Problems of scientific research in developing countries

by P.B. Vose and A. Cervellini*

Since World War II there has been intense activity concerned with training and developing research – particularly agricultural research – capacity in most developing countries, under many national, bi-lateral and UN Agency and other programmes. Although sometimes both governments and individuals are pessimistic when they see how difficult it is to make much of an impression on the problems, this should not blind us to the fact that a great deal has been achieved. The pool of trained scientists in developing countries is incomparably greater than it was twenty-five years ago.

Nevertheless, a very large gap between desirability and achievement clearly exists, and the question is what can be done to close it?

Human resources

The overall problem is largely one of resources and their allocation, coupled with a much smaller base of educated people in developing countries than usually found in the developed countries. Increasing the educated population is a slow business which will take a couple of generations or more, in many cases. It is therefore necessary to make the best use of the scientific manpower that there is available in the short term. Nowadays with the improved facilities which exist in most countries, undergraduate training is best carried out in the country, rather than in a developed country, which can lead to problems of re-assimilation on return home.

At the graduate level many countries do not have adequate training and research programmes and training abroad is essential. Even when graduate level instruction exists, the broader experience gained from a period of study in another country is almost required education of a scientist, whether from developing or developed countries. Governments can be remarkably short-sighted here: they pay large sums of money for their nationals to receive higher education abroad, and then fail to provide them with adequately paid employment or facilities when they return home. The lack of adequate status, as reflected by relatively low salaries and inadequate career structure is a major deterrent to the proper advancement of science in many developing countries – and some developed ones too!

The phenomenon of overseas graduate students trying to remain in their country of training is well known in all developed countries. The only long term solution is to improve status and facilities in the home country. As a general rule it seems likely that a policy of sending abroad for graduate study only those scientists who already have jobs and an established commitment to an institution and a career at home, is one way of achieving both a greater proportion re-establishing themselves in the home country, and may also ensure studies most in line with national requirements.

Research priorities and funding

Scientists should realize that at least some of the responsibility for achieving general government support and specific funding rests on them. They cannot expect support just to come to them as of right. Members of government and higher civil servants are mostly non-scientists and it is necessary for scientists to go out and explain the significance of their work and what they hope to achieve, with the objective of building up a climate of support. This is true for scientists in developed countries, too, but it is especially important in developing countries.

Having obtained support then the work should be pursued with the serious intention of showing results for the money received. The reason that the governments of many developing countries do not support scientific research more enthusiastically than they do, is because they regard research as a sack into which money is poured and nothing of apparent value comes out.

It is inevitable, probably desirable, that most research in developing countries will be applied or mission-oriented. Applied research need not really be restrictive – there is always room for original and basic approaches

* Mr Vose is Project Manager of the IAEA/UN Development Programme project at the Centro de Energia Nuclear na Agricultura (CENA), Piracicaba, São Paulo, Brazil.
Mr Cervellini, formerly Director of CENA, is now an adviser to the Comissão Nacional de Energia Nuclear, Rio de Janeiro, Brazil. This article is reprinted from the collection of *Papers Dedicated to Professor Johannes Moustgaard* published by the Royal Danish Agricultural Society, Copenhagen, Denmark (1981).

within the framework of programmes having ultimate practical objectives. Such an approach is more likely to receive increased government funding than programmes not linked to practical requirements. Purists may balk at the idea of scientific research being channelled towards specific national requirements – but they have to face reality. Competition for resources is too great to support programmes which cannot in the long term help to improve the development of the country.

Particularly in pure science, on occasion the research priorities will follow the availability of personnel. In many developing countries there is not a broad spectrum of equal competence in all branches of science, but there may be outstanding individuals and groups in certain fields, who may be of international level. Government policy should be to support such individuals and groups, as they are the catalyst and growth centre around which other activities will be encouraged. Moreover, they add to a country's scientific prestige abroad.

Of course in the long term more money needs to be made available; there are very few developing countries supporting their scientists at a level which make national research programmes self-sustaining and significant in world terms. Probably not more than US $2000 million is spent on scientific research by all developing countries at the present time. Overall this is a very small proportion of total expenditure, particularly if one realizes that such research is the basis of all advances in agriculture and technology, the twin goals of most developing countries. We need to look to expenditure of at least five times this amount in the medium term.

Considering international aspects, it is clear that "big science" is becoming too costly for many developed countries, and they are finding a solution through the joint funding of laboratories and projects. Thus in Western Europe, countries have joined together to pursue advanced nuclear physics research through the European Organization for Nuclear Research (CERN); molecular biology through the European Molecular Biology Laboratory (EMBL); and nuclear fusion research through the European joint project at Culham. Similar regional co-operative research endeavours must surely be the way for developing countries to follow, although the difficulties of funding and intra-regional jealousies should not be underestimated.

The International Atomic Energy Agency has shown the possibility of regional co-operation between countries in South Asia and the Pacific through the Regional Co-operative Agreement (RCA) for research and development related to nuclear science and technology [1]. At present the international money involved is trivial and the development objectives diverse, but the important thing is the establishment of the principle of co-operation for scientific and technological goals, and to establish an instrument through which to build scientific co-operation in the future.

Research facilities

Scientific research is not cheap these days. At one time the most expensive item in a research programme was the salary of the research worker involved, nowadays the cost of equipment and its maintenance are ever increasing factors. Moreover, science is no longer neatly compartmented – every branch is interdependent with a number of other disciplines. Today, too, biological and agricultural research is more dependent on physical methods of analysis, isotope and radiation techniques, etc., and a modern research station requires a whole range of sophisticated equipment.

Probably many developing countries might have made more progress in scientific research if they had concentrated their effort. Rich, developed countries can afford the luxury of many research institutes and centres, but the situation in developing countries is different.

The demand for resources far exceeds the funds available and concentration of equipment is not only desirable but has become virtually a necessity in some areas of activity. Consider the costs of some equipment items. The present price of an automatic liquid scintillation counter is upwards of US $40 000, the most economical and basic mass spectrometer that you can buy for nitrogen-15 studies is US $100 000 and more adaptable ones are US $200 000 upwards. An emission spectrometer for nitrogen-15 is US $35 000. These prices take no account of possible import duties. Electron microscopes, plasma spectrographs, radiation sources, and dozens of items of essential equipment are also very costly.

The rapid obsolescence of scientific equipment is especially acute at present due to the adoption of microprocessor control of so many instruments, and the consequent introduction of many new models. The useful life of instruments is little more than five years as spares are often not available; one suspects due to "planned obsolescence". This may be irritating to laboratories in developed countries but quite crippling to laboratories in developing countries where money and importation are major difficulties.

For many countries it is therefore essential to concentrate specialized facilities and equipment at a few sites, where it may be most efficiently utilized and maintained. Maintenance is a real problem, and often one finds laboratories in developing countries with much unserviceable equipment, because there is no-one available to carry out even minor repairs. Larger research centres can be much more effective, as they are large enough to have their own workshop and repair facilities. Some equipment, like mass spectrometers, are not really self-contained but demand glass blowing and repair facilities, liquid-air plant, and so on.

Too few countries have recognized the value of having a powerful, well-equipped central unit and have tended to disperse their effort between too many institutes.

The concept of a "science park" with a concentration of facilities is one which needs to be considered. As physics is becoming increasingly important for the solution of biological problems, the provision of such facilities can only become more necessary as the cost and complexity of equipment is ever increasing.

CENA* is an example, on a small scale, of this approach [2]. Specialized equipment for advanced agricultural and biological research has been assembled on a small and convenient campus; it includes 30 000 Ci radiation source, three mass spectrometers, electron microscope, ultra-centrifuge, radioisotope and radiation measuring equipment. Facilities for soil microbiology and nitrogen fixation research are good, with normal microbiology equipment and sophisticated gas chromatography instrumentation. Biochemistry has special facilities and expertise in plant tissue culture and amino acid and protein analyses. There is an experienced electron microscopy group, an active soil physics group and an analytical laboratory with autoanalyser equipment, two atomic absorption spectrometers and a plasma spectrograph capable of quantitative determination of 19 elements simultaneously. Naturally, there is a workshop, too.

Now, although it was not initially intended that way, this concentration of equipment and expertise has resulted in CENA being a participant in nationwide co-operative programmes. For example, a majority of the people trained at CENA do not have nuclear facilities in the institutes where they work, consequently they often develop joint work. CENA now has contacts in 16 Brazilian States, with 51 Brazilian universities, and with another 25 individual research centres or institutes [3]. Brazil is a large country with a relatively well developed scientific infrastructure, but the CENA experience clearly suggests that many smaller countries would benefit from concentrating expensive equipment and critical expertise.

Such centres would also support better and more comprehensive library facilities. Despite the development of such information systems as AGRIS for agricultural sciences and INIS for nuclear sciences, obtaining recent literature is still a serious problem in many developing countries.

Communication

Keeping in contact with the mainstream of ideas and developments is a major problem for scientists in most developing countries, if a high level of scientific attainment is aspired to. Particularly South of the Equator, there is both a geographical and communication problem relative to the well-established scientific centres of the Northern Hemisphere. Frequent contact for intellectual stimulation, as well as for keeping up-to-date is thus very important, and for this the short scientific visit or study tour has proved to be extremely valuable.

Such tours provide the opportunity to attend international meetings, renew contacts, observe developments elsewhere, and to check the relevance and standard of one's own work with some of the best work in other countries. Often this provides new information and new ideas for further research, and often for better organization and improved facilities.

Although short term visits are invaluable for maintaining contacts and keeping informed, longer fellowships (at whatever level) provide the basis for new skills and enlarged experience. The cumulative effect of a broad and sustained fellowship programme can be very great. As an example, there can be little doubt that the international fellowship programme has played a substantial role in the development of CENA expertise to its present internationally recognized position, with contacts with some 15 countries, some direct and others through IAEA and other programmes.

Existing support for international fellowship programmes comes from national, bilateral, Rockefeller or from agencies of the UN system, such as the International Atomic Energy Agency, Food and Agriculture Organization or the UN Development Programme. The source of funding of the fellowship is basically not important, but the essential thing is that the provision of fellowships should be recognized as one of the most important, yet cheapest, ways of improving the level of research in any country, and in developing countries especially.

Visiting scientists from developed countries can also provide valuable contacts. More specifically they can transfer skills, give experienced advice, and act as a catalyst for new work. Sometimes directors of institutes in developed countries are unwilling to release staff for overseas assignments, because they consider it a loss to the home research programme. This is short-sighted, as most scientists who undertake an overseas mission are enriched by the experience and particularly those working in biology and agriculture, get new ideas and see their work with new objectivity.

The co-ordinated research contract programmes pioneered by the Joint FAO/IAEA Division have also provided valuable means of contact in many agricultural research areas. The programmes have combined a mixture of contractors from developing countries and costfree research agreement holders from developed laboratories, all working in a specific research field. The participants have not only collectively achieved more than they would have done working separately, but the annual planning meetings have been extremely valuable for peer review and constructive criticism, and for making and retaining contacts. The amount of money required has been relatively very small, and it is a very cost-effective way of combining the efforts of a group of twenty or so scientists. The method of operation could usefully be more widely adopted.

Theoretical physicists in developing countries have benefited considerably from the International Centre for

* Centro de Energia Nuclear na Agricultura.

Theoretical Physics at Trieste, sponsored by IAEA and UNESCO. The Centre holds annually many courses, workshops and seminars, and on average over a thousand scientists a year have attended the Centre [4]. Biologists could similarly profit from an International Centre for Biological Sciences – it is true that there are many specialized meetings and training courses, but no major international centre exists where there is a continuity of course programming, with laboratory, library and study facilities primarily directed towards stimulating advanced biological research in the developing countries.

Importation problems

In most developing countries the difficulties and cost of importing scientific equipment and spare parts is a principal limiting factor to scientific research but seldom recognized by governments. Obtaining permission for the necessary foreign exchange can be both difficult and time consuming. Almost all developing countries have balance of payment problems, especially since the great increase in the price of oil, and governments' basic reasons for tight foreign exchange control are fully understood. They wish to reduce imports and to encourage local manufacture.

The fact is that there are very few developing countries that can either technically or economically produce sophisticated scientific equipment in the foreseeable future. In any case, to attempt to produce highly specialized costly-to-develop equipment represents a diversion of national effort which might be better utilized in other areas. Chemicals, especially biochemicals, and radioisotopes are also items which can be obtained from only a limited number of countries and their importation is vital.

The enlightened answer to scientific importation problems must be, in most cases, the exemption by government of import restrictions and customs duties, with the provision of the necessary foreign exchange. In most cases the total foreign exchange involved in totally exempting scientific equipment and supplies from import restrictions would be a quite insignificant proportion of the total import bill. Yet this could be of the most significant importance for the stimulation of science and technology for development.

Conclusions

Some of the problems of scientific research in developing countries, such as creating an increased pool of trained people, providing more resources and strengthening the whole national infrastructure, can only be solved through time. Although in the long term there can be no substitute for spending more money, some aspects such as improving the relative status of scientists, choosing rational and useful research projects, removing unnecessary bureaucracy and making the importation of scientific material easier, could be improved comparatively quickly with relatively little expenditure.

Similarly, the special encouragement of existing effective research groups and the concentration of facilities are often more a matter of wise planning rather than requiring massive additional expenditure.

Apart from the direct financial support of specific projects, there will be a continuing need for international assistance through the provision of fellowships, visiting scientists, and facilities for study at well established centres. In the future many developing countries may need to develop co-operative regional projects, if they wish to participate in more costly advanced research areas.

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