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SCIENCE AND TECHNOLOGY

National Development

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The background

The fifty years of independence and planned development have taken India several steps forward in various areas of human concern. Indeed, the increases in food production, the diversity of our energy, industrial and commercial sectors, and the breadth of our scientific endeavour are widely and justifiable held up as examples of achievement unparalleled in history.

In these fifty years, the official figures show that literacy has gone up from 17% to 56%, steel production from 1.5 million tonnes to 25 million tonnes, electricity generation from 3.5 million kW to 90 million kW, and grain production from 50 million tonnes to nearly 200 million tonnes.

Some 10 million Indians can today consider themselves a part of the global elite, holding their own on every front: material possessions, energy consumption, physical comfort, mobility, wealth and world-wide influence.

Another 100 million people live in relatively comfortable economic circumstance, comparable to those in middle income countries. And perhaps yet another 200 million manage a passable existence, with access to television, telephones and modern transport – if not privately, at least through public facilities.

As a nation progressing towards becoming a modern technological economy, we have something to be proud of.

And our scientists and engineers can well take their fair share of credit for this achievement.

The reality

The flip side of the development coin is, however, not so pretty.

A large majority of our people is still on a never-ending treadmill of poverty and deprivation.

The remaining 600 million of our fellow citizens live in conditions that vary from the sub-human to the abysmal, comparable to those in other least developed economies on earth. Almost none of these people have drinking water sources or toilets in their homes, let alone electricity connections or other modern amenities for their most basic day-to-day needs.

Many among the last 300 million, which comprises a population greater than that of North America or Europe, don't even have proper homes. Nor safe drinking water within reasonable distance of their dwelling. They have access to virtually no product or service resulting from modern science beyond safety matches, kerosene lamps, bicycles, and of course the ubiquitous transistor radio. And the kerosene or batteries are often too costly or difficult for them to get.

In the language of science, these numbers are astronomical. For example, our country has:

(1) more than 500 million people living below the poverty line;
(2) more than 300 million people with no access to safe water supply;
(3) more than 700 million people without proper sanitation;
(4) more than 150 million people without proper homes;
(5) more than 500 million people without electrical connections;
(6) more than 400 million people who are illiterate;
(7) more than 1,500,000 children who die each year before their first birthday.

Each of these numbers is more than twice as great today as it was at the time of independence in 1947. And each is still growing.

The Ivory Tower

Few decision-makers and even fewer scientists in our country seem to be aware of the rapid downhill slide we are on. For most of them, the doubling of the numbers who are illiterate, houseless or poor during the 50 years of so-called socio-economic development is a fact completely lost within the selective statistics of national achievement. The best response most officials can offer is that there are, of course, "many more people now".

But that, precisely, is the point. There are more people because there is more poverty. And there are more poor people because most of them have been by-passed by the whole so-called "development process". It is this vicious cycle that our plans and policies have chosen not to break. And the scientists have stood by, unable to create a role for themselves in this effort.

Even a cursory look at the plan allocations for programmes which can create lasting improvements in the living conditions of the poor will quickly show why this is so. There is virtually no money for them. Or for the scientific research needed to make these programmes more effective.

"But there are vast allocations for poverty alleviation".

Indeed there are: to respond to the emergencies and "natural" disasters which take place with frightening regularity, to provide temporary work, and to construct sub-standard houses, roads and civil works that disappear as soon as the rains come. Most of the money allocated never reaches the so-called "beneficiaries" anyway.

And "vast" is a relative word. Per capita, these funds are pitiably inadequate to meet even their own ill-conceived objectives.

How long will it take for us to realise that these palliative measures aimed at superficial cures cannot possibly have any long-term impact? Without deeper, structural changes, the economy cannot provide sustained benefits for those who need them most. And even if it could, the practical realities—massive leakages, inadequate information and the bunching up of expenditures in the last two months of the financial year—ensure that nothing of permanent value will reach the poor.

Until the transition is made to socio-economic conditions in which more people can share the fruits of modern development, "development" *has*, inexorably, to be a losing proposition.

There exist many underlying causes for this inexcusable state of affairs, but growing population is *not* one of them. Continued and unabated rise of population is the *result*, not the cause of our gradual slide to national impoverishment and under development.

The causes of under-development

This trend is clearly not tenable, nor can the present system which has led to it form the basis of sustainable development.

The failure of development can primarily be ascribed to inadequate policy level attention to:

1. Social services such as health, education and shelter.
2. The changes needed in the structures of society, economy and government - most of which are fundamentally continuations of centuries old practices unsuited to today's needs.
3. The choices we must make among possible development goals and technological options.
4. Priorities for scientific research.

Perhaps the greatest tragedy in this profound failure lies in the minuscule role our country has given to science and technology for solving the problems of poverty.

Policies for science and technology cannot be formulated in a vacuum—they must reflect the broader issues confronting society, and be embedded in the wider national policies for development.

In more specific terms, the shortcomings of our past development planning can be ascribed to an over reliance on imaginary goals such as some arbitrarily chosen growth rate for agricultural, industrial or national development. Most of these have ignored the real (natural) resource issues, since the term "resource" in planning practice has generally come to refer only to the amount of money available. They have also ignored the human, cultural and other issues that can only be understood with much greater participation of the people for whom development is being "planned".

We have spent far too much of our time pursuing intellectual arguments about "the lack of absorptive capacity" of the rural sector and its relatively low purchasing power. Almost no practical effort has been made to test these assumptions in the real world in dispassionate or objective manner. There is ample evidence to show that the rural poor wish to, and can, improve their lives just as much as their counterparts in urban areas provided they have access to similar technological, financial and institutional resources.

The reason that there are more illiterate, diseased and poor people today in our country than ever before is, quite simply, that past (and existing) planning methodology has essentially been designed to make the rich richer and the poor poorer and alienating both from the land and its natural resources.

The alternatives

The way out of this problem is not all that complicated. It requires the redefinition of the goals of development.

To bring the growth of population into balance with the opportunities offered by development and the limits imposed by environment, development action must be designed directly to:

- Satisfy the basic needs of every citizen
- Fulfill the potential of our children
- Raise the status and self-determination of women
- Create opportunities for meaningful work for all
- Enlarge the possibilities for social advancement
- Enhance the personal security of old people
- Facilitate access to the means of family planning

Until the demographic transition is well under way, any activity which does not meet these criteria is largely short-sighted and peripheral to the interests of our country as a whole.

Many of these causes and factors are, unquestionably, linked with the central issue of population growth which now confronts the country. They cannot be tackled without deep changes in our social paradigms, public policies and development programmes.

All of them have solutions which require inputs from the best possible science.

If science and technology are to have any impact on the sustainable development of our country, our whole approach to it must clearly be changed. With annual budgets in the thousands of crores, and manpower in the tens of lakhs, the momentum of the existing system can obviously not be changed overnight. However, if no attempt is made to change it, it will not change even in a hundred years.

The time to change directions is now.

The malaise of Indian science

Every scientist in the country can provide a view of why science in our country is not what it should be.

Some claim that its emphasis on theory and the avoidance of the practical is a result of our long, brahminical traditions. This may be so, but the insight can hardly help us find immediate, operational solutions.

Others cite the hierarchical and autocratic structures of our scientific institutions which prevent younger and more creative scientists from actualising their potential. This is certainly true, but science in this regard is merely afflicted by a failure of human relations which pervades all our national institutions.

Still others suggest that the poor infrastructure and the bureaucratic redtape which prevents scientists from working efficiently is the main handicap of Indian science. This is also true, but it is the scientists who have chosen to pursue their narrow interests and to leave the control over decisions crucial to their enterprise to others.

Yet others mention the lack of job opportunities. This again will continue to be a fact as long as scientists cannot recognise that it is they who must create opportunities for themselves as well as for others.

Criticisms of Indian science such as these are frequently heard, and have been heard for the past three decades, at the numerous symposia on subjects like "What ails Indian science" and "why have Indian scientists not been able to make a contribution to national development?" Almost all of them address the superficial symptoms and rarely tackle the root causes.

Eminent scientists complain of inadequate funding and lack of support from society for their valuable endeavours. Few, however, are in a position to describe what their community can contribute in return for such support. Scientists clearly feel no more compulsion to be accountable than any of the other privileged groups of our country.

The younger scientists cannot look beyond their salaries, promotions and trips abroad. The older ones spend their time climbing the professional ladder, preparing their post-retirement pastures and keeping the younger ones in their place. All of them believe that society owes them a living, very few of them are prepared to place their science at the service of society.

Root causes

Even the root causes are so numerous that a short list of the more important ones can only be arbitrary.

While there is unquestionably room for basic research of a much higher order and in many more fields than exists today, the quality and mix of R&D efforts must now be radically changed. The change must be in favour of endogenously designed programmes based on indigenously defined goals. Apart from the relatively successful scientific efforts in the field of agriculture, virtually no scientific institutional framework is at present designed or geared to address the problems of sustainable national development. The host of evaluations and Review Committee reports commissioned over the past three decades have, by and large, addressed minor, peripheral and irrelevant issues and generally come up with fine tuning proposals of an administrative nature rather than suggestions for the kind of deep structural changes needed.

National policy as a whole must address the issue that no matter how sophisticated and wise the policies for science and technology may be, if the patterns of market demand and the premises underlying choice of technology do not change, nothing very much can be achieved for changing the policies on science as well.

The imperatives of sustainable development now require us to take stock and redesign development so that its benefits can immediately reach the largest possible number of our people. This, in turn, will require complicated and difficult decisions of consumption patterns, investment allocations and other socio-economic choices which lie outside the relevant Science Policy. However, the scientific community will have to play an infinitely stronger role in helping the Government and the people of this country in making that transition.

Given the impossibility of solving existing or emergent problems without substantial innovation, and the relatively large multipliers that S&T can have where so little innovation has already taken place, it is clear that a substantial effort has to be made to redress the balance. This can only be done by a massive increase in expenditures on problems of the poor. Just to achieve a commitment of even 1/10th that is now being devoted to science that has applications relevant for the upper income groups, a ten-fold increase is needed for relevant science and technology. Even this amount, approximately Rs.200 crores, is within the normal variations in plan allocations as they get adjusted during the course of the five years of implementation period.

Government policies for science must address the need to establish solid institutional capability to undertake innovative work on relevant Science and Technology. In this respect, even the existing S&T sectors could benefit by substantial changes in structure and function.

Science in our country continues to be too far removed, indeed divorced, from the realities of social needs and resource availabilities on the one hand and from the imperatives of the production systems and the market on the other. Unless scientific innovation is much more directly linked to the realities of the economy, it cannot but continue to perpetuate its path of irrelevance and peripherality.

External factors

The "external factors" are those policy interventions, institutional frameworks, etc. which lie outside the control of the scientific community, but which impact the scientific enterprise.

Perhaps the most fundamental among these is the choice of societal goals. Few nations have been able to define their overall objectives in specific and concrete terms and India is no exception. However, implicit choices are constantly made by any society whenever a specific policy or decision is made. The underlying patterns which emerge from an analysis of Indian development planning decisions clearly shows an implicit bias towards issues concerning the more privileged of our country, and this has deeply influenced the choices we make relating to science and technology.

Another fundamental set of largely implicit choices relates to the selection of technology, and thus to the way we manage resources and impact the environment. In almost every sphere of life, there are many possible technological solutions. Given the differences in factor endowments (land, labour, capital, etc.), in culture and in social expectations, the choices in any case should be endogenous. In India, we have tended largely to adopt solutions which were adopted earlier elsewhere, usually in the West. The shortcomings of many of these solutions are beginning to be apparent and many in the countries of their origin have started questioning of their value. As in adoption, however, India lags behind in rejection.

The third major external factor is institutional design. For a variety of reasons, our choices of organisational frameworks for science invariably betrays deep cultural prejudices. The existing and unquestioned assumption that the only possible way to make progress is to deliver the job into the hands of the public sector, whether it is to innovate, teach, produce or distribute, is a fallacy which this country is paying dearly for. Government policy on science and technology appears to be blind to virtually any possibilities for innovation or R&D outside government or publicly controlled institutions. The fact that these public institutions have tremendous inefficiencies and inherent losses, and that other mechanisms may be far superior for producing effective and timely results is lost in worries about audit objections, Parliament questions, and the general untrustworthiness of fellow citizens.

Unless these external factors are changed, the specific interventions to improve the doing of science in our country can be no more than a superficial, unproductive exercise.

Internal factors

Among the "internal factors", namely those which are amenable to decision making processes within the scientific community, certainly the most important are the relevant priorities and allocations assigned to different S&T areas. Society supports scientists in their work because the returns amply pay for the investment. Looking at the allocations for the different sectors in the economy, clearly the assumption among our scientific decision makers is either that only the rich can make use of scientific innovations or that science has no possible relevance to lives of the poor.

"Science for Society" programmes (the terminology unconsciously betraying the assumption that the remaining science is for other purposes than social good) were allocated expenditures of about 20 crores for the entire 8th Five Year Plan. At less than 4 crores per year, they come to less than one tenth of one per cent of the total 4,000 plus crores allocation for the S&T sector as a whole. Allowing for possible "trickle down" effects from the other scientific areas (space, atomic energy, "sponsored research", etc.) one might generously multiply this figure by a factor of 10, and even so the part of the budget for science which addresses the problems of the poor comes out at below 1%. Taking account of the fact that the population affected is close to 5 poor people for every higher income person, the per capita expenditures on science for the poor remain pitiably low.

This is not even a symbolic gesture.

The priorities in allocation will have to be radically different from what they have been over the past 50 years; indeed, they will have to be turned upside down with two orders of magnitude increases in expenditures on research and development for the problems of over 650 million fellow citizen who have so far been entirely ignored.

The second internal factor which primarily impacts the possibilities for application of science to practical problems is the lack of linkages between the innovation, production and marketing processes. Neither in the conventional scientific institutions (CSIR, IITs, Universities or other publicly funded research organisations), nor in "Science for Society" have we established a single mechanism that is geared to the imperatives of getting needed products and processes into the market on a large scale. Less than half a dozen corporate R&D institutions exist in the whole country capable of addressing this problem in an effective manner, and even these need to be restructured considerably.

The third internal factor requiring major redesign is the management of our scientific institutions to overcome the difficulties faced by scientists as described by themselves and enumerated in the section above "The Malaise of Indian Science".

The problems of national, academic and industrial research laboratories can only be addressed by fundamental changes in their mandates, stated objectives, personnel policies, infrastructural endowments and result orientation. The evaluation of their performance also needs radical change in thinking, to allow for the lead times any scientific discovery must have before becoming successful in the market. It is for this reason that 50 years of public R&D costing several tens of crores and nation-wide efforts have not been able to produce improvements in handloom technology which were recently achieved by a small "corporate R&D" effort involving a tiny team of young technologists with a budget of Rs.5 lakhs and a time scale of two years.

The responsibilities of the scientific community

In addition to the external and internal factors, the third type of issues confronting the scientific community in India, namely, is its responsibility in view of its knowledge and expertise, to identify emerging issues and alternative approaches for sustainable development. The community as a whole has to play a much stronger role in this respect and the institutional frameworks needed must be strongly supported by Government, even though they might appear to be inconvenient.

While export orientation and internationalism are extremely important to maintain the quality of science and technology in the country, they have little to offer for determining development objectives or for the choice of scientific thrust areas. These must be endogenously chosen by science and geared to the indigenous needs for development. Self-reliance must not be simply a planning shibboleth but a fundamental movement for grass roots involvement in the identification and solution of people's material problems.

Planning for the future

The allocations for science relating to the problems of development and poverty must now be expanded manifold. Even if they are increased by a factor of ten, they will still be miniscule compared with the investments currently going into "high" science.

The question of absorptive capacity has to be solved by setting up totally new kinds of institutions capable of focussing the methods and tools of modern science on the real issues confronting our nation: poverty removal, population growth and proliferation of resource depletion.

The distinction between basic science and applied science is spurious and irrelevant for the purposes of sustainable development. The crucial attributes of any effective scientific effort designed to impact socio-economic development:

1. The scientific research programmes should be designed to encourage science of the highest quality, particularly in areas of relevance to sustainable development.
2. The internal and external professional reward systems must be designed so as to attract the very best scientists for research on societal problems.
3. The management systems for these programmes should be designed to address the problems of society in a much more efficient and effective manner than heretofore.

In order to do this, scientific research institutions need to be designed and established which go beyond the traditional and irrelevant dichotomies such as:

- The Public vs. the Private
- The Big vs. the Small
- The Modern vs. the Traditional
- Basic research vs. Applied research

An institutional framework for rural technologies

An institutional framework to incorporate these considerations has been designed and is currently being implemented and tested in India at Development Alternatives.

A larger scale effort is now needed, at the national level.

In essence, we propose that a completely autonomous institution be established which will comprise a network of local units throughout the country capable of dealing with geographically or topically relevant societal problems. It will need initial funding from public sources, but with the proper leadership, could quickly start generating revenues to cover a good part of its costs.

It will employ a "corporate R&D" approach to identifying and solving basic societal development problems.

Its capacity to attract the best scientists and strong financial support will be maximised by establishing the right mix of basic and applied research and by freeing the organisation from unnecessary bureaucratic hurdles.

Taking a systemic view of its mandated and work, such an organisation will, if it is properly designed, be able to produce impact on the lives of the poor which is several orders of magnitude higher than that of any existing institution in this field.

The absorptive capacity of this institution can easily be built up within a few years to employ a reasonable fraction of the good scientific minds presently under-employed in the country and to utilise funds similar in magnitude to those currently being spent on conventional scientific research. Only thus can we begin to hope for the needed improvement in the lives of the majority of our people.

Precise design of this institution should be the subject of a specific project to be commissioned by the Scientific Advisory Council to the Government of India.

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