in the same journal in the corresponding two years period).

Institute for Science Information (ISI) ‘stresses that a journal’s impact factor is a meaningful indicator only when considered in the context of similar journals covering a single field of investigation or subject of discipline’. Clearly the ‘citation counts’ are primary and are not confined to a narrow field or discipline and are much higher for original and seminal work and tend to diminish further and further more the work is extended and trendy. Accordingly, the emphasis on ‘impact factor’ as well as ‘other considerations’ rather than the ‘citation counts’ – the acid test of quality – can result in awarding Padmabhusan to some one having papers with ‘citation counts’ less than ten for about twenty five years covering the

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CORRESPONDENCE

Publication lists, citation counts and the impact factor

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The list of publications being the linch pin in assessing the work of the academicians in the research institutes, universities and other places, has become the barometer for their selection and growth. Hence the correct assessment of the list of publications has become the cry of the day. The selections/assessments are always done through the ‘peer review’ by a team of learned experts. Since the learned experts for selection/assessment have neither the inclination nor the time for an informed and just judgement, the judgements are mostly subjective, prejudiced and accordingly, honest, objective, open, impersonal criteria free from limitations has become mandatory for the correct and just assessment.
period of the award. Thus the ‘growing emphasis on impact factor’ and ‘other considerations’ rather than the ‘citation counts’ is abortive and suicidal even if ‘it signals a new trend in India’. Non-emphasis on ‘citation counts’ in selection and other matters and also the domination of science in India by the persons who have more skills in the ‘politics of research’ rather than the original research and also do not have the needed courage to stand up to the authority and speak their mind like C. V. Raman, have resulted in research of inferior quality in India. Thus only when quality is preserved by emphasizing the ‘citation counts’ will our country produce many original scientists like Raman, and only then will the future of science in India be assured.

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Teaching research students, and scientific career vs engineering

The editorial ‘Teaching research students’ (Curr. Sci., 2000, 79, 262) highlights three points in particular, (1) The number of top-quality students available for research specially in physics and chemistry is declining, (2) The research institutes and universities in general have no pre-Ph D training programmes, and (3) Admission to research for a Ph D degree is solely managed by the supervisor. The editorial very rightly points out that Ph D work is a logical extension of M Sc with subsidized student life which provides time for finding a suitable job. One would have appreciated if the editorial had suggested ways and means to improve the credibility of Ph D starting from admission to its evaluation for a degree.

There is no pre-Ph D course for study perhaps in any Institute or University in the country and whatever, wherever student learns, is through informal teaching by the supervisor during the period the student works for his Ph D degree. Although M Phil is not equivalent to pre-Ph D course, in absence of the latter, UGC may consider a suitably modified M Phil course compulsory for taking admission to Ph D. UGC must also ensure that for the teaching of M Phil syllabus there are appropriate facilities of library, laboratory and faculty in the department. It would be academically safer not to permit colleges to run M Phil courses. Normally such facilities are not available in a college. Whether it is running of M Phil or of supervising research, both can be operated to some degree of success only when there is a group of teachers actively engaged in research.

It has been rightly mentioned in the editorial that of late the number of top-quality students joining the scientific career and research has been decreasing. Students always preferred the engineering and medical careers which ensured them a decent life and earning, and what was available for the scientific career was third/fourth rate stuff. To make things worse, the engineering colleges have multiplied several times. Another avenue for better and bright prospects is finance and management. It is, therefore, the academics and research that suffer. It has already been mentioned earlier (Curr. Sci., 1999, 77, 1227) that unless through a highly competitive procedure the talent of the country in required number is not picked up right after Intermediate/Twelfth standard with assured jobs after obtaining Ph D, in a cadre, say Indian Scientific Service (ISS) like IAS, future of Science in the country is not bright. Although such talented stuff may not have the research aptitude, the situation would be better than what we have at present. ‘Teaching of research students’ is a must even for top-quality students.

Another grey aspect of Ph D research today in our country is the admission to Ph D which is more a matter of convenience between the supervisor and the student than any academic criterion. This can be stopped to a large extent if each student for research is recruited in a funded project through selection committee. The M Phil and funded research together will eliminate/reduce the less meritorious admissions. Thus there will be two streams of research career, one by an integrated programme with an assured scientific career and a job for the top brains, and second for the less fortunate ones doing graduation, PG and research on their own.

Finally one should recognize that scientific research career suffers from one great disadvantage compared to an engineering career. The scientific career would require almost nine years (3 for B Sc + 2 for M Sc + 1 for M Phil + at least 3 for Ph D) before the student will have a settled life, whereas for the engineering career only four years are enough to secure a job and settle. Thus only the determined ones with scientific aptitude would opt for the scientific career, and the latter would not be able to attract the talent in general, unless the proposed Indian Scientific Service (ISS) has super pay-scale, perks and national recognition. This is not unreasonable since the future of the country is shaped by the scientists.

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CORRESPONDENCE

Some remedial measures for unemployed young and not so young Indian scientists

During the past one year, Current Science has published letters about the plight of young Indian scientists. I wish to attract the attention of concerned high-ups in the hierarchy of science and HRD bodies towards the genesis of the problem and offer some concrete remedial measures.

Creation of a floating or overflowing population of bright scientists on short tenure fellowships or jobless state after 8–10 years of doctoral and post-doctoral researches begins with the success in UGC/CSIR National Test and GATE test fellowship up to 5 years. The best brains 15–20 years back went to the science stream and the very best succeeded in NET/GATE. A few join Central and State Civil and Forest services, while those who opt for research as a career try for Research Associateship. The cream of the creamy layer gets into Research Associateship for 3–5 years and carves a name in the chosen specialty through publications. By this time many cross the age of 35 years which is the cut off point for lectureship and Scientist B post. Due to an acute famine of jobs, particularly for those unlucky ‘unreserved’ or open category citizens of India, most of the Research Associates have failed to get selected. Perhaps in no other country in the world, is there so much discrimination against its own citizens and that too the most meritorious brains in the matter of recruitment.

Some extremely talented scientists get Senior Research Associateship (Pool Scientists) of CSIR, for a maximum period of 3 years, renewable on year-to-year progress. Usually between the age of 30 and 35 they get married and have family and children. In the absence of jobs, the world has become too gloomy to survive and manage household expenses. Some of the remedial measures suggested are:

1. For all Research Associates and Pool Scientists, an age relaxation of 5 years be given.
2. The candidate selected through NET/GATE with Ph D degree in science should be assured of a job and so long as the job is not provided, a reasonable maintenance allowance be given. A Central Scientist Manpower Commission (CSMC) may be formed to take care of placements appropriate to the achievements of the scientist. The employing laboratories, universities, colleges, and other organizations may be subsidized by the Government of India through UGC/CSIR, to appoint Research Associates and Pool Scientists, say by way of 80% of their salary for the first five years.
3. There is a great international demand for trained scientists. The CSMC may prepare a centralized CV of qualified job-seeking scientists and float these on web sites internationally to universities, laboratories and multinationals. On each such placement, CSMC may charge some money from employers for hiring qualified scientists.
4. A few of the former Research Associates have taken up a short-term post-doctoral fellowship assignment in foreign countries. CSIR and DST laboratories, and central universities in India should be directed to consider in absentia such candidates for placement.
5. In the meanwhile, the tenure of all such Research Associates and Pool Scientists who are nearing completion of their full tenure should be extended for two more years so that some concrete steps may be taken for permanent placement.
6. A small but important action to be taken is timely release of fellowship/salary grants and standing directives to the host organization for regular payment so that delays of order of 4–6 months currently seen in payment may be overcome.

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Does language influence original thinking?

Language is the medium of communication and inducer of brain functions. We perhaps do not know which was the first language spoken by humans, however, as different languages developed over several millennia. Ancient humans used different kinds of voices, different types of symbols and movements and these were the ways of communication in the beginning. Currently humans are using many languages for communication. The pathways of evolution of different languages were different in many nations and among different cultures. The consciousness of science in the human mind, was initiated by the discovery of fire by an unknown ancient human being. The later inventions and discoveries made by humans have made great impact on the human race. The invention of alphabets for many languages has a great impact in social development. The millennium event has coincided with the globalization in a number of aspects that has had tremendous impact in terms of use of a single language for communication. However, science and its implementation has been accelerated by the use of English as a major language, even though many nations like to use their own languages to ensure scientific activities and to understand science. Both have merits and demerits. Modern English language and its present alphabets evolved by the collaborative efforts of many people.
The middle of the last century saw the discovery of the language of the genes, the elucidation of the structure of the DNA molecule by Watson and Crick. The molecular and cellular legacy of functional proteins in a living cell is mostly unknown until now and we need to understand the structural and functional basis of languages of every molecule of a living cell. And the template of a gene has only four alphabets. A – adenine, T – thymine, C – cytosine and G – guanine, and it is arranged so uniquely that it controls millions of events in a cell.

The French language helped Jacob and Monod to think of the regulation of genes. The Indian subcontinent is unique because it has a diverse population and many languages. During the Vedic period, people used different languages; however in course of time Sanskrit came to be the medium for communication for many people.

Latin is the language used by biologists in naming living organisms and fossils. Other languages such as German, Russian, French, Japanese, Chinese, etc. are languages for communication in their respective nations and great inventors and discoverers, perhaps, thought of using their own language. As a matter of fact human social development came from the achievements of thousands of years of a long chain of thinkers in many aspects; the language has played a pivotal role to activate and execute them.

To understand how the human minds thinks, perhaps one may note that logic is the regulated expression of thoughts and that perhaps gets initiated with the language of thinking. The phenomena behind thought processes in the human brain might be conceptualized as coordinated perception followed by its translation into a language and it is a quick process. A man cannot think without a language. The question arises therefore whether great discoveries and inventions need a separate kind of language? How does the brain do what it does – its activation with language of thinking? The functions of the human brain and detailed molecular inceptions still remain in the juvenile stage, and those making contributions in science – possibly think using their own language which they possess from the very beginning of their lives. A new avenue for understanding is thus perhaps to examine how language helps in thinking. Out of thousands of languages, which language helps supra sensible thinking is an open question and the answer to this riddle will help in choice of an appropriate language for learning by future generations.


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Need for development of a model for natural hazards and disaster management

India is prone to a variety of natural calamities such as cyclones, floods, earthquakes, landslides, droughts, etc. besides many types of man-made disasters. Increasing population and economic activities have brought more people and areas under the risk of these disasters.

The policies and strategies for disaster management and mitigation presently are focused on ‘Crisis Management’ and therefore long-term aspects of disaster reduction are almost ignored. Neither a definite policy nor appropriate models for disaster management and development for the disaster-prone areas of the country have been evolved. Whereas short-term measures like relief and rehabilitation are undertaken, little has been done to undertake preventive and protective measures on a long-term basis to mitigate impact of disasters.

Added to this, in spite of considerable efforts by government and non-government agencies, persistence of superstitious beliefs indicates the ineffectiveness of our education/extensional education. To overcome different hurdles we have to basically evolve a definite policy and create appropriate models for disaster management and development with a long-term perspective. This is possible by creating a well-organized scientific database system which not only helps in improving preparedness but also provides decision options in disaster management. People living in California, USA are fully aware that they are living in an earthquake-prone zone and the San Andreas fault is an active fault zone capable of producing high magnitude earthquakes. Whereas not even the educated are aware that they are living in an earthquake-prone zone and the San Andreas fault is an active fault zone capable of producing high magnitude earthquakes. Whereas not even the educated are aware that the Himalayan belt is highly seismic, Cambay rift and surroundings, parts of Narmada–Son lineament, segments of Eastern Ghat Mobile Belt and zones along and closer to Western Ghats are in seismically (micro to moderate level) active zones. Because of this, the common man reacts invariably in an unbalanced manner creating a type of chaos during and after a disaster. Awareness to prepare the community to plan for probable eventuality is extremely essential to lessen the effect of disasters. In this respect one can take note of various developments and behavioural aspects prior to, during and after the recently occurred natural disasters, namely the super cyclone that hit Orissa, the earthquakes in Latur (Maharashtra), Chamoli (Himalayan foothills region), Jabalpur (Narmada–Son lineament), Bhavanagar (Cambay rift zone), and Western Maharashtra and the very recent floods in Assam and Hyderabad.
I am of the opinion that to achieve anything that is long lasting and effective, we should properly educate the various groups and communities in a committed way through a systematic and planned training. Such a well-planned preparation helps those who implement the disaster management plan to be fully posted about the subtle nuances of the plan and be made aware of the tasks each would be expected to perform (including the common man). People should not only be made aware but also be involved in managing disasters. In this respect it is appropriate to implement the suggestions made by the disaster management team of the US (ref. 1). The disaster continuum model (Figure 1) clearly brings into focus the importance of the involvement of various groups for not only planning disaster preparedness programmes but also in meeting various post-disaster reconstruction and developmental activities. Something tangible can be achieved if organized training is imparted by select expert groups associated with both the national research organizations and planning and management centres.

Since the very genesis of any natural hazard is not fully understood, this very aspect turns out into a major bottleneck in taking up any developmental programmes or predisaster plans. An expert in remote sensing has to provide inputs to a specialist in earthquake studies or a specialist in floods and droughts and vice versa. As a first step, earth system scientists have to understand the interaction between the lithosphere, atmosphere, hydrosphere, cryosphere and biosphere through integrated interdisciplinary studies as they have social and economic implications. As on today no effort is made in our country in this direction. At a later stage, a close interaction between resource persons associated with training and earth system could hopefully lead to development of an ‘effective model’ that could address various problems associated with natural hazards and disaster management.

Figure 1. Disaster continuum model (Adapted from Thomson\(^1\), and revised).

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NEWS

Mapping the biognomy of India – the plants

‘Biodiversity’ is the buzzword today. This is being seriously discussed in India at it should and ought to be. It implies variety of life on Earth, of both plant and animal origin. Recently, ‘The Biological Diversity Bill, 2000’ has been referred to the Parliamentary Standing Committee on Science and Technology, Environment & Forests, for examination and report. The Bill seeks to provide for conservation of biological diversity, sustainable use and equitable sharing of India’s biological resources.

India stands tenth in 25 most plant-rich countries of the world. Plant richness means greater uniqueness of species present. According to one estimate, there are about 15,000 unique species of higher plants distributed all over India. But without proper census, this number is subject to serious debate. In fact, it is the need of this hour to actually put a figure on the exact number of unique species of higher plants available in India. It is relevant to note here that India has been described as one of 12 mega-diversity countries possessing a rich measure of all living organisms when biodiversity is viewed as a whole. The greater the multiversity of species, greater is the contribution to biodiversity. There are 25 clearly defined areas in the world called ‘hot-spots’ which support about 50,000 endemic plant species, comprising 20% of the world’s
total flora. India’s defined location of ‘hot-spots’ are the Western Ghats and the North-eastern regions.

Endemic species are indigenous to a geographical region and hence have an area restrictedness. Diversity of such species is measured in terms of a unit called the species count. It gives an indicator of the number, type, location (geographical) and other variations in a particular site. The study of the taxonomy of higher plants deals primarily with the recognition, comparison, classification and naming of the different types of plants that exist. The general features of a taxonomic hierarchy are presented in Figure 1. The nomenclature of any particular plant always adheres to the International Code of Botanical Nomenclature.

Here, we must for a moment pause to ponder ‘if the exact number of plant species is not known and the full range of taxonomy not clear’, what is it that needs to be done? It is required to have a detailed and precise list of all flora which is a complete taxonomic detail of the plants. While creating a database of flora of higher plants, several problems do arise. The commonly encountered pitfalls are the following. In spite of the enormous data available and documented in several archives and herbaria spread across the country, gaps are present even in carefully compiled taxonomic information. These surface in the
form of different names existing for the same plant, arising sometimes from names provided by folklore, cultural and regional roots handed down through generations. In some cases false identification has led to repetition in assignment of names. The need of the hour is to straighten these glitches and have a precise number and type of plant species presently available. Else, in this highly patent-oriented society we shall lose credit for discoveries which naturally belong to us.

The compilation of flora of higher plants is underway. There has been considerable work by several researchers to provide reliable biodiversity atlases and reports based on monitoring of India’s biodiversity. Ganeshaiah from the Department of Genetics and Plant Breeding and Uma Shaanker of Crop Physiology, both at the University of Agricultural Sciences, Bangalore have stressed the need to have a national agenda for mapping biodiversity using ‘contours of conservation’. In collaboration with Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore and networking with various sources for information collection, they have arrived at a consolidated view titled ‘Conservation/Contour Maps of The Biognomy of India – The Plants’. This will be available soon. An expected date for its formal release is slated for the third week of November 2000. The release would be in the form of a CD-ROM whose contents can be accessed via the web. The exact details will be known at the time of release.

These maps have been achieved by forming a database of all available information on the flora of plants. Inventory of the floras, published literature, unpublished yet accessible data and an estimate of collections held at national herbaria have provided inputs. These have then been linked to a spatial distribution. The spatial distribution includes parameters such as where a particular species is located (state, region, latitude and longitude of occurrence), together with type of forest, rainfall and soil conditions, etc. The standardization of the various modules of the relational database that contains information about the characteristics of the species and their taxonomic linkages has been accomplished. Algorithms to detect redundant entries as well as synonymous names in botanical nomenclature or records have been developed. This reduces the error bar for obtaining an exact number of plant species in India. For the end user of these maps, accessibility to information is simple due to a user-friendly system developed consisting of standard and custom built querying.

Contour maps provide for a three-dimensional view of species richness as depicted in Figure 2 (ref. 2). The figure shows data for the *Dalbergia* species (some of which are commercially important) found in India whose areas of maximum availability are in the Western Ghats and the North-eastern regions. The latitude and longitude were assigned for each record and mapped. The density of species in each grid of size 1° × 1° was computed and contours for the density obtained. Based on the contour data, the three-dimensional view was constructed using a suitable Geographic Information Systems (GIS) software.

Bamboo and rattan-based industries are of importance in India. The natural forests of India provide the raw material for the industry. India is the richest source for bamboo and cane next only to China. The country possesses about 130 species of bamboo in 24 genera and 45 species of canes in 5 genera. The map of the distribution of the species richness of bamboo in India is shown in Figure 3. The map indicates a clear concentration of species in the two mega-diversity centres, Western Ghats and Eastern Himalayas. Updating the records of bamboo and rattan in India is ongoing with the development of an exhaustive species distribution map. This would give vital information on the depletion of the species due to over harvesting or conversion of forest land for other uses.

Utility of these conservation maps is multiple. One immediate use is in pinpointing areas deserving conservation including identification of rare species. The composite map for the spatial structuring of the plant diversity profile would also provide important inputs for national conservation strategies for our rich plant heritage. Therefore allocation of resources in conservation activities would be resources well spent. A national initiative for a complete digitized inventory of our plant reserves, other than medicinal species, by a national team is in the offing.


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**Geometry conference to commemorate Patodi**

An international conference on Geometry, Analysis and Applications was organized in the Department of Mathematics, Banaras Hindu University, Varanasi (21–24 August 2000) in which about 150 delegates participated. Amongst them 17 were from abroad. It was a fitting tribute to the University alumnus, late V. K. Patodi that this conference was held in the World Mathematical Year 2000. His joint work with Atiyah and Singer is well known in physics literature as well [see review by T. Eguchi et al. (*Phys. Rep.*, 1980, 66)](https://doi.org/10.1016/0370-1573(80)90077-5). Patodi did MSc from BHU in 1966; and in a brief active period enriched mathematics by his last contributions in the field of geometry and topology; he died at the young age of 31. The Atiyah–Patodi–Singer index theorem (APS) proved in the first half of 1970s is an extension of the index theorem to the manifolds with boundary. APS was applied to quantum gravity and Hawking’s Euclidean Taub-NUT metric immediately. Recalling the Hodge theory (1930s) relating topology to algebra...
using linear elliptic equations, and topological invariants in Yang-Mills nonabelian gauge theories which are nonlinear elliptic equations, the importance of the index theorems can be realized, which essentially relate the analytic index with the topological index of elliptic complex over manifolds.

The proof of the APS was presented by B. L. Sharma (Allahabad). L. Rodino (Torino) discussed asymptotic expansion of the heat equation for quasi-elliptic operators, while P. Panarese (Bologna) found asymptotics of the $L^2$-unbounded operators on a class of non-compact Riemannian manifolds. R. Sharma (New Haven) gave a talk on contact Riemannian manifolds. H. Pedersen (Odense) presented his work on hyper-complex manifolds. That quantum-state space may be Weyl-Kahler was proposed by S. C. Tiwari (IONP). S. Pattanayak's (Bhubaneswar) talk was on the Toeplitz operators.

R. D. Carmichael (Wake Forest) reviewed generalization of the Hardy H functions, and H-J Glaeske (Jena) presented a survey on the convolution structure of Hermite transforms. M. W. Wong (York) on localization operators on the Weyl-Heisenberg group, M. Nagase (Osaka) on Garding's inequality, P. K. Jain (Delhi) on imbeddings of Sohalev spaces and several contributions on these topics were included in the session on analysis. Colombeau's generalized functions were the focus of attention in the review by M. Oberguggenberger (Innsbruck), and J. Schmeelk (Virginia Common Wealth) introduced Stieltjes transforms in the study of these functions. Microlocal filtering with orthonormal wavelets was discussed by R. Ashino (Osaka Kyoiku).

Modern trends relating to computers in mathematics and application-oriented research was reflected in the opening remarks of H. P. Dikshit (M. P. Bhoj Open Univ.). Most of the papers presented by Indian institutions were on the applied mathematics, however there were good contributions on geometry and analysis too. Patodi's teacher S. N. Lal and class-mate I. K. Khanna shared their reminiscences with the audience during the inaugural function. Convener of the conference R. S. Pathak and the sponsoring agencies NBHM, CSIR and UGC/BHU deserve appreciation for conceiving and making this event possible. It was intriguing that in spite of the key role of geometry and topology in the current fundamental physics, there was no presence of physicists in this conference. Perhaps it would be a rewarding exercise to organize a conference on APS and Physics exclusively.

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MEETING REPORT

Biotechnology of plant protection: Application and technology development: A report*

A national symposium on ‘Biotechnology of Plant Protection: Application and Technology Development’ was organized by the Mycology and Plant Pathology group of the Centre of Advanced Study in Botany, Banaras Hindu University. The 3-day long deliberation centred around eight major themes: (1) Genetic engineering and plant protection; (2) Biochemical and molecular approaches to plant defence mechanism and immunization; (3) Plant pathogens: ecology, biology and epidemiology; (4) Molecular identification and detection of plant pathogens and diseases; (5) Biotechnology and biocontrol: new options; (6) Forest/post-harvest technology; (7) Plant protection and emerging technologies; and (8) Biotechnology: Basic and applied aspects.

The opening lectures were delivered by Anupam Varma (IARI, New Delhi), Paul Bridge (University of London, UK), A. N. Mukhopadhyay (Assam Agriculture University) and B. L. Jalali (Haryana Agricultural University). Varma elaborated upon the emerging trends in biotechnology of plant protection, Bridge highlighted the use of ‘molecular markers’ in understanding the epidemiology of fungal plant pathogens, and Mukhopadhyay dealt with the role of biotechnology in management of plant diseases in agriculture, especially within the framework of integrated disease management system. Jalali discussed the role of molecular biology in plant disease management in the next millennium. Rakesh Tuli (NBRI, Lucknow) deliberated upon the commercial release of genetically engineering plants for durable pest management and the need for studying variations in insect populations, spontaneous frequency of native resistance genes, type of dominance, migration and mating behaviour of insects and computer simulation of population dynamics-based knowledge strategies for the lasting release of transgenic plants. Sunil Mukherjee (IARI, New Delhi) gave an account of molecular characterization of UIMYMYV genome and viral replicase with emphasis on possible use of Rep-DNA to induce viral resistance. K. Narayanan (Project Directorate of Biological Control, Bangalore) highlighted the impact of molecular biology and genetic engineering aspect of insect viruses with emphasis on their efficient utilization in pest management. D. V. Amla (NBRI, Lucknow) delivered a lecture on

‘Development of transgenics of grain legumes for improved resistance to insect pests’. R. P. Thakur (ICRISAT, Patancheru) spoke about the application of marker-assisted back crossing to transfer all downy mildew resistance quantitative trait loci (QTLS) to a common genetic background and discussed in general about the pathogen variability and QTLS for downy mildew resistance in pearl millet. The prospects of biotechnological application of microbes for protecting plants through alleviation of environmental stress effects were covered by Aruna Mishra (Utkal University). The current status of biotechnological approaches to crop protection in Phytophthora foot rot disease management was presented by Y. R. Sarma (Indian Institute of Spices Research, Calicut). N. Ramon (University of Madras) discussed the role of mycorrhizae in biocontrol of plant pathogens and mechanism of disease control. A. R. Podile (Hyderabad University) dealt with the current status of the role of chitinolysis by biocontrol agents and the prospects of improving their efficiency. H. S. Chaube (G. B. Pant University of Agriculture and Technology, Pantnagar) discussed the impact of soil and plant factors in population dynamics, PGPA and biocontrol potential of Pseudomonas fluorescens. Delivering the Young Scientist special lecture, S. S. Sandhu (R. D. University, Jabalpur) talked on the molecular biology of entomopathogenic fungi for control of insect pests. The ‘biocontrol’ session was followed by poster sessions. The evening session had two invited lectures under the theme ‘Biotechnology: Basic and applied aspects’, which were presented by M. S. Manocha (Brock University, Canada) and Z. K. Khan (CDRI, Lucknow).

On 26 February, during two concurrent sessions the lectures delivered were on the themes ‘Biomedical and molecular approach to plant defence mechanisms and immunization against pests’ and ‘Molecular identification and detection of plant pathogens and diseases’. These lectures focused attention on pathogenesis-related (PR) proteins in plants induced by various pathogens and their molecular signals, management of rice and sugarcane by selection of transgenic system(s) and PR-proteins, biochemical and molecular basis of hypersensitive response during pearl millet downy mildew host–pathogen interaction, technology development of antiviral agents using viral resistance-inducing proteins in host plants, significance of putative resistance determining gene(s) in developing viable strategies for disease, identification and utilization of resistance gene(s) against spot blotch of wheat, use of different molecular detection techniques in the identification of plant pathogens based on species/strain-specific DNA probes, identification and classification of phytoplasmas using molecular tools, molecular aspects of mollicute interaction with insect and plant, utility of immunological techniques for early detection of fungal plant pathogens, molecular biology of rice tungro viruses from India and its application in disease diagnosis and control, and molecular strategies in developing transgenic plants utilizing various viral genes in rice. The invited lectures were followed by oral and poster presentations ranging from transgenic plants for pest resistance to mechanism of resistance to biological disease management and the molecular mechanism(s) of microbe–microbe interactions. During the evening session on the theme ‘Plant protection and emerging technologies’, three invited lectures were delivered. These lectures drew attention to application of genetic engineering for management of virus and virus-like pathogens infecting citrus, importance of natural products of microbial origin in developing resistance in crop plants, role of siderophore-producing microorganisms in the biocontrol of important crop diseases, and molecular biology of sub-family Bigeminiviridae and disease management strategies with special reference to cotton leaf curl virus.

A special plenary/round table discussion on the theme ‘Plant protection in the next millennium’ organized by B. L. Jalali, had M. N. Khare, H. N. Verma, A. K. Sarbhoj, V. K. Gupta, P. Bridge and R. P. Thakur on the panel. In the beginning the panelists presented their ideas on plant protection in the next millennium. This was followed by opinions expressed by a large number of distinguished delegates concerning: (1) Seed health as measure for plant protection; (2) diagnosis and plant pathological clinics for disease management; (3) modern taxonomy employing molecular techniques; (4) application of information technology in plant pathology to bridge the communication gap; (5) human resource development in the new areas like molecular plant pathology, cloning of genes for resistance to produce transgenics; (6) development of commercial biological control and IPM for disease management; and (7) exploration and patenting of micro-organisms for plant disease control. It was felt that these aspects need more emphasis in this millennium.

On 27 February, there were four major sessions run concurrently. The ‘forest/post-harvest technology session’ comprised two keynote and three invited lectures. The deliberations were on ectomycorrhizae and their biocontrol potential, management strategies of apple scab by disease forecasting, post-harvest/forest plant pathological problems; protection of tree seedlings against soil-borne fungal pathogens by ectomycorrhizal (EM) fungi, seed quality control as disease-free seeds plant quarantine system, and application of biotechnology in forestry with a case study of sandal wood.

A concurrent session on ‘Plant pathogens: ecology, biology and epidemiology’ had a keynote address by U. P. Singh, who presented a detailed account of losses to farmers by powdery mildew of pea and also the various facets of the disease with emphasis on measures control. This was followed by lectures on the potential of indigenous VAM isolates on growth and development of tomato in Zambia, ascospore germination in Sclerotinia sclerotiorum and its pathogenesis in cruciferous hosts, and management of insect pests on cotton crop by mycopolicides.

In a session exclusively devoted to oral presentations, 10 papers were presented. These were on variability in Rhizoctonia solani responsible for sheath blight of rice, detection of plant diseases using an innovative technique of Photoacoustic Spectroscopy (PAS), characterization of variability in Fasaria oxysporum f. sp. pisi from Himachal Pradesh using RAPD analysis, PCR-RFLP analysis of IGS region of Fusarium oxysporum f. sp. ciceris, molecular techniques for identification of citrus greening disease, development of transgenic strains of entomopathogenic fungus Nomuraea rileyi for bio-management of tobacco caterpillar (Spodoptera litura), effect of biopesti...
The best paper award was presented to B. R. Sarosh (University of Mysore). The best oral presentation award was given jointly to A. Chakraborty (BARC, Trombay) and Amita Singh (G. B. Pant University of Agriculture and Technology, Pantnagar). The best poster award was presented jointly to S. Kim (Institute of Agricultural Research, South Korea) and S. R. Khandelwal (North Maharashtra University, Jalgaon).

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COMMENTSARY

Future challenges in food grain production in India

R. R. Daniel

The overall performance in food grain production in post-independent India, spurred by the Green Revolution, is worthy of the highest admiration. Notwithstanding, the trends in grain (rice, wheat, coarse cereals and pulses) production over the last decade portend a wide variety of major challenges and compulsions to meet the accelerating demands in about 20–30 years. Yet there is no clear expression of government action for a long-term strategy and integrated action plan to match the severity of the unprecedented challenges and the exploitation of emerging technologies. The purpose of the present note is to bring together these challenges to highlight how important it is to understand and surmount them in order to increase our future grain production.

Food grain production

India’s food grain production has an impressive record of growth from a mere 50 million tonnes (mt) in 1950 (population: 360 million) to 200 mt in 2000 AD (population: 1 billion). This growth, kick started by the Green Revolution, lost its momentum during the 1980s. In retrospect we have learnt that the energy-intensive Green Revolution relying primarily on a few high yielding crop varieties is unsustainable and that it has polluted and exhausted the soil–water system. During the 1990s, in spite of good monsoons year after year, the growth rate of grain production haltingly rose by 1.7% per year compared to 2.6–3.5% during 1960–1980 (ref. 1) while the population grew at 1.9% (ref. 2). Further, a worrying factor is that over the last four years, the annual production is hovering close to 200 mt only. These days we rightly take pride that we are self-sufficient in grain production. But we must not forget that hidden in this statement is the fact that it is at the cost of the hunger of 350 million of our people in poverty.

Agriculture and national development

An important factor closely linked to grain production in India is that 70% of our vast but economically weak population is dependent on agriculture. It is therefore evident that if we are to elevate their standard of living, it can only be through productive agriculture augmented by non-farm employment and human development. Thus genuine self-sufficiency in food grain production and poverty alleviation are intrinsically linked. Sustainable national prosperity will be jeopardized if the farm sector does not receive its due priority from the government.

The challenges

Population

Currently, our population is one billion and we are growing at the rate of 1.9% per year. For the year 2025, the UN Medium Projection is 1.392 billion. It is clear that, in future, the grain demands will depend strongly on how well we control population growth.

Grain land

Land is a fixed resource. The gross cropped area in India is 191 million hectares (m.ha) and the net cultivated grain area is only 124 m.ha. Although over the last 10 years the cultivated grainland area has hardly increased, it is widely believed that it may shrink in future due to soil erosion, urbanization and human settlements, commercial agriculture, laying new highways and rural road networks and migration of farm labour in search of employment. The high population density, rural poverty and scant pasture land for the 450 million heads of livestock also bring pressure on the land and forests. Furthermore, it is important to note that the per capita arable land available in India dipped from 0.36 ha in 1960 to 0.2 ha in 1990 and is forecast by Population Action International Report 1995 to decrease alarmingly further to 0.12 ha. For comparison a Western type diet including pasture land requires 0.5 ha per capita.

Soil degradation

The Green Revolution has degraded the soil–water system and depleted the soil...
fertility due to a variety of reasons. It has also led to salination of 8 m.ha of irrigated crop land and water logging in some parts. Side by side the neglect of dryland farming and soil erosion are continuing threateningly till today. The present degraded state of irrigated and rainfed agricultural land is a matter of grave concern for increasing productivity. Restoration of the degraded crop land is inescapable for the future but it is going to be capital intensive.

Water availability

Water is yet another fixed natural resource. The annual per capita water availability in India was 5277 m^3^ in 1955 which declined to 2451 m^3^ in 1990; according to World Bank Report 1998 it sank further to 1957 m^3^ in 1995. The projection for 2025 by the Population Action International Report is 1392 m^3^, well below the water stress limit of 1700 m^3^. Acute variations in water availability in different parts of the country (in 1990 the water use in Rajasthan was a meagre 562 m^3^, a state of absolute scarcity) and the dangerously falling water table are other major concerns for the future. Of the net sown area of 142 m.ha (ref. 2), only 48 m.ha are irrigated. The rest 94 m.ha of rainfed fields account for 90% of pulses and coarse cereals, 53% of rice and 15% of wheat with a frighteningly low yield of hardly 1 tonne per ha. It highlights the importance of enlarging the irrigated grain land even if it is capital intensive.

Calories and nutrition

Rural people in India traditionally depended on coarse cereals, pulses and fish for their intake of calories and nutrition. While the average intake of calories is marginally satisfactory, the consumption of proteins which was 64 g of pulses per day in 1951–1956 has dropped below 40 g in 1998 compared to the WHO–FAO minimum of 80 g per day. Even after allowing for additional intake through fish, meat, milk, etc. the daily consumption rises only to 55 g (ref. 5). The average intake of vitamins and other micronutrients is also grossly inadequate. This hidden hunger stealthily wreaks havoc on children’s growth and leads to acute malnutrition among the people. The quality and quantity of grain production using new hybrids to be developed is a decisive factor in the amelioration of protein and nutrient inadequacy in future.

Fertilizer use

The traditional use of organic manure was almost phased out with the introduction of chemical fertilizers heavily subsidized by government and widely promoted by the industry. Even so, the prevalent average annual use of 69 kg per ha of chemical fertilizer is grossly inadequate to restore the nutrient content of the degraded soil and compensate the heavy intake by high-yielding hybrids. This may be compared with the use of 366 kg per ha by China. It is said that the ‘miracle rice’ with a potential to yield 10 tonnes per ha will need a minimum of 200 kg of nitrogen per ha together with other major and micronutrients. From the foregoing it would also have become evident why our yield is so low.

Productivity or yield of food grains

Our average grain yield of 1612 kg per ha (i.e. 200 mt from 124 m.ha) is one of the lowest among the large countries of the world. The reasons for this, as we have already seen are many. However, our great asset of having perhaps the largest area of arable land in the world could be converted into a unique advantage. If the productivity in China is more than double that in India, there is no reason why we cannot meet our long term demands by doubling the present productivity in the next 2–3 decades.

Other challenges

In addition to the foregoing, we face problems some of which are listed here:

(i) As the economy improves, it is expected that the meat-eating diet of the people will burgeon. It is forecast that by 2020 the demand for grain as livestock feed will soar to 50 mt (ref. 8);

(ii) It is estimated that of the 42,000 folkland races in rice that originally existed, only about 5% are extant. This reduces our options for selective infusions of favourable hereditary qualities in new hybrids; it also emphasizes the urgency of measures for conservation.

(iii) If we are to counter the unprecedented impacts of global warming, India must take wide ranging anticipatory action in the agricultural sector. Yet other factors that must receive equally important attention are need for greater support for rural infrastructure, post-harvest management, strengthening R&D in agriculture including plant biotechnology, empowerment of farmers particularly rural women and farm policy reforms.

A target for food grain production by 2025 AD

Having brought together the array of future challenges for increasing food grain production, it will be instructive to make a reasonable estimate of the domestic grain demand in future, say by 2025 AD. Such a target is necessary to assess the magnitude of the task and formulate plans to realize it. This is attempted with the following assumptions. (a) India’s population will be 1.392 billion by 2025 AD; (b) the livestock feed needed will be 50 mt of grains; (c) the present level of 35% of population below poverty line will be reduced to 10%; and (d) the present direct per capita grain consumption rate of 210 kg per year of those above poverty line will apply to the 90% in 2025 while for the remaining 10% below poverty line it will be 120–140 kg per year. It is true that some of the assumptions are more subjective than others but the final grain demand is not very sensitive to reasonable variations in the assumptions except (c) above, which is taken as a national goal for poverty alleviation.

The outcome of such an estimate is an annual total demand of 330 mt of food grains in 2025; it corresponds to an annual growth of 5 mt. Considering the wisdom of planning for a modest exportable surplus and allowing for the possibility of a higher per capita direct consumption rate with improving economic performance, a target of 350–375 mt does not seem unreasonable to aim for at the present time.

National action

Taking note of the foregoing, if the scientific community is convinced with the gravity of the challenges, the paramount need of achieving a target of
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330–350 mt of food grain production per year in a matter of 2–3 decades from now and that the nation has the capacity and human resource to overcome the challenges and threats, it is the collective responsibility of the scientists to bring them forcefully to the attention of the people and the government for immediate action.


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FROM THE ARCHIVES

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Current Science and the Indian Academy of Sciences

In view of the recent publication of certain disputatious statements in the press regarding the institution of an Indian Academy of Sciences and the totally unexpected and embarrassing trend which the affairs have assumed, the Board of Editors, *Current Science*, desire to announce that the Journal, having taken the initiative in the proposal to establish such a foundation, now stands aside in a spirit of detachment. It will not lend its support to any movement which is apt to produce a factious spirit among the scientific workers, which must be absolutely fatal to the fundamental cause of progress in India. The policy of the Journal is to follow and promote peace, and in pursuance of this declared object, it will seek for opportunities to establish good understanding in all endeavours calculated to advance the higher destinies of science.

This policy of the Journal does not, however, impose restraints on the freedom of action on the part of the individual members of the Editorial Board as also those of the Board of Editorial Co-operation who may desire to participate in any particular movement and if and when they do so, they act either in their own private capacities or as members of some one or other of the scientific institutions favouring such a movement. The public utterances of such members or their action in the committees in which they choose to function, do not reflect the official views of the Journal.

– Editor

“Current Science” and “South Indian Science Association”

Our attention has been drawn by one of our Editorial co-operators and one correspondent to the effect that Dr S. Subba Rao, President, South Indian Science Association, in his opening address at the Easter Congress of Scientists at Bangalore, claimed *Current Science* as an organ of the South Indian Science Association. On referring the matter to him, Dr Subba Rao has written to say that he made no such statement.

It is needless to emphasize that *Current Science* is an independent all-India Journal and stands for the progress of scientific work in India as a whole.

– Editor