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INTERNATIONAL SYMPOSIUM ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

SINGAPORE, 22-26 JANUARY, 1979

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Under the auspices of:

AAAST	African Association for Advancement of Science and Technology
CHEC	Commonwealth Human Ecology Council
CIOMS	Council of International Organizations of Medical Sciences
CIPSH	International Council for Philosophy and Humanistic Studies
Club of Rome	
ICSU	International Council of Scientific Unions
IFIAS	International Federation of Institutes for Advanced Study
IFS	International Foundation for Science
IIASA	International Institute for Applied Systems Analysis
IIED	International Institute for Environment and Development
ISSC	International Social Sciences Council
IUCN	International Union for Conservation of Nature and Natural Resources
Pugwash	
SID	Society for International Development
UATI	Union of International Engineering Organizations
WERC	World Environment and Resources Council
WFEO	World Federation of Engineering Organizations
WFSF	World Future Studies Federation
WFSF	World Federation of Scientific Workers

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PROGRAMME FOR INTERNATIONAL SYMPOSIUM
ON
SCIENCE AND TECHNOLOGY FOR DEVELOPMENT
Singapore January 22-26, 1979

Monday, January 22

09:30 Opening and Welcome
- Singapore Minister for Health
- Symposium Convenor
- UNCSTD Deputy Secretary-General

10:45 Plenary Session 1 - "SCIENCE, TECHNOLOGY AND DEVELOPMENT - AN OVERVIEW"
- Symposium Objectives
- S&T in the Development Process
- International Cooperation for Development

14:00 Plenary Session 2 - "DEVELOPMENT OF INDIGENOUS S&T COMPETENCE"

15:30 4 simultaneous sessions:
- (1) Education and Training
- (2) S&T Policies and Institutions
- (3) S&T Information/Communication
- (4) Research and Development including Management and Linkages with Education, Government and Production Systems

18:00 Adjournment

Tuesday, January 23

09:00 Simultaneous sessions continue

10:15 Conclusion of Plenary Session 2

11:15 Plenary Session 3 - "SECTORAL DEMONSTRATION OF S&T CONTRIBUTIONS TO DEVELOPMENT: FOOD, POPULATION AND EMPLOYMENT"

14:00 4 simultaneous sessions:
- (1) Food/Population
- (2) Population/Employment
- (3) Food/Employment
- (4) Bio-Resource Potential

17:00 Conclusion of Plenary Session 3

18:00 Adjournment

20:30 Seminar on Alternative Mechanisms for Funding S&T for Development with Presentations by Representatives of: IDRC (Canada), GTZ (Federal Republic of Germany), NUFFIC (Netherlands), SAREC (Sweden), and FITC (U.S.).

Wednesday, January 24

09:00 Plenary Session 4 - "ROLE OF SCIENTISTS AND TECHNOLOGISTS IN THE DEVELOPMENT PROCESS"

10:15 4 simultaneous sessions:

(1) Natural Sciences
(2) Social Sciences
(3) Technology/Engineering (including Technology/Transfer)
(4) Transdisciplinary Problems

12:00 Conclusion of Plenary Session 4

14:00 Plenary Session 5 - "SOCIAL, POLITICAL, ECONOMIC, CULTURAL AND OTHER CONTEXTS OF DEVELOPMENT AND THE LINKAGES AMONG THESE ELEMENTS"

15:30 Conclusion of Plenary Session 5

Thursday, January 25

09:00 Plenary Session 6 - "INTERNATIONAL COOPERATION IN S&T FOR DEVELOPMENT - REPORT FOR UNCSTD and RECOMMENDATIONS FOR CONTINUING PROGRAM & INSTITUTIONAL ARRANGEMENTS"

10:15 Simultaneous sessions for general discussion

12:15 Conclusion of Plenary Session 6

14:00 Free
Preparation of session reports
Ad hoc meetings

Friday, January 26

09:30 Plenary Session 7 - Presentation of Reports

12:30 Plenary Session adjourns

14:00 Final Plenary Session - Approval of Recommendations

16:00 Closing

17:30 Press Conference

INTRODUCTION

By

Maurice Goldsmith and Alexander King

The United Nations decided to convene a major intergovernmental conference on science and technology for development (UNCSTD), which will take place in Vienna from 20 to 31 August 1979. This follows a series of world meetings which began with the Stockholm conference on Environment. UNCSTD is to be welcomed if it succeeds in demonstrating the potentialities of science and technology, their limitations, and the conditions for their rapid and effective application in the service of humankind. UNCSTD is conceived, not merely as an end in itself, but as the culmination of preparatory activities now nearing completion. For example, each member of the United Nations has been requested to prepare a position paper expressing its views on how science and technology can better be evolved and applied for national purposes; and regional meetings have taken place to integrate the views and needs of the individual countries of the region.

The present moment is thus particularly propitious for a reassessment of the place of science and technology for development, of how the world repertory of knowledge can be utilized more effectively for the general good, and how the international arrangements of science can be improved.

There is much to be done. Well over 90 per cent of the world's research and development is undertaken in developed countries, hence only a marginal proportion in the Third World, with even smaller amounts of development of original technology. International cooperation in research, for which there were ambitious schemes in the immediate post-war period, has, with infrequent exceptions, never fulfilled hopes.

Within the Aid programmes, science and technology has been mainly of an auxiliary, problem-solving type. The main emphasis has been on the transfer of specific technological processes from the industrialized countries. There has not been sufficient concern for the building-up in each receiving country of an indigenous competence to ensure that the imported technologies were the most appropriate to meet local economic and social needs, that there was sufficient skilled manpower to assure their assimilation, and to prepare the ground for original innovation in the future. In many of the developed countries the scientific elements of aid have remained somewhat remote from the main national activities, and seldom have been articulated intimately within the national science policy.

When the plans for UNCSTD began to mature, and independent scientists in many countries were involved in the elaboration of national position papers, many began to realize that their knowledge and experience were being insufficiently utilized. A few individuals concluded that an overt and coherent demonstration by the world scientific community was essential, and that the worldwide interest at the moment provided a unique opportunity to suggest that the world of science, with its understanding of the promise and constraints of research and development, its knowledge of multifaceted nature of the technological innovation process, and its awareness of the vastly different tempo of research from that of politics, might offer to the governments a new partnership for world development.

The International Council of Scientific Unions, which had already gained experience of the development needs through its Committee on Science and Technology in Developing Countries, called a series of ad hoc meetings of representatives of many of the scientific and technological organisations to consider whether an international symposium on science and technology for development could be useful, possibly leading to continued activities after the Vienna Conference. The representatives became a Liaison Group on the Contributions of Science and Technology for Development and set up a Steering Committee (See page for composition and terms of reference) to plan the organisation of the Symposium.

This joint sponsorship by 19 NGOs representing science in the broadest sense -- the natural sciences and engineering, the social sciences and the humanities -- was a unique move, since never before had these bodies, so representative of the world intellectual community, united in a common undertaking. Singapore was selected as the location of the Symposium, to provide on the spot evidence of how some countries in the Third World have been able successfully to use science and technology in their development.

The initiative for the Singapore Symposium was discussed with the UNCSTD Secretariat which was both supportive and helpful. As the preparatory phase of UNCSTD progressed, the "Singapore Symposium" became one of several major international conferences encouraged by the UN Advisory Committee on Science and Technology.

The stated purposes of the Symposium were:

- to make a substantive contribution to the United Nations Conference on Science and Technology for Development (UNCSTD), Vienna, August 1979; and

- to develop proposals for continuing activites by the international nongovernmental S&T communities in support of sustainable world development.

As illustrated in the Symposium programme, the discussion included an attempt (1) to identify essential conditions for the utilization of S&T by developing countries in conjunction with other aspects of development; (2) to discuss the concepts and actions necessary for an S&T infrastructure capable of interaction nationally and internationally; (3) to illustrate the problem solving capabilities of S&T in a specific topical area; and (4) to devote special attention to the creation of a world wide S&T apparatus to assist national development programmes on a continuing basis.

Participation in the Symposium was by invitation with selected participants being asked to co-chair the individual discussion sessions. There were no presentations of papers at the meeting, rather all sessions were devoted to discussion and the preparation of summary conference papers. A special word of thanks is due all the Co-Chairmen and Rapporteurs who worked so hard in a short space of time to produce written reports. These brief session reports are included in Part II of this report.

The Symposium took place in conditions of great harmony: there was no North/South confrontation, and little or no ideological dispute since all the participants, irrespective of background, were united by common resolve to use their collective knowledge in an attack on the problems of world development. They were unanimous in their intention to continue collaboration with each other, with their various governments, and with the international agencies, hopefully in a new and more effective system.

To reflect the principal outcome of the Singapore Symposium, it was agreed that three documents which emerged from the meeting are key. These are: (1) Declaration of the Singapore Symposium which expresses in brief the spirit and sense of the discussions; (2) a paper entitled "International Cooperation in Science and Technology for Development" by D.A. Bekoe which summarizes the major substantitive recommendations; and (3) a paper on "Recommendations for Continuing Programme and Institutional Arrangements" by Thomas R. Odhiambo which suggests an organisational framework for future activities. These papers, coupled with the Report of the Chairman of the Steering Committee, constitute Part I of this Preliminary Report. The full proceedings of the Symposium will be published by the time of the UNCSTD meeting.

March 1979

PART I

DECLARATION OF THE SINGAPORE SYMPOSIUM

ON SCIENCE & TECHNOLOGY FOR DEVELOPMENT

This meeting, held in Singapore on January 22-26, 1979, may prove to have been a decisive moment in the attitude of scientists towards development. For the first time ever, some 19 of the most important and relevant of the Non-Governmental Organizations -- covering the natural, economic and social sciences and technology -- and thus representing, directly or indirectly, a high proportion of the world's scientists and technologists, jointly sponsored the initiative. The purpose was not to consider science as such, but how its collective knowledge and wisdom could best be mobilized to attack the problem of development in a world of increasing disparities.

The initial importance of the meeting was thus its demonstration to the world of the concern of the scientific community for the situation of the 800 millions of the underprivileged and its conviction that such disparities endangered world harmony and peace. An important resolution of the meeting was thus a pledge to sustain, spread and deepen this concern after Vienna and to mobilize the forces of science and learning to cooperate with the individual countries and the United Nations programmes and agencies for a massive attack on the problems of development.

The meeting took place in an atmosphere of urgency. Its conviction was that the present moment is one of great danger for all humanity. The growing disparities of wealth, the prospects of large increases in the world population carrying grave consequences with regard to the provision of food and shelter, pressures on materials and energy resources which we have come to appreciate as finally limited, threats to the environment; these and other problems of a global character cannot be solved by individual countries and demand a concerted international effort if humankind is to survive with dignity and in reasonable material conditions. It is doubtful if present policies, attitudes and structures are capable of dealing with all these matters, which should no longer be tackled one by one sequentially, but, because of their strong interactions, have to be faced as a whole.

On the other hand, science and technology have much to offer, in combination with other approaches, including the political, not only to provide remedies, but to construct a new world of greater equity in which each individual and society would have the opportunity to develop within the diversity of cultures and objectives of each. In the absence of a more integrative approach to science and technology and, in particular, the building up in each country of an indigenous capacity for such activity, including the full use of the potentialies

of women, the developing nations are unlikely to achieve the conditions necessary to reap the full benefits and to escape indefinite dependence on other nations.

Science, taken in the broadest sense, represents the total accumulation of human knowledge. Its significance in development is not merely in the solution of specific problems but as a new force which can help to shape policies and strategies for the future. Much new research is, of course, required; this will include social, organizational and systems research, including contributions to the process of decision making in addition to advances in the natural sciences and technology to meet the material needs of humanity.

The meeting deplored the continuing arms race which involves half of the research and development scientists of the world, who are thus not available to work on the constructive problems of human survival and betterment.

The meeting considered many aspects of the development problem and proposed many detailed resolutions aimed at contributing to their solution. It stressed, for example, the need for some of the developed countries to create and fund national, but internationally oriented bodies to undertake research on the whole spectrum of development problems, similar to those already in operation by Canada, Sweden and a few other countries. It gave particular importance to the stimulation of a massive development of technical institutes in the Third World to produce technicians of high quality and explored means whereby the industrialized countries, their scientists and engineers could assist in this. It considered also how an aptitude for science and engineering could be inculcated and nurtured in the young throughout the developing world and how a broad public awareness of scientific promise and national needs could be cultivated. It suggested that the multi-national corporations be encouraged to operate apprenticeship schemes in modern technology in countries where they operate.

The Symposium proposed in some detail a number of institutional arrangements for the continuation and implementation of its work and how financial resources might be made available to make this possible. Great hope was expressed that new and dynamic methods might be developed in cooperation with the UN Agencies and Programmes to make concerted efforts towards the solution of the problems.

Appeal is therefore made to scientists in all fields and in all countries to share these concerns and also to the United Nations and its member countries to endorse this approach and join with the scientists and technologists of the world for a new impulse towards a better future.

INTERNATIONAL COOPERATION IN S&T FOR DEVELOPMENT
Statement of the Symposium

By

D. A. Bekoe

On January 22, 1979, a truly significant step was taken in Singapore. One hundred and thirty scientists (including social scientists) and technologists (including engineers and social technologists) representing various non-governmental organizations in the field of science and technology met to take concerted action on their common concern for removing the major obstacles to economic and social development. The sentiments and opinions expressed at this meeting reflect the deep anxiety of the scientific and technological community for the future of the world in the face of an increasing population competing for survival on finite resources, the associated problems of food, nutrition and employment, the environmental consequences of man's activities, and the everpresent threat of international conflict.

Never before has there been such an international non-governmental assembly for the specific purpose of uniting in a common enterprise so crucial to the peace and welfare of all the peoples of the world.

The Singapore Symposium which provided the opportunity for the meeting of representatives of 19 non-governmental organizations and other invited scientists and technologists was inspired by the need to

a) make a substantive contribution to the UN Conference on Science and Technology for Development, which will complement those of the Conference Secretariat and other governmental and inter-governmental bodies; and

b) explore institutional and other innovations which would enhance the opportunities for scientists and technologists to contribute more systematically and effectively to sustainable economic and social development.

Many efforts have been made in the past by governments and the UN agencies to deal with the unequal development that has taken place throughout the world and, in particular, the widening gap between the LDCs and the developed industrial countries. In such inter-governmental circles, there is no doubt that science and technology are essential for development. There has, however, been a growing awareness that the lack of active involvement of scientists and technologists in development planning and overall implementation has contributed, in part, to the limited success of two international

development decades. It was the unanimous view of the meeting that scientists and technologists must therefore join more actively in the search for solutions which have so far eluded governments and the United Nations.

The world is faced with crisis situations which require immediate action but, as scientists and technologists, we are also conscious of the need to provide more lasting and self-sustaining solutions. Meeting in Singapore, we cannot help but quote the Chinese proverb which says: He who gives a fish to a hungry man feeds him for a day; he who teaches a hungry man to fish feeds him for life. We consider it most important to provide the hungry man with fish now while giving him instruction on the art of fishing. We believe that the opportunity presented by the Vienna Conference must be seized to initiate new mechanisms to ensure that we make a significant change in the scale of development.

While development is fundamentally a national issue, it is recognized that many of the problems facing the LDCs are regional or global in character and require international efforts for their solution.

Contrary to the frequently expressed view that there is sufficient knowledge available and that there is no need for further research, it is our conviction that basic research in the natural, social and applied sciences is necessary to support the substantial transition that we searching for. The world has never faced a problem of this magnitude and it would be naive to suggest that we need no new knowledge for its solution. The Symposium considered critical aspects of the problem, such as the need to:

(a) reduce unemployment and under-employment, and raise the real incomes of the poorest classes by creating and strengthening appropriate rural and urban industries;

(b) increase and diversify agricultural production;

(c) develop forest and fishery resources;

(d) expand the range and quantity of energy resources for agricultural, industrial and domestic uses in rural areas and develop means for energy conservation;

(e) improve the health of the people;

(f) protect watersheds, soils and other environmental resources;

(g) find and bring about the social and economic changes which will help to slow down population growth and ultimately stabilize the size of the population;

(h) develop transportation and improve transport vehicles.

So far, the world wide scientific and technological community has not been organized in such a way as to make its optimum impact on the search for solutions of critical developmental problems:

> Scientists in the LDCs are relatively few in number and ofte isolated from each other and from their national planning and implementing agencies. Many of them are consequently either ineffective or attracted to jobs in the industrialized countries, where they are often very much in demand.
>
> Research institutes and universities in the LDCs have insufficient opportunities for cooperation with other similar bodies both in other LDCs and in industrialized countries. Scientists in LDCs have been inadequately supported and without many of the tools (equipment, journals, appropriate forms of science and technology information systems, etc.) and supportive technicians and craftsmen.
>
> Scientists in the industrialized countries have not been sufficiently encouraged and supported to work on problems related to the needs of the LDCs, and there have been inadequate opportunities for communication between them and their counterparts in the LDCs, vital to the advancement of knowledge and the development of technology in the LDCs.
>
> World wide funding for science and technology related to development in the LDCs has been meagre compared to that for defense or the support of the industrialized economies. The diversion of the world's military expenditure for one month each year in this direction will release resources of finance and manpower which would make an unprecedented impact on development.
>
> Further, the non-governmental scientific and technological organizations have been unable to mobilize effectively their members and other scientists and technologists in support of development efforts because of insufficient funds and staff.

Also, some of the specialized agencies of the UN have not had effective linkages with corresponding non-governmental S&T organizations. In this regard, the Symposium welcomed, in the statement from

the Deputy Director-General of Unesco, the commitment by Unesco to help the NGOs play a more effective role in their consultative capacities. The Symposium also commended and endorsed the very enlighted programme and mode of operation of the United Nations University. It was appreciated that some of the other agencies are making efforts in this direction.

We realize that the contributions which women, who form fifty per cent of the population, can make as scientists, technologists and social scientists to development are hampered by the unfavorable socio-economic environment in which many of them have had to operate. Nor has the impact of technology on them been closely studied and assessed. The world cannot reap the full benefits of technology until this vital human resource has been fully mobilized and equipped for full participation in the development process.

The Symposium realized that any programme for development must eventually be implemented at the practical level if it is to benefit the masses of the people. In many cases, such practical action will involve industries in both the developed and less developed countries; and it is important, for the avoidance of misunderstanding and conflict that representatives of industry should be involved in the planning of development at the earliest possible stage. The absence of representation from industry at the Symposium was therefore regretted.

In the light of the above considerations, the Symposium seriously addressed itself to specific and practical steps aimed at strengthening the capabilities of governments, institutions and the scientific and technological community to tackle the problems of the LDCs as they are perceived in those countries; mechanisms of international collaboration for effectively linking science and technology to development, collaboration between the scientific and technological community and national governments, and with funding agencies; and finally collaboration between the S&T community and other social groups who have their own expertise to offer. The Symposium expressed the hope that as a context for these collaborative efforts, mankind will continue to enjoy the peace and international understanding without which it will be impossible to achieve these aims.

Recommendations

After careful and intensive discussions, the Symposium arrived at a number of recommendations. Some of them were specific and went into considerable detail. We highlight the following general recommendations:

(1) Each of the LDCs should be urged to develop and strengthen its own scientific and technological capability in order to enable it to

improve on its indigenous technology, make a rational choice of foreign technology, effectively absorb imported technology and create new technology to suit its circumstances.

Each of them should establish institutional structures for S&T for development, delineating the domain of activities within the total S&T system.

In tackling world wide problems, such as the depletion of energy resources, desertification and other environmental consequences of human activity, international collaboration and integrated approaches must be encouraged. In some areas, such as tropical diseases, active regional centres in the tropics should be stimulated, as such problems are unlikely to receive adequate attention elsewhere. International centres for advanced fundamental and oriented research should be set up in the LDCs and strengthened to reduce the brain drain.

(2) For the immediate future, efforts must be made, on a massive scale, to correct the imbalance in the availability of the various cadres of scientists, technologists and support staff:

(a) A large number of technical colleges should be opened in the LDCs (over the next five to ten years) to train the technicans, craftsmen and other skilled workers required to support programmes for the provision of shelter, food, transportation, and medical care. Some institutions should also be established to train teachers for these technical colleges so that this programme can be self-sustaining within a few years.

(b) Steps should be taken to improve school curricula and provide equipment and construction sets in large numbers to help generate the basic technical skills.

(c) Every year, thousands of university and technical college teachers from the developed countries should spend about a year working on projects in one of the LDCs.

(d) A large number of technicians from the LDCs should each year participate in apprenticeship programmes and in actual production work in the developed countries, including work with multinational corporations.

(e) There must be a vigorous international campaign within the international science and technology community to make them aware of the magnitude of the problem, and to bring into sharper focus the development objective of education at all levels.

(3) Special attention must be paid to the integration of women in the LDCs in the development process through:

(a) the provision of adequate education and training as scientists, technologists and support staff for full participation in all stages - conception, planning, implementation and management - of development projects;

(b) by close examination of the effect of technology on their lives.

(4) There should be a network of national or regional agencies in the LDCs which should be encouraged to exhange ideas and experiences and possibly evolve principles of wide applicability in the use of S&T for development. The network should consider the feasibility of setting up regional development insitutions with responsibility for transforming research findings into industrial production.

(5) Member nations in the developed world should be urged to emulate the excellent examples of countries, such as Canada, Norway, Sweden, Netherlands, and the Federal Republic of Germany which have set up distinct, and in some cases autonomous, funding organizations outside their aid agencies (IDRC, FITC, IFS, SAREC, NUFFIC, ATI and GTZ) for the specific purpose of supporting S&T in the LDCs. Specific notice was taken of IFS as an international agency, with membership from 45 countries from both the developed and developing world, which concentrates on work done by scientists in the LDCs. There should be a coordinated network of such donor organizations to exchange ideas and experiences in such a way as to preserve their individual strengths and promote their common interest. The Academies of Sciences in the Socialist Countries, some of which have provision for funding S&T in the LDCs, should also be encouraged to increase their level of support.

(6) The NGOs should make positive efforts to include scientists and technologists from the LDCs among their membership and to give them sufficient professional support in building up the capabilities of their countries. They should also mobilize their members in the developed countries to tackle some of the problems of the LDCs, and to work out the mode of cooperation with others, especially social scientists, on problems that require an interdisciplinary approach.

(7) Attempts should be made to involve leaders from industry, including the multi-national corporations, in planning, implementation and management of development projects at both the national and international levels so that they can contribute to, and benefit from, the discussions and recommendations.

(8) UNCSTD should initiate action to facilitate the transmission and exchange of machine-readable S&T information and computerized data among all countries of the world, as has been achieved for books and printed materials through a Unesco-inspired international agreement more than a quarter of a century ago.

(9) The specialized agencies of the UN should follow the lead of Unesco in facilitating effective partnership between the NGOs and these agencies. The work of the United Nations University should receive adequate support from all countries.

(10) Finally, the Symposium recommended to the Steering Committee the establishment of a suitable mechanism to keep alive the momentum generated by the Symposium and to ensure that follow-up action is taken on these recommendations and those that will arise from the Vienna Conference.

RECOMMENDATIONS FOR CONTINUING PROGRAMME AND INSTITUTIONAL ARRANGEMENTS

By

Thomas R. ODHIAMBO

1. Introduction

From the presentations made at the first plenary session of the International Symposium on Science and Technology for Development in Singapore (ISSTD), in January 1979, and the succeeding discussions, a number of ideas and suggestions have emerged that would seem to offer a firm basis for a continuing programme of action for the next decade. These include proposals for new initiatives for institutional arrangements - at both national and international levels, but also it has other components which, working together and in concert, contain a good measure of assurance that the entire scientific community (comprising the natural scientists, social scientists, engineers, and technologists) can effectively be plugged into the process of development together with: (a) the governmental and inter-governmental systems, and (b) the autonomous funding agencies.

In putting forward these initiatives, a number of criteria have been taken as part of an underlying philosophy of implementation:

(a) The use of existing institutions will be enhanced as far as possible, although the creation of new institutions has become a matter of paramount importance.

(b) It is realized that the stages and needs of development are varied in the so-called developing world, and that what is being offered here is a set of general guidelines for concerted action by the world community.

(c) It is emphasized that the scientific community is a vital participant of the development process;

(d) The availability of the technical, guild, and support cadre for research, development, design, and production is essential for any country wishing to mobilize its human resources for science-based, socio-economic development.

(e) It is recognized that social innnovations in the field of development might well play a considerable part in the

impulse towards creating a new international scientific and technological order in the fields of the LDC economy and wellbeing.

(f) A major objective of the ISSTD initiative is that the programme of implementation gives the highest priority to the increase of LDC capabilities in R&D for development relevant to their particular circumstances, and that this goal is being met in the context of international cooperation.

A lean programme, characterized by flexibility and rapid action, is proposed below.

2. Programme of Action

(a) The ISSTD recommends to the convenors of the ISSTD the establishment of a small continuing committee, based on the Steering Committee, to start an action programme by 1st March 1979, on the basis of the proposals made under (b) to (f) herebelow. The continuing committee should consist of independent persons, of diverse expertise and experience, supported by a small executive staff.

(b) The first action of the continuing committee would be to identify up to six areas of LDC global concern, where critical scientific knowledge and development innovation are lacking, as its first line of attack. For each priority area, the continuing committee should establish a small programme identification mission, to spell out in detail the principal scientific questions related to specific development priorities, the approach, the programme, the implementation schedule, proposed management structure, and criteria by which implementing institutions will be selected, and the budgetary requirements. It is highly desirable that the continuing committee should appoint only one mission at a time, and not go on to a second mission, until the first has completed its work, and has been disbanded. After examining the findings of the programme identification mission, and selecting its action programme therefrom, the continuing committee should then energize the consortium of donors proposed under (d) below.

(c) An urgent appeal is directed to the nations of the world to establish autonomous, or semi-autonomous, funding agencies, on the model of the IDRC, SAREC, NUFFIC, and GTZ, in both the LDCs and DCs. The continuing committee is requested to pursue this matter with vigour.

(d) It is proposed that a consortium of donors be established, as soon as possible, to fund the activities recommended by the programme identification missions, the work of the CC, and associated activities. The consortium should be co-sponsored by the appropriate arms of the United Nations family (for instance, by Unesco, whose mandate includes science; UNEP, which has a major concern for environmental problems of development; and UNDP, which has a major preoccupation with development projects), and at least one of the autonomous or semi-autonomous funding agencies. The three-to-five co-sponsors would then invite, for each particular area of concern (where a specific programme has already been defined) several other potential donors (governmental, inter-governmental, private sources, and technical assistance organizations) to participate in the final definition of a specific programme and budget, and to contribute to the agreed core programme activities on a continuing basis. The grants should be put into a special fund - The Science and Technology for Development Fund (STD Fund), to be managed by one of the development-oriented financial agencies (e.g. The World Bank or UNDP).

(e) A system of monitoring of the action programme, and of evaluating its effectiveness, is vital. It is proposed that the ISSTD (reorganized as a manageable professional programme review mechanism) be convened every three years by the NGO Liaison Group and ICSU to carry out this task. The first such review meeting would be in January 1982. This activity would be funded through the STD Fund.

(f) It is expected that an outcome of the programme identification missions would lead to the following institutional developments:

(i) Establishment of a new network of international and regional centres focused on particular LDC global problem areas: these centres could be largely funded by the STD Fund.

(ii) Establishment of new centres of advanced R&D at national level, to deal with particular national R&D problems: these cenres should be largely funded by national or bilateral sources.

(iii) Enhancement of the effectiveness of existing institutions.

A pragmatic mechanism for enmeshing the work of all these institutions will urgently be explored.

(g) Development of a reward and award system (including the question of a career pattern in S&T), specifically to attract talented LDC scientists to become involved in LDC problems, as well as to make tropical problems fasionable in the entire world community, is proposed. The NGO Liaison Group and ICSU should be charged with working out a practical scheme for effecting this, including the establishment of a family of prestigious awards aimed at specific development targets, in consultation with other national and international groups (including those specializing in technological and industrial R&D).

REPORT OF THE CHAIRMAN

of the

STEERING COMMITTEE

The International Symposium on Science and Technology for Development was held in Singapore from 22-26 January 1979.

SUMMARY

The Symposium:

(1) demonstrated that cooperative action could be taken by international nongovernmental organizations which are concerned about the role of science and technology in the UN Conference on Science and Technology for Development (UNCSTD);

(2) caused a coalescing of these concerns in a commitment to bring the resources of science and technology to bear on Third-World problems;

(3) resulted in a strengthened commitment to revitalize the patterns of cooperation of nongovernmental S&T organizations and to expand their ties to intergovernmental agencies.

INTRODUCTION

In 1963 at the time of the first UN Conference on Science and Technology for Development, many participants spoke of "galvanizing the scientific conscience." During the last sixteen years, consciousness raising has been effective only within a small portion of the S&T community. The convening of a second UN Conference on this topic in 1979 provides another welcome occasion to pursue this objective. However, as preparations for 1979 proceeded, there was a feeling that if science and technology are to be employed to promote human and economic development, then scientists and technologists have an obligation to deliberate their role.

On the initiative of the International Council of Scientific Unions (ICSU), representatives of nineteen international professional organizations formed a Liaison Group on the Contributions of Science and Technology to Development and agreed to convene an international forum to discuss their contributions to development generally and to UNCSTD specifically.

The 136 participants from 40 nations who met in Singapore encompassed a wide geographical and disciplinary mix. Sixty-seven participants were from developing countries, forty-three from the industrialized West, nine from the socialist countries, and seventeen observers from the United Nations and its agencies and from national development funding agencies. Fourteen of the nineteen Sponsoring Organizations sent at least one participant thus covering many disciplines within the natural, social, economic, and engineering sciences. Many participants had working experience applying science and technology to development. There was no North-South or East-West confrontation.

In the course of the discussions, a number of basic assumptions were accepted:

(a) development is a continuous socio-economic-political process of which science and technology must be an integral part;

(b) scientists and technologists have a responsibility to offer their knowledge, experience and competence to the community at large as a tool for the resolution of development problems;

(c) strengthening S&T infrastructures in developing countries is essential to acquire the knowledge and resources critical to development; and

(d) the international mode of collaboration so basic to programs in science and technology must be made a more effective component of development.

There was a shared conviction among the participants that an expanded commitment by the world community of scientists and technologists to the problems of development could be articulated in an action program that would entail a reshaping of the present attitudes and institutions of the international S&T community to work on the technical problems restricting social and economic development. New patterns of cooperation should be devised using existing institutions, but characterized by increased flexibility and experimentation. The cadre of scientists and technologists dedicated to the creation of new S&T knowledge for development and to its application to the solution of key development problems must be greatly expanded.

FRAMEWORK FOR ACTION

An innovative system of interaction at four levels was proposed: (1) a network of institutions in developing countries to identify problems from the perspective of the developing countries themselves;

(2) a "switching mechanism" in the nongovernmental sector to link LDCs with the resources of scientific and technological talent in industrialized nations; (3) a multiplication and collaboration of donor institutions; and (4) a revitalization of the UN system for the application of S&T to development accompanied by a more active working partnership with international nongovernmental organizations.

(1) Indigenous LDC S&T Institutions

Within the developing countries, institutions for the application of scientific and technological knowledge can make a contribution. The exact features of these institutions obviously vary depending on local circumstances and needs. They may be national, bi-national or regional. They may be similar to the "centers for alternatives" that are being considered in India, to be manned by scientists from a range of disciplines to assess and recommend suitable technological options in the context of the total development effort. Whatever their design, the salient feature is the identification of local problems by local people.

LCD capabilities to produce S&T knowledge applicable to development problems was stressed repeatedly at the Symposium. Research in the natural, social and applied sciences is needed desperately; however, for this knowledge to be truly effective in development, there should be close and effective interaction with national policy planners and decision makers. The involvement of industry representatives in development planning appears critical for effective implementation procedures at the practical level to evolve.

The establishment of networks among national development-oriented institutions was regarded as desirable because there are potential cost advantages in terms of avoiding duplication of effort and pooling of resources, and such a network could serve as the institutional base for collaborative contacts and programs to provide support and stimulation for the activities of the individual institutions in their local environments.

(2) International "Switching Mechanism"

The discussions at Singapore emphasized the need to enhance the participation of the industrialized nations' S&T communities in development at the nongovernmental level. Representing a broad range of disciplines in the natural, engineering, medical, social and economic sciences, the nongovernmental organizations in the Liaison Group might be considered as potential sponsors of an international secretariat or clearinghouse to provide developing countries with the scientific and technological skills available in the developed countries and to promote cooperation among those working on common

problems. This nongovernmental resource could complement the intergovernmental and bilateral arrangements already in place.

It would be the responsibility of the central switching mechanism to catalogue the problems identified by the developing countries and match them with the appropriate talents and resources of the S&T communities wherever they might be. For example, using the institutional resources of the nongovernmental organizations and institutions in developing countries, teams from developed and developing countries might be brought together in workshops or research centers to concentrate on a solution of a specific local problem.

Whatever the form of the switching mechanism, the goal would be participation of increased numbers of scientists and technologists from developed and developing countries in collaborative development-oriented work.

Nongovernmental professional organizations can offer intellectual resources, but not financial support. For this purpose, development funding agencies might offer assistance.

(3) Collaboration Among National Development Funding Agencies

The Symposium heard presentations by representatives of research funding agencies in Canada, Germany, Netherlands, Sweden and a report on plans for a new agency in the United States. The useful work being accomplished underscores the need for a multiplication of such enterprises. The meeting in Singapore also marked for some agency representatives, the first opportunity to compare their work publically. The establishment of a communications network to exchange ideas and experiences was raised. The possibility of interested agencies acting as joint sponsors of international collaborative endeavors based on the matching of LDC problems and S&T resources identified with the assistance of the NGO switching mechanism could be examined also.

(4) International Nongovernmental Organizations and Relations with Intergovernmental Organizations

At the Singapore Symposium a unique group of international nongovernmental organizations joined together for the first time. Their presence may signal a significant expansion of interest by these groups in development. The Singapore participants called on their organizations to motivate their membership to a new international order of S&T for development. The participants urged the NGOs to strengthen themselves through improved support from their own membership, a more active collaborative working relationship with each other, and partnership with intergovernmental organizations.

The Symposium welcomed the call by the Deputy Director-General of Unesco for a more dynamic and effective system of international collaboration between the nongovernmental and intergovernmental sectors. The magnitude of development problems warrants new international arrangements. The call for a new partnership built on existing insitutions, but with specific financial resources committed to its implementaion, offers hope for harnessing the interrelated talents of the NGO and IGO communities.

SUMMARY OF THE RECOMMENDATIONS

(1) Scientific and Technological Communities

As the scientific and technological communities participate in development, they should join actively in development planning and implementation in cooperation with governments and the United Nations. At the international level, the lack of cohesive organization of the nongovernmental S&T communities has limited their contribution to development. Development is a national issue, but many of the problems are regional or global in character and can benefit from international efforts for their solution. A vigorous international campaign should be launched among the international S&T communities for an improved methodology to increase awareness of the magnitude of global and Third-World specific problems.

(2) Other Community Members

(a) Women - The professional and non-professional contributions of women to development are often impeded by the unfavorable socio-economic environment in which they operate. Developmental progress will remain incomplete until women fully participate in the community. Therefore, special attention is needed to the integration of women in development through (a) provision of adequate education and training as scientists (natural and social), technologists and support staff in all stages - conception, planning, implementation and management - of development projects and (b) close examination of the impact of technology on their lives.

(b) Technicians - For science-based socio-economic development to be fully effective, adequate use must be made of technical support people in research, development, design and production areas. Creation of this valuable resource can be aided by improvements in pay and recognition to cause additional persons to seek technical training geared to local requirements.

(c) Industry - Recognizing the pivotal, practical role of the industrial communities in developed and developing countries, the

Symposium urged their involvement with development policies at the earliest stages. It was suggested that leaders from industry, including multi-national corporations, should be involved in the planning, implementation and management of development projects so they can contribute to, and benefit from, the discussions and recommendations.

(d) Social Scientists - Social innovations may well play a key role in the reorientation of attitudes, structures and policies which is being sought to improve the well-being of the LDCs. Improved international collaborative activity between the social sciences communities and other communities in the natural, engineering and economic areas is to be encouraged also.

(e) Political Leadership - Recognizing that development is a political problem and that science and technology are some of many tools for progress, the Singapore participants pledged to cultivate a more sympathetic and understanding approach to political needs and limitations.

(3) S&T in the LDCs

LDC development and strengthening of their own scientific and technological capabilities to improve technology, to make appropriate choices of foreign technology, and to create new technology can be encouraged and helped. Most LDCs have or seek institutions for S&T in development. Although the enhanced use of existing institutions was recommended, it was recognized that new institutions may be necessary. The need for new national centers of advanced R&D was cited as an example. To identify the technical elements in major development issues, to encourage the exchange of ideas and experiences, and to evolve principles of wide applicability in the use of S&T for development, it was recommended that there be a network of national or regional development institutions from within the LDCs. The network could consider the feasibility of regional development institutes which would have the responsibility of transforming research findings into industrial production.

Several specific, immediate recommendations for action were made including the opening of a large number of technical colleges in the LDCs with provision of equipment and construction sets to help generate basic technical skills and participation by a large number of LDC technicians in production, including work with multinational corporations.

(4) S&T in the Developed Areas

Scientists in industrialized countries should be encouraged and rewarded for work on problems related to the needs of the LDCs and

there should be improved opportunities for communication between them and their counterparts in the LDCs both for the advancement of knowledge and the development of technology relevant in the LDCs. Those who are already active in S&T for development could encourage colleagues toward greater involvement in development issues. In terms of immediate practical action, it might be useful for university and technical college teachers from developed countries to spend a year working on projects in a developing country.

(5) International Nongovernmental Organizations (NGOs)

NGOs should be encouraged to make positive efforts to include scientists and technologists from the LDCs among their membership and to give them professional support in building up the capabilities of their countries. Members in developed countries should be encouraged to tackle some of the problems of the LDCs and to work with colleagues in other disciplines on interdisciplinary approaches as necessary. The development of a reward and award system (including the question of a career pattern in S&T), specifically to attract talented LDC scientists to become involved in LDC problems, and to stimulate the concern of the world community with tropical problems, should be investigated. ICSU and its associates, in consultation with other national and international groups, should be charged with preparing a practical scheme of implementation.

(6) Relations with the United Nations

The Symposium supported the call for an improved working relationship between international nongovernmental S&T organizations and related UN agencies through more effective consultation and invited the agencies to improve their linkages with nongovernmental organizations. The Symposium commended in particular the work of the United Nations University.

(7) National Funding Agencies

An urgent appeal was directed to the nations of the world to establish autonomous or semi-autonomous funding agencies for the specific purpose of supporting S&T in the less developed countries. The examples of such agencies in countries such as Canada, Germany, Netherlands and Sweden were particularly noted. The possibilities of a coordinated network of donor agencies to exchange ideas and experiences in such a way as to preserve their individual strengths and promote their common interest and, when appropriate, to share funding of particularly promising programs, should be explored.

(8) Continuing Program

The Symposium recommended the establishment of a suitable mechanism to keep alive the momentum generated by the discussions

and to ensure that follow-up action is taken on these recommendations and those that will arise from the UN Conference. It will be the responsibility of the Liaison Group to examine these suggestions and to discuss the framework for action that has been proposed.

S&T CONTRIBUTIONS

Although it was not the sole purpose of the Symposium to discuss science and technology as such, there was opportunity to consider potential contributions in some areas. In general, the sentiments and opinions expressed at the Symposium reflected the deep anxiety of the S&T community for the future of the world in view of increasing population competing for survival on finite resources, the associated problems of food, nutrition and employment, the environmental consequences of man's activities and the ever-present threat of international conflict. Based on the Symposium agenda, the following specific areas of concern are highlighted:

Education and Training

Advances being made in science and technology can play an important role in more effective education and training programs particularly in the communications areas. To sustain long-range development, a strong education and training base is essential with technician training perhaps the key element.

S&T Policies and Institutions

International attention to the development of general guidelines and principles for formulating S&T policies was suggested perhaps as part of an international program of collaborative research in S&T policies for development. Linkage of S&T policies with other national policies was viewed as critical.

S&T Information/Communication

Knowledge transfer through effective communication of S&T information can speed development but user education and the use of well-trained intermediaries is necessary to locate, extract and apply pertinent data. The frequent attitude of indifference toward information should be changed and incentives to use S&T information should be created or the already rapid acceleration of STI systems sophistication will widen the gap between developed and developing areas even further.

Research and Development

The international S&T community can assist the national R&D systems in defining problems and emphasizing those that are Third-World-specific, helping to design the methodologies of problem solving, identifying new research developments, and providing support to local institutions in their relations with other authorities.

Food/Population/Employment

Through increased research, investment and productivity the earth's food production level can be increased manyfold although it should be noted that the shortage of competent manpower is a greater impediment to scientific and technological development than inadequate funds for applied research and development. In agricultural research, more attention should be given to post-harvest systems, to socio-economic conditions and to systems research. The creation of non-agricultural jobs is critical to reduce unemployment particularly through the development of rural-based agro-industries with emphasis on manpower training.

Bio-resource Potential

A transdisciplinary, systems-oriented, ecological approach in the bioresource area might be particularly beneficial to developing countries since most of them have access to four under-utilized resources: solar energy for photosynthesis, high temperatures for accelerated bioconversion, large amounts of agricultural residues, and a wide range of micro-organisms awaiting domestication.

Role of Scientists and Technologists

Natural Sciences - The creation and support of national research councils was recommended as a mechanism for harnessing the talents of the national scientific community, whether in oriented or non-oriented research, to facilitate the development of an intellectual scientific manpower resource.

Social Sciences - The social sciences component of development planning and implementation efforts was felt to have been of uneven quality in the past necessitating an upgrading in terms of educating future social science contributions to development strategy.

Technology/Engineering - Emphasis was placed on improving the training of engineers through development courses and training links with multi-national corporations both of which might lead to the creation of a small international cadre of advisers capable of assisting governments and others on technology and development.

Transdisciplinary - As many development problems are transdisciplinary in character, there should be specific attention directed to a motivation and incentive scheme for workers in these research areas.

CONCLUDING REMARKS

The foregoing summary is not to suggest that there was complete unanimity of opinion on all issues under discussion at the Singapore Symposium. A variety of approaches was recommended during the deliberations, but there was a clear sentiment to spearhead a drive for increased involvement and action by colleagues in the S&T communities in a variety of development-oriented programs. There is no question that the S&T community is ready to add its resources to the common quest for a better future.

April 1979

PART II

DEVELOPMENT OF AN INDIGENOUS CAPACITY FOR SCIENCE AND TECHNOLOGY

By

B. Awe and A. King

It is increasingly recognized that all countries endeavouring to achieve development through industrialization, improvement of agricultural practices and modernization of other sectors such as transport and communications, can only do so with sureness if they possess a national competence for science and technology. Indeed, without this, imported technology may be ill-chosen for the attainment of economic and social goals, may be assimilated only with difficulty, is unlikely to be efficient and to evolve, so that the country in question will continue to be dependent for its continued development on foreign countries and enterprises indefinitely.

The existence of an indigenous capacity for science and technology provides many benefits. Amongst the most important of these are the following:

(a) it provides to the country an awareness of the state of science and technology throughout the world which enables selection to be made of processes, products and arrangements which are particularly relevant to the natural needs and circumstances;

(b) it enables imported technology to be modified to use the local raw materials and skills of the country and to provide products which meet its needs;

(c) it provides a base of knowledge, skill and experience which should make possible indigenous technological innovation in the future;

(d) it enriches the culture and the educational system.

It is not easy to generate such a capacity and the process is necessarily lengthy. It is not just a matter of expanding the research capacity of the universities, or of establishing institutes for industrial research and agriculture. Such action is, of course, necessary but is by itself insufficient. For the results of the research to be applied and for the skill and experience of the scientist to be of real use in direct relation to national well-being,

the scientific and technological activities have to arise in close articulation with the educational system on the one hand and the productive system on the other. This means that mutual confidence has to be established between the scientists, the decision-makers and industry, so that the natural objectives are explicit, and the scientists concerned with national needs and industry are open to technological improvements. The prerequisite for the achievement of a natural competence is this understanding on the part of the decision-makers and a political will to exploit the potentialities and nature of technological innovation.

In the creation of a national competence for science and technology, it will be found necessary to establish a Council for Scientific and Technological Policy. This should include economists and sociologists, natural scientists, engineers and representatives of government at policy-making level, especially those associated with national planning. Its work, considerations and findings should be presented regularly to the general public; science policy should not be left to an elite, but wide participation should be encouraged so as to share the general aspirations of the people at large.

The functions of a Science Policy Council will vary from country to country in relation to the possession or lack of raw materials and energy, the stage of development and the political and administrative structures. For example, in most cases the role will be essentially advisory; in others some executive responsibility might be involved. Many functions will, however, be common in most cases. Amongst these are:

(a) To acquire detailed knowledge of the total national effort in scientific research and technological development; to supervise this; to suggest priorities and to bring the national development needs to the attention of the scientists; to suggest conditions for research creativity; to advise on institutional structures and on the allocation of resources to research;

(b) to act as a contact point with international science and to scan the new scientific discoveries of the world so as to identify the most significant items relevant to the national needs;

(c) to analyze particular national problems and to identify where and how science and technology might contribute to their solution either through the application of existing knowledge or by new research;

(d) to participate in the national planning process and, in particular to advise on new industrial projects and imported technologies.

(e) to assist in preparations for particular innovation in relation to the methods to be used and to foresee cultural and social consequences;

(f) in general to maintain contact with policy-makers, to have the right to make suggestions and the duty to provide advice on request; to do this effectively necessitates attachment to the machinery of government at a high level;

(g) to examine the scientific and technological manpower needs of future plans and to communicate these to the educational and training authorities;

(h) to encourage schemes for the upgrading of technical skills, and, in particular to promote schemes for the training of technicians and of technical managers;

(i) to insure effective services for the provision of scientific, technical, managerial and other relevant information. These should operate on a highly selective basis so as to communicate highly specific information from the world literature;

(j) to promote extension or field services in industrial and agricultural technology;

(k) to improve techniques and tools in the traditional sectors by the application of well-known scientific principles, and to make available information on technological advances to all relevant parts of the population.

A much higher proportion of research in the developing countries is of a fundamental character than in industrialized nations. This is not surprising in view of the somewhat weak development of the industrial sector. While far from discouraging fundamental research, so necessary for the general scientific awareness and cultural needs of a country, it was hoped that more could be done to interest scientists in the national problems and encourage them to orientate their work accordingly.

The importance of creating an awareness among policymakers and planners of the significance of science and technology in the development process was also discussed at length. The possibility of including programmes for this purpose into existing training schemes or setting up short courses in local institutions was considered desirable.

Since effective technological development depends for its implementation largely on the availability of technicians, the meeting particularly stressed the importance to developing countries of producing sufficient numbers of skilled technicians, and of instituting training courses, preferably in the countries themselves or on a regional basis. Short training and refresher courses were advocated, particularly those with a multiplier effect: the training of trainers was one instance for appropriate help from overseas. In order to maintain a stable supply of teachers, the need for developing countries to make their conditions of service attractive was emphasized.

The concern of the international scientific community as manifested by the ISSTD should be sustained and arrangements made for continued cooperation. In addition to the training of scientists and technologists from developing countries in industrialized countries, there is an urgent need for the provision of facilities and resources for scientific and technological research in the developing countries by the international scientific and techological community. Help from foreign scientists would also be welcome in technician training, through cooperative research projects and in the provision of advice for the development of science policy based on experience elsewhere. The concept of a new dynamic interplay between the NGOs, the U.N. agencies and the developing countries would be warmly welcomed.

EDUCATION AND TRAINING

By

S. Ramakrishna and F. Staicu

The group on education and training was strongly convinced that education and training, with special reference to learning, play a vital role in the process of applying science and technology to development and in particular, for the development of an indigenous S&T capability in the developing countries. The absence of the necessary educational base in a country is a major hurdle hindering the most effective use of modern science and technology for development.

In the area of education, the group identified the following as urgent and priority needs:

(a) literacy programmes;
(b) adult education programmes;
(c) training of teachers;
(d) training of technicians;
(e) education of women.

Among several urgent needs, these five stand out prominently; they need to be tackled immediately. While the percentage of illiterates has shrunk, the actual number of illiterates has indeed increased to nearly a billion; a quarter of the world's population. Considering the fact that the conditions in different countries are likely to vary widely, the relative priorities amongst these five need to be determined individually in each case.

Learning is a characteristic phenomenon in the human universe of the development of the individual and societies. We can discover the learning process behind all essential activities, macro- and micro-economic management, decision making, organization, scientific research and discovery, human, social and international relations and the ability to solve problems. All national and international efforts seeking to achieve economic and social goals have shown that once the material factors (investments, resources and technology) have been assured, the decisive role is played by the degree of training of the population. The result thus depends heavily on the learning process.

Learning is primarily a reduction of uncertainty, of averting costly and traumatic experiences, of anticipating them and of reducing

their impact. The most important of the concepts and methods of learning are the following:

(a) permanent education;
(b) inter-disciplinary learning;
(c) technology of learning, including audio visual aids and computerized instruction;
(d) open education; and
(e) inclusion of work and research into education.

The importance of training technicians in order to provide the necessary base on which to build the development structure in a country has to be recognized adequately. It is unfortunate that even when technicians are trained, there are losses because either they do not remain technicians, leaving to take up 'white collar' and 'better paying' jobs, or their training is inadequate to help them carry out their tasks effectively. In many countries, technicians are looked down upon as second-class citizens and are not given an appropriate place in society. This has to be remedied by ensuring that education is vocationalized from the very beginning and a respect for skills and working with the hands is inculcated in the mind at a sufficiently early age. In addition, the technicians should be better paid and their role and status adequately appreciated and accepted, if necessary by conscious governmental action. International cooperation in designing and implementing such training programmes in the developing countries would be a significant step.

New developments should be introduced for imparting education and training. The availability of mass media for taking education to the large masses, particularly radio and T.V., can be profitably exploited. These techniques can also be fruitfully employed in the preparation and large scale use of teaching aids, in the form of slides and demonstration experiments.

The group considered at length the methodology that should be adopted to ensure that every person is aware of the role science and technology can play in development. While several alternative strategies were considered, the most feasible and appropriate one appears to be to see that a development perspective is interwoven into education at all levels. This would make it possible for students to absorb more readily the situation in their own country and at the same time make them more receptive to the possibilities of using S&T for development. It sometimes may not be practical to reorient a man's thinking after his education is complete. In the case of people, who have already completed their education process and are occupying positions of importance (either managerial and/or governmental), courses on S&T for development may be desirable.

It would greatly benefit the developing countries if funding agencies could be pursuaded to provide on a larger scale aid for educational programmes in developing countries on liberal terms. A recognition of this need and its priority is of considerable importance.

The group was very appreciative of the type of activity that has been initiated by the International Foundation for Science and other similar agencies. The concept of encouraging research in developing countries, by providing the necessary financial support for augmenting the facilities in the local institute has many attractive features. This appears to be an excellent method for spreading the benefits of such international cooperation and aid on a broad base. The group strongly recommends strengthening of such programmes.

While considering the desirability of providing requisite facilities for interaction between scientists from the developing and industrialized countries, it was felt that the most effective way of utilizing the funds that may be available would be to strengthen and support the formation of regional centres of advanced education and research. Such centres could act as focal points where intellectual satisfaction can be forthcoming from interaction amongst scientists from countries in the region in a suitably equipped centre. It would also be most effective to invite experts from the industrialized countries to work in such centres to help build up and sustain the efforts there instead of a large number of people from the developing countries travelling to developed countries for advanced work.

Recommendations

The group recommends that:

(a) regional centres for advanced education and training be funded and set up in the developing countries;
(b) development perspective be incorporated in the educational programmes at all levels;
(c) modern methods, including radio and T.V., should be used more effectively to make education more wide-spread;
(d) programmes of research support like those of IFS should be enlarged in scope and magnitude considerably; and
(e) serious attention should be paid to the training of technicians in the developing countries.

SCIENCE AND TECHNOLOGY POLICIES AND INSTITUTIONS

By

F.R. Sagasti, Kim Hyung-Ki, and A.A. Sabet

It is widely recognized that there exists in most developing countries an increasing need for formulating a set of explicit science and technology policies, which are designed to affect functions and activities related to production, diffusion, transfer and utilization of scientific and technological knowledge in a coherent and complimentary way. This is considered particularly important in those countries which suffer from either a scarcity of resources for scientific and technological development or obstacles to their mobilization.

Even in the case of countries where such policies have been formulated and implemented the experiences have not been uniformly satisfactory. One of the reasons may have to do with the narrow coverage, often considering S&T policies as if they are almost synonymous with R&D policies. In the case of developing countries, the need for broader coverage than that of more R&D is absolutely essential.

Another reason concerns the context within which S&T policies have been formulated. It is clear that such policies should be formulated within a broad context of national socio-economic development strategies if they are to be at all effective.

This discussion led to the problem of linkages, particularly those between policies and priorities of science and technology and of socio-economics, and those of national and international efforts to name a few. The question of linkage is, in a sense, a matter of relevance in a broader context.

The formulation of national S&T policies is necessarily a political process, involving the understanding and/or commitment of the public, in general, and the scientists and technologists and the users of science and technology, in particular, and the support of political leadership.

The reflection of the users' points of view as they relate to productive sectors is particularly essential in the framing of S&T policies. The need for creating an informed public vis-a-vis S&T policies cannot be overemphasized, for the people can act as an influential agent in communicating their wishes based on 'felt needs'

to be reflected in policy formulation through external review of S&T policies by select groups, or through public debates. Through these processes the relevance of S&T policies might be enhanced as it can obviate problems associated with so-called "scientific and technological illiteracy" which is common-place even in advanced societies.

With regard to formulation and implementation of S&T policies, it was emphasized that explicit S&T policies alone are not sufficient unless they are well linked with an array of implicit policies, namely economic and social policies in general. While the integration of S&T policies with those of socio-economic development is desirable, the approaches for developing S&T capacity in a country should be selective. To cover everything across the spectrum once and for all is impossible, and impractical in view of the limited resources available. Building up infrastructures for S&T, however, necessary they may be in all fields must be carried out selectively on a priority basis.

To ensure effective and efficient implementation of S&T policies it was emphasized that the following tasks should receive priority, as the major targets for attention and action:

(a) establishment of institutional structures, delineating their domain of activities within the total S&T systems, and ways and means to maintain them relevant, viable, and innovative;

(b) creation and management of demand for S&T through active participation of scientists and technologists in the formulation of policies for broader socio-economic development, which in itself, is an integration process;

(c) coordination of policies and activities at all levels, particularly among agencies and institutes both at national and international level either to bridge the gaps or to avoid excessive duplication of efforts;

(d) devising appropriate policy instruments that can help to realize the attainment of the S&T policy objectives within a broader contact in which they operate;

(e) mobilization of scientific and technological community for critical but often global problems such as energy, food, population, environment, and health, for which the scope for concerted international collaboration is large, and

(f) incorporation of basic human needs in S&T policies.

As an item for international action, the need for some general guidelines and principles for formulating S&T policies was recognized. Such guidelines may not have universal applicability and yet may contain sufficiently important set of common elements that could be utilized with some modification to suit peculiar and particular circumstances. The Group recognized a general need for supplementing resources of many developing countries through international auspices for the attainment of S&T policies, but not for substituting internal values by foreign external values.

International Cooperation on Science and Technology Policies for Development

While no attempt was made during discussions to survey the field in detail, participants in the Group felt it was necessary to take into account as a departure point for future international collaborative efforts in S&T policy, the experiences of various international organizations, professional associations, and scientific unions that have been active in this regard. Among the inititiatives that should be considered for possible action, the Group highlighted the following:

1. The various scientific union members of ICSU and other professional associations should encourage their members to take active part in studies and action programmes related to science and technology for development in general, and science and technology policies for development in particular. Initiatives, such as that being considered by the International Council for Science Policy Studies to hold summer schools on S&T policy for development, should be encouraged in order to sensitize members of the scientific community, interchange experiences, and increase the more active participation of scientists in S&T policy debates.

2. An international programme of collaborative research in S&T policies for development should be designed and proposed. National, regional and international organizations should be involved in it through research networks, and a variety of possible funding mechanisms of bilateral, multilateral and of consultative group type should be explored. Of particular interest is the comparative study of national S&T policies for development, with the aim of deriving lessons and general principles that may be of wide applicability in developing countries.

3. Recognition and encouragement should be given to research and studies in science and technology for development, primarily from the point of view of career patterns, with reward systems that may include, among other mechanisms, prizes for groups and individuals who carry out outstanding work in this field. In this regard it is important to encourage and bring together young scientists from developing countries who are committed to development, and who in some cases have chosen to remain outside the career patterns of the formal S&T establishment.

4. It is necessary to recognize that there have been distortions introduced in the developing countries with regard to studies on science and technology for development, primarily through the form in which the S&T community in developing countries have linked to international financial support and to prevalent currents of thought in industrialized countries and international organizations. In the field of S&T policies for development, this fact underscores the importance of relating research programmes to the local conditions of less developed countries, the importance of cooperation among developing countries, and the need for assistance from bilateral and multilateral agencies for research programmes of this type.

5. There are also many actions that can be taken with respect to the United Nations system. Among them, the following were highlighted during the Group discussions:

   (a) Encouraging the participation of scientists in U.N. Agencies' meetings, in order to bring forcefully the perspective of S&T for development. In this regard the activities of the Committee on Science and Technology for Development (COSTED) of ICSU, and ICSU's role as an advisory body to Unesco, should be given preferential attention.

   (b) Coordinating the activity of various agencies dealing with science and technology for development, and with S&T policy in particular. A suggestion was made regarding a centre where people in the United Nations system can study and reflect on this subject for a limited period before returning to their agencies.

   (c) The United Nations University should encourage and strengthen studies on science and technology for development, and on S&T policies for development.

(d) A mechanism of United Nations fellowships should be explored and established to foster studies and research on S&T for development.

SCIENTIFIC AND TECHNOLOGICAL INFORMATION AND COMMUNICATION

By

C. Keren and M. Katzen

Scientific and technological information (STI) as well as communication systems and media are terms whose definition frequently varies with the context within which they are discussed.

Definitions and Rationale

The following rationale was adopted:

Information is knowledge in a form in which it can be transferred Information is any message which is useful to its recipient. Without adequate and up-to-date information there can be no development.

For information to be transferred it must be communicated, by voice, by print, by pictures, by electronic transmission. Information and the channels through which its messages are communicated are a basic ingredient of any activity.

Information is needed by any society, industrialized or developing and in all its strata: the S&T community, students, workers, managers, farmers, etc. Information use is a function of need. The more demanding the need, the more intensive the use of information, and the greater the dependence on the communication channels which make it available.

The communication of information assists any activity (including decision-making) where current and accumulated knowledge must be brought to bear. It is a service function. The information/communication activity thus mirrors the activities it is designed to serve and must be responsive to the needs of the environment in which it is installed. This environment is (partly) conditioned by such elements as users' motivation, vehicles of information transfer, time scales, ratios of different types of information, sophistication of technology and concepts of cost-benefit and cost-effectiveness.

It is therefore obvious that in spite of the all-pervasive nature of S&T information and communication, their performance is largely dominated by the socio-economic environment with which they interface. The given educational level, the indigenous and imported technology, the scale and performance of the R&D establishment, the

degree of sophistication and effectiveness of the bureaucracy, the apportioning of capital and other resources, all influence and model the information user. In the nation-system, interrelationships are based on the interchange of knowledge, manpower, goods and services, which political and cultural systems being cast into a regulatory role.

Existing Mechanisms for STI Handling

Several international mechanisms exist for mobilizing S&T to contribute to accelerated human and economic progress in developing countries by making STI and supporting communication channels available to them.

The S&T community has its own, well-tried and long established mechanisms to disseminate the knowledge it produces: primary, secondary and tertiary publications; invisible colleges; meetings and personnel mobility; libraries, information centres, data analysis centres; formal and informal networking arrangements, etc. The trained manpower, and the material and technological resources necessary to operate, maintain and develop the vast knowledge industry, have been built up at a rate concomitant to the activities and environment they are designed to serve. Most of the products of this industry are freely available internationally, barring constraints put by finance, available technology, know-how and motivation for use.

Similar mechanisms have been established by other information producers and vendors. Information produced by the mass-media (press, radio, TV, films, etc.), information by and for the business community, information pertaining to regulatory activities (standards, patents, customs rates, etc.) can all be had, a veritable "embarrasse de richesse", provided the user knows which questions to ask, has established modes of access, selects judiciously and has resources with which to purchase information.

The larger international organizations frequently maintain extensive information-gathering, repackaging and disseminating activities. The U.N. family alone reported recently on about 100 data banks of various types which it maintains and puts, at least partly, at the disposal of Member States. The Scientific Unions, OECD, the Socialist States and many others produce copious quantitites of information which are widely circulated.

Computers, communication systems and advances in reprography/ printing processes have revolutionized long-established methods of information handling. Vast stores of knowledge are opened up and made available to users via complex man-machine systems and networks.

Due to lack of an adequate indigenous supporting infrastructure, high cost and different scales of priorities, many developing countries are unable to take advantage of the available information and are sliding behind in their capability to use existing knowledge to assist in the solution of their problems.

Various international programmes and organizations such as UNISIST, FID, ICSU/AB, UNIDO, to mention just a few, have made it their principal goal to ensure equal information access to all, industrialized as well as developing societies. If and when they fail, it is because the recipients; scientific, technological and educational infrastructure; political, socio-economic and administrative constraints; the common information user; and the national aims and goals are not conducive to the utilization of modern information systems.

Recommendations

(a) It was stressed that the concepts mentioned above apply to the communication processes used by scientists and technologists in all disciplines. The communication of STI should be directed to any potential user, the researchers, the administrator, the manager, the engineer, the peasant, etc. To be effective, the communication of STI to different users will and should involve the transformation, and, where necessary, the reformatting of the information, by information specialists (journal editors, information officers, agricultural extension workers, mass media personnel) so that it becomes tailored to the needs and capabilities of the user concerned.

(b) It was agreed that even in industrialized countries only a limited number of users know how to utilize the STI system optimally; in developing countries this problem is very much magnified, and a significant amount of user education is necessary. It was emphasized that the lack of those able to obtain and apply information is a very important factor that hinders an effective transfer of technology, and that priority should be given to training.

(c) In order for information to be useful need and incentive have to be established. In many developing countries the need is there but no strong incentive exists to make it surface. Therefore many potential users do without STI and frequently are not even aware that it exists. It was emphasized that well trained intermediaries are needed in order to identify sources of information, to assist the user in selecting STI which is relevant to his needs and to provide the information in a usable form. The need for these intermediaries to be fully qualified

professionals is not universally appreciated. Their presence and competence (or lack of it) is crucial to a successful knowledge transfer. The role of the S&T communicator and STI mediator in the industrialized countries is filled by a great variety of specialists, each recognized and acknowledged in his profession (editors, publishers, librarians, computer specialists, information scientists, and others). By enhancing the level of equivalent professionals in the developing countries the quality of their work would certainly be enhanced.

(d) Amongst the various barriers and constraints those resulting from provisions of secrecy, proprietary information, financial restraints etc. need urgent attention.

(e) In many LDCs the attitude of indifference to STI results in a less than adequate knowledge transfer causing unnecessary duplication of effort, waste of rare resources and non-utilization of opportunities. With the rapid acceleration in the sophistication of STI systems, the gap between industrialized and developing countries is widening constantly. In industrialized countries the knowledge industries are fast becoming dominant sectors of the socio-economic structure and the use of the product of this sector is nowadays an essential, and still growing component of everyday life. Increased participation by developing countries in the STI activity should be accorded high priority status.

Specific Activities Proposed

(a) A clearing-house and/or data bank of information on programmes and problems on the application of S&T to development should be created. The facility should be able to provide information on past and ongoing development-related projects, institution, personnel, problem-configurations, funding activities, and include within its scope national and international organizations, and possibly also, findings and evaluations of past activities.

(b) The Unesco-inspired convention on the free exchange of printed material should be extended to include machine-readable and similar non-print information carriers.

(c) It is urgent that steps be taken to enable developing countries to participate in modern computer and telecommunications related STI systems. UNCSTD should be

alerted to the importance of this activity, because otherwise even the present low use will not be maintained in the foreseeable future.

(d) The feasibility of establishing a science newspaper to disseminate significant development-related STI to developing countries should be investigated. It is considered that such a newspaper aimed at a broad target audience, and published in several languages would significantly increase awareness of the uses to which science and technology could be put, demonstrate the need and application of R&D, and in general enhance social awareness of its importance in solving the problems confronting developing countries.

(e) A marketing mechanism for STI exchange. STI is a commodity of national as well as international importance and value. For other commodities, which are as freely negotiable, such as money, raw materials and others, various marketing mechanisms exist to facilitate and ease commodity exchange and flow. The creation of an appropriate exchange mechanism for STI, principally designed to facilitate STI flow to developing countries and promote their participation in the international STI system, is proposed.

The rules and procedures to operate such a "commodity market" for STI would need to be worked out. Should the "market" deal with the product itself or only with surrogates (such as value equivalents); how should inputs be obtained and from whom and how should outputs be allocated; should the "market" management be an operational or only bookkeeping organization? These and a host of other questions have to be resolved before the scheme becomes operational. It is, however, considered that conditions are ripe to establish an appropriate mechanism; even more so, it may be the most immediate solution to overcome some of the significant barriers, which increasingly impede STI flow to and from the developing countries.

RESEARCH AND DEVELOPMENT INCLUDING MANAGEMENT AND LINKAGES WITH EDUCATION, GOVERNMENT AND PRODUCTION SYSTEMS

By

J. Ayala and H. Charles

The development process is a very complex one involving political, social, cultural and economic variables and scientific and technological inputs of which research and development is only one. To date, the pattern of research and development in the Third World has largely been one of supporting the transfer of know-how from the industrialized countries. It has been realized that this development pattern has, in fact, perpetuated the dependence of the Third World on the industrialized countries and widened rather than narrowed the technological gap. The fact remains however that in the area of R&D 95 per cent of the world's expenditures are devoted to work in the more developed parts of the world.

R&D in the development process cannot be treated in isolation. It must be linked backward to the education process, which provides the human resources for its development and the assimilative infrastructure for its results. R&D must also be linked forward to the productive system which must be oriented to the reception of locally-generated R&D. Even more important, the indigenous R&D system must obtain the confidence, respect and goodwill of those in authority. The international S&T community possesses the possibility of assisting the national R&D system in all aspects of its role in the development process: in defining the problems, helping to design the methodologies of problem solving, bringing attention to new developments and providing support to local institutions in their attempts to attract the attention and support of the authorities.

The general points of discussion were:

(a) The organization of R&D at different levels, for example, the national, sub-regional, regional and international levels. Emphasis was given to the national level but also to the linkages of activities between programmes at different levels.

(b) The involvement of different institutions in R&D activities at the national level in industrialized countries, the universities, the government institutions, the production sector and finally the role of the government in general support of the R&D activities.

(c) The role and characertistics of industrial research institutes in developing countries, especially in comparison with other sectorial research institutions. Mechanisms should be generated which would make R&D related to local problems more attractive to scientists: (i) by establishing clear objectives which could be seen to be socially desirable; and (ii) in the generation of a peer group approval system which would reward scientists who dedicated themselves to such work.

(d) The problem of management of R&D and of R&D institutions. In this respect, the training of managers is seen as the key factor in promoting the orientation of R&D to local problems and increasing the professional merit of this work. The role of the international scientific and technological community was seen as strengthening the impetus in this direction by suggesting methodologies to be used and/or by collaboration with the national institutions to obtain the support of those in authority. Also by assistance in generating the critical mass which is sometimes needed to launch a programme.

Existing channels of international cooperation could be enhanced by the identification of areas for R&D which may have common aspects either regionally or inter-regionally for developing countries. The possibility was put forward that the NGO S&T community consider the establishment of a mechanism to further this aim. In addition, it was noted that among industrialized countries a questioning of the pattern of industrial development and its effect on the quality of life has begun. As a result, it may be an appropriate time to take new initiatives to try and direct more of the world's scientific and technological capacity to the consideration of problems which may be considered "Third World specific", or which may have mutually-beneficial results for both developing and industrialized countries in the light of these recent considerations. In this regard, the Group felt that recommendations could be made for the international recognition of R&D on problems specific to the Third World. R&D related to the problems of the developing world could be equally respected internationally since "appropriate technology" solutions can involve intellectual inputs and conceptualization at the highest level. International scientific recognition of the value of this work could be initiated by the community represented at the Symposium and by so doing would promote the greater attention of the world's scientific community to Third-World-specific problems, thereby increasing the percentage of that capacity which is now devoted to the subject.

In the context of the role of women, the Group felt that the area of R&D lends itself particularly well to an increased role for women in the promotion of international development. As this field of activity is already accepted, as an area of operation for women, even in male-dominated society, the promotion of national and international acceptance of Third World specific R&D would provide an additional avenue for focusing attention on the contribution of women.

Recommendations

(a) The NGOs sponsoring the ISSTD should establish a small secretariat which would:

   (i) Promote and strengthen the spirit of cooperation which has made the Symposium possible in the first place;

   (ii) Locate sources of and obtain funds for carrying out the succeeding recommendations.

(b) Existing channels of cooperation between R&D institutions should be enhanced by identifying and promoting cooperation in R&D areas of common interest both amongst developing countries and between developing and industrialized countries. The areas of mutually beneficial cooperation between developing and industrialized countries have been widened by the latter begining to question the effect of traditional pattern of industrial development on the quality of life.

(c) The acceptance of R&D on Third World specific problems as work of high social and intellectual significance should be promoted at both the national and international levels. To this end it is suggested that Departments of Resource Development essentially devoted to Third World specific problems be established at Universities both in the developing and industrialized countries. These departments would be multi-disciplinary and would utilize a teaching staff that was largely itinerant and inter-active. The "twinning" of these departments internationally is also suggested.

(d) The training of R&D managers is a key factor in providing the necessary orientation for the implementation of the above recommendation.

(e) The field of R&D is particularly well suited to focusing world attention on the contributions women can make to the development of human society.

FOOD and POPULATION

By

J. H. Hulse and R. de Zeeuw

It was recognized that the balance between population growth and food supply varies widely among regions, nations and communities within nations; the factors by which food and population are influences are exceedingly complex and within the time allocated only a small proportion of the many relevant factors, determinants and influences could be considered.

The meeting concentrated upon broad issues of wide applicability, though certain special cases deserving specific attention were brought forward.

The questions asked were:

(1) What actions can the NGOs take or recommend: (a) individually or collectively independently of existing multilateral or bilateral assistance agencies? or (b) in cooperation or affiliation with one or more existing agencies?

(2) Is there a need for new institutional mechanisms to encourage and enable a larger and more coordinated contribution from the World's Scientific and Technological Community?

The existence was recognized of such effective existing organizations as the Consultative Group on International Agricultural Research (CGIAR) and the International Committee for Contraceptive Research of the Population Council and their structure, mode of finance and programmes of research were reviewed. The value of this form of organized concentration of applied research effort was commended and the opportunities they offer for cooperation with other research institutions, including universities in both developed and less developed countries, was recognized. The intention of the CGIAR to provide a new mechanism by which to strengthen national agricultural research facilities in developing countries was welcomed.

It was specifically noted that no comparable organization exists for the development of agro-based industries in developing countries though it was considered that the Industry Cooperative Programme, formerly administered by FAO and now operated as an independent NGO,

provides a potential souce of advice and assistance for industrial development and investment in developing countries.

Particular reference was made to the need for a greater sharing of technological knowledge and experience by food and agricultural industries in developed countries with infant industries in LDCs.

It was the consensus that a shortage of trained man- and woman-power represents a more serious constraint to scientific and technological development than a shortage of financial resources. It was therefore considered more urgent and more important to increase the number and competence of managers of research and technology than to establish a new consortium of donors. The classical patterns of university training for degrees in Science do not provide the capacity to manage, to determine priorities and select among alternative technologies and courses of scientific action, or to translate research findings into socially acceptable, economically productive technologies.

It was emphasized that all applied research, whether in agriculture food or industrial sciences must start with a thorough understanding of the opportunities and constraints, and the economic and social environment of those who are to use and benefit from the applied research. The rice breeder must fully comprehend the rice farmer; the food technologist must work closely with the food processor and all must understand the needs and resources of the intended consumer.

It was the prevalent view that too little attention is given to the needs and attitudes of consumers and particularly to reducing the drudgery that is imposed on the majority of rural women in developing countries. Examples were given of simple milling technologies and the establishment of village wood lots that eliminate the necessity for rural women to spend most of their working lives in grinding grain and searching for firewood. It was stressed that the needs of the smallholder, whose resources for capital investment are very limited, should be taken into consideration in all agricultural research programmes.

It was also heavily emphasized that efficient agriculture is the basis of almost all successful and progressive economic development: all nations should therefore assign a high priority and give dignified recognition to the importance of the farmer, the food processor and to scientists and technologists who work to improve agricultural production, food distribution and nutritional well-being.

In agricultural research more attention needs to be given: (a) to the post-harvest system; (b) to socio-economic considerations; (c) to systems research that can indicate those production and production-processing-marketing alternatives that are likely to provide greatest and most stable returns at lowest risk.

It was pointed out that not only cereals, roots and legumes should be considered in post-harvest research, but that fruits, vegetables and fish also deserve greater attention by scientists and technologists.

The specific problems of island and isolated communities deserve special research attention with particular concern for multiple cropping systems, improved land and water utilization. Throughout the developing world studies of farm water management deserve much higher priority among research workers.

It was considered that population to arable land ratios should be of greater significance to planners than percentage rates of natural population increase.

Though the continuation of research into new methods of family planning is encouraged, for both males and females, social and ethical factors cannot be ignored and in the long run significant decreases in population growth will have to be preceded by improvements in economic and social well-being.

It was suggested that a small secretariat either at ICSU or some other suitable location could serve to encourage a greater and more coordinated contribution from the world's scientific community.

In general there was optimism that the earth's food productivity could be increased manyfold - but to achieve the full potential will require continued research, higher investment and increased productivity by smallholder farmers, processors and distributors.

To realize this greater potential productivity, new technologies including some degree of mechanization appears essential and therefore research into small farm mechanization is a continuing necessity.

Some statements implied an inadequate degree of cooperation among donors. Several examples of productive cooperation among donors were cited. It was emphasized that in all these cases, the cooperation was preceded by a clear definition of objectives and a programme of action.

It is recommended that more facilities be created for scientists of different developing countries to meet regularly to define programmes of applied research which can be supported by consortia of donors.

It was also the belief that the shortage of competent manpower is a greater constraint to scientific and technological development than inadequate funds for applied research and development.

The International Scientific Unions and learned societies represent an immense untapped resource of scientific competence: it is recommended therefore, that a mechanism, possibly a small secretariat at ICSU, be established by which to channel the scientific manpower resources of the International Unions to programmes of research and development where they are needed.

POPULATION AND EMPLOYMENT

By

R. Revelle

In order to diminish rural poverty new non-farming jobs must be created. One critically important way to do this is to develop small industries in market towns and small centres scattered throughout the countryside. Wherever possible, these industries should be based on indigenous materials, including agricultural products, and should be designed to meet rural needs, including mechanization and the preparation of products necessary to increase agricultural production.

Rural industries have sprung up spontaneously in some small cities of the Indian subcontinent and these have been helped by government or private agencies. Jobs in ferro-crete construction, kraft paper manufacturing, diamond cutting and polishing, rug weaving, making of dry foods such as "papar" and production of brown sugar, are among the industries established by rural development agencies. Some have been created at an average capital cost of $500 per worker.

Preliminary surveys of human and natural resources are a necessary prerequisite for such development. Depending on the situation, mobilization of rural capital through farmer organizations and in other ways; provision of outside credit; training of workers and managers in appropriate technologies; considerable increase in rural energy supplies; and adaptation of existing technology to meet local conditions, are also necessary. Possibilities exist for new industries based on applied research which could lead to new technologies especially adapted to local conditions. Technological innovations will often be required in conventional industries in order to utilize available raw materials and production equipment.

A careful analysis of the entire national economy is needed in each country. Because of the great diversity among developing countries, different kinds of solutions will be required in different regions. Moreover, different industries must be considered on a case by case basis. In some industries, economies of scale are so great and the needs for networks of suppliers of raw materials and distributors of finished parts is so extensive that only large centralized plants in large cities will be economically viable. Other industries where economies of scale are relatively small and raw materials are locally available can be appropriately established in the market towns and small cities of rural areas. In some countries, particularly in Africa

and South America, the growth of large "primary" cities may already have precluded development in smaller towns throughout the countryside.

In these countries, rural employment may have to be provided by the use of human labour to create the capital infrastructure of roads, land and water resources for agriculture, forest and tree plantations for energy, and development of resources for aquaculture. These are examples of the use of human labour to create capital. Although some mechanical equipment and material supplies will usually be required, most operations can be accomplished by human work for they consist largely of earth moving or various sorts of manual operations. However, every endeavour should be made to avoid drudgery.

Employment should not be thought of as an end in itself, but rather as a means to attain greater equalization of incomes; to enhance human dignity based on the freedom that comes from self-reliance; and to raise average incomes through fuller use of human resources in areas of widespread unemployment or underemployment. Empirical evidence indicates that equalization of incomes acts as a powerful force towards the stabilization of the population size.

Studies of the socio-economic factors affecting human fertility show conclusively that employment and education of women can act as a powerful force to lower the numbers of children per family. Education that provides women with employable non-domestic skills appears to be of great importance in giving women a sense of independence, self confidence, and self reliance in decision-making which help them to resist the pressures for large families that characterize most traditional societies. Both employment and education help in improving communication channels for women and in bringing them into contact with modern attitudes, values, and information. Traditional "women's work" in many rural societies of the developing countries consists mainly of unalloyed drudgery - gathering wood, dung and straw for fuel and feed for livestock, collecting and carrying water, cereal milling by hand.

Recommendations

(1) Greater attention must be paid by funding and development agencies to training of personnel for small industries - perhaps largely by non-formal education on and off the job. Three kinds of manpower are needed:

(a) trained technicians who are thoroughly familar with the technology to be used;

(b) a skilled labour force;

(c) managers who can deal with problems of marketing and pricing, inventory and cost control, efficiency of energy used, worker organization and plan layout.

(2) Analytical studies should be made of economies of scale in different industries and for different technologies, as a base for rational development of labour in intensive, capital-saving large-scale urban industries and complementary smaller scale industries in country towns and small cities.

(3) Development agencies should employ a multiple approach including the following in the use of science and technology for creation of rural industries:

(a) Applied research in the natural sciences to create the basis for new industries;

(b) Adaptation of existing technology and innovation where necessary to meet local social and environmental conditions and to utilize available resources;

(c) Development of technological and managerial skills in the rural labour force;

(d) Social science studies including market and other economic analysis to guide the choice of rural industries and technology.

(4) Every effort should be made to provide paid employment opportunities for women in both urban and rural industries and to equip them with employable skills including functional literacy and further education.

FOOD and EMPLOYMENT

By

J. D. Drilon, Jr., and O. Galal

The Group concentrated on recommendations that may be related to the following:

(a) Possible international mechanisms for generating and mobilizing science and technology for development;

(b) Roles the non-governmental science and technology communities could play to provide and enhance incentives for and reduce constraints on development and application of science and technology for development, and

(c) Actions that might be recommended to UNCSTD.

The importance of food as one of the basic human needs and as a factor relevant to employment was emphasized. Labourers in the industrial and agricultural sectors in developing countries have seriously low levels of nutrient intake, and pre-school children and pregnant women are particularly vulnerable to a lack of appropriate food in the right balance.

Assuming that high population growth rates will continue to introduce large numbers into the labour force, in the developing countries, there will be an increased need to ensure that adequate employment opportunities are generated.

If this trend is accompanied by a flow of population from the rural areas to the urban areas, leaving less people in the rural areas to produce food, and concentrating large numbers in the urban areas, it will create or add to such problems as unemployment, under-employment, inadequate public services in health, education, peace and order, and environmental problems.

In this regard, there is on the one hand an apparent need to develop for the rural sector the capacity to retain as much of its population as possible, and this means the capacity to achieve and maintain reasonably high agricultural productivity and the capacity to generate viable additional, off-farm employment. High agricultural

productivity, particularly in food, should lead to more employment and higher income, but the small size of the land holdings of most farmers in developing countries will limit this. Because of this limitation there is a need for the small farmers to have additional sources of income, and for the landless to be able to obtain non-agricultural work. There is the additional need to generate employment opportunities in the urban sector to accommodate the influx of migrants. Obviously, a balance must be sought between the attractiveness of the rural areas and the urban areas.

Recommendations

(a) More attention should be given to nutrition as a consideration in the planning and educational processes. In a developing country, food planning should begin with an appreciation of the nutritional requirements of the country and the country's resource capacity to respond to these requirements. In the country's educational system, provision should be made to instill, at various levels, the importance of nutrition and the ways of meeting nutritional requirements, into all parts of the population. It would be necessary to employ a wider spectrum of disciplines and expertise in the planning and educational processes, particularly in relation to food.

(b) Technological improvements toward higher productivity and small scale techniques should be fostered and promoted. These should receive the conscious attention of scientists and technologists, particularly because large scale techniques appear to be of current interest in the developing countries. A significant part of the manpower training programmes for developing countries, conducted by government or non-government entities, should be devoted to such techniques.

(c) In creating technologies, scientists and technologists should consider employment as an objective and should consider this together with other objectives such as productivity, income, growth, and equity.

(d) In generating food production technology, the people involved, particularly farmers, should be consulted in order to ensure that the technology generated is better understood and more easily adopted. Experimentation at the farmers' level should be encouraged. Agricultural research institutions should show the way.

(e) Mechanisms should be invented, devised or improved to deepen the understanding in both the industrialized and developing countries about the technology of generating and spreading technology for development. Two examples that come to mind are: (i) information systems that can be useful at the global, regional and national levels; and (ii) national research systems capable of adapting technologies developed by the international agricultural research systems, as well as creating indigenous technology.

(f) The participation of the non-governmental organizations in assisting the total development process through science and technology, particularly in the food sector, should be promoted. The experience, expertize and flexibility of some of these organizations will enable them to make effective contributions to the total effort. Two areas in which NGOs can provide effective inputs are: (i) the organization and operation of funding agencies that can, with the flexibility usually associated with the private sector, provide assistance to science and technology programmes; and (ii) the provision of independent assessment services required for maintaining the viability of various efforts in science and technology for development.

THE BIORESOURCE POTENTIAL

By

C. G. Heden and Y. Yuthavong

A systems approach and an ecological outlook is needed in view of the diverse impact areas: food, energy and environment, and considering the potential of integrated systems (for example solar oxidation ponds for waste recycling and aquaculture, composting for mushrooms cultivation, biogas production for fuel and fertilizer, etc.), for improved health and for functionally oriented education at all levels, particularly in the rural environment. A trans-disciplinary effort is obviously essential in the bioresource area which is highly relevant to developing countries since most of them have access to four under-utilized resources: solar energy for photosynthesis, high temperatures for accelerated bioconversions, large amounts of agricultural residues and finally a wide range of micro-organisms awaiting domestication. However, scientists and engineers in the industrialized countries should also pay greater attention to the bioresource problems of the developing countries, because this would give them an experience that can be highly relevant to the development of the "equilibrium technologies" which their own countries might need when the easily available hydrocarbon sources have been exhausted. A co-operative effort of scientists and engineers from both developing and industrialized countries could have a strong synergistic effect.

The exploration and identification of bioresources require greatly increased efforts in taxonomy, and in several other disciplines of the life sciences. The wild flora is extremely rich and diverse, and only a small fraction is utilized at the present time. A systematic search would not only provide more varieties for use, but it would also make possible a more efficient utilization of the traditional varieties. Exploration of traditional practices could also be very useful, as has been shown in the case of indigenous fermentations in Asia. The tempeh fermentation of soybeans, for instance, gives rise to a nutritionally significant enrichment of vitamin B_{12} and it saves fuel by reducing considerably the cooking time. Increased efforts should also be directed towards studies of unconventional species, such as the winged bean and certain leguminous trees for food, forage, and fuel.

Conservation of gene pools must be given high priority in view of the rapid spread of mono-cultures. In this regard, the efforts of the International Biological Programme of FAO and

the World Data Bank on Micro-organisms and the World Federation of Culture Collections must be encouraged. They try to prevent loss and to ensure efficient use of significant genetic stocks of certain micro-organisms. It must be emphasized that gene pool conservation must be a dynamic and not a static effort. Its similarity to the operation of a museum or bank is limited to the need to keep the holdings in perfect order. The process of collection and storage is itself a source of variation in the genetic make-up, and the ideal culture collection should maintain and characterize the material for its properties of practical importance. These collections form one of the main sources for genetic improvement by selection and breeding. The significance of breeding efforts and applications of genetic engineering to the LDCs should not be underestimated.

Information losses through ecological stresses or "modernization" should be minimized through the study of ethoecology i.e. through investigations of the practices and behaviour of local people and animals.

Conservation of the biomass produced can be achieved by various means that deserve increased attention: pest management, post-harvest technology including transport and refrigeration as well as the prevention of losses in storage and processing, utilization of "waste" materials, etc. However, in the removal of materials from the site of production caution must be exercised so that the environment is not overexploited, resulting in depletion of trace elements or in a deterioration of the soil structure. This is especially important in areas where the essential inorganic nutrients are already at a marginal level, or where erosion is significant and the soil is prone to laterization.

The soil and its fertility must be conserved by the reduction of massive deforestation, already occuring in many developing countries and beginning in others. In this effort, continuous monitoring of various soil constituents is essential, and is a subject suitable for cooperation with countries that have the sophisticated equipment which is sometimes necessary.

Improvements in bioproductivity can also be expected as a consequence of cooperation focused on appropriate biotechnology. This could range from the development of simple solid phase fermentations, such as that designed for starch upgrading at the village level, to industrial applications of enzyme engineering or computer technology used, for instance in water and fertilizer management or in numerical taxonomy applied to ecological problems. The bioengineers in the industrialized countries should be exposed to the need to translate complicated laboratory devices into robust equipment that will stand up to field use. Their counterparts in the developing countries should appreciate the fact that it is a

greater intellectual challenge to develop methods that work well in the hands of uneducated people than those which require advanced training. Practical experience gained over centuries should be respected and indigenous creativity carefully nursed.

A stepwise development process built on a reinforced agricultural base, first giving rise to cottage industries and then to advanced systems for decentralized bioresource upgrading is an important goal which underlines the need for a multi-disciplinary approach and for international cooperation. This could take the form of a series of activities ranging from breeding and development of polycultures in agriculture, via extraction and purification of natural products, such as essential oils or pharmaceuticals, to advance technologies like submerged tissue culture.

Plant tissue culture also deserves great attention as a means to speed up breeding and to produce new hybrids. A focus on major cash crops is natural and could give a developing country a scientific leadership of the type already attained in rubber research.

Simple, more efficient, and easily applicable biogas plants suitable for large scale deployment in the rural areas of poor countries should be developed. An impressive number of units is already operating in Asia, but there is still much scope for contributions from microbial ecologists and geneticists and from creative engineers all over the world.

Basic research relevant to biological nitrogen fixation, to photosynthetic processes and to salt and temperature tolerance can all lead to far reaching consequences for bioresource utilization. In fact, the present dynamic interactions between genetic engineering, fermentation technology, and enzyme engineering might rapidly translate scientific breakthroughs in any of these areas into tehcnological "quantum jumps" with dramatic socio-economic consequences.

The speed of progress in the bioresearch field will depend on many factors. Will the developing countries be able to create a scientific infrastructure capable of developing a long-range bioresource strategy? Will this strategy generate a suitable base not only for advanced biotechnology but also for indigenous creativity? And finally, will the industrialized countries realize the value of the knowledge they would gain by directing some of their research potential to the bioresource related problems of the LDCs. The complexity of those problems and the linkages between the solutions of the various sub-problems in the food, fuel, and fertilizer areas and related to the health and environmental issues makes it essential to establish advisory structures that cut across the traditional borderlines between ministries and specialized agencies. Nongovernmental bodies like the International Institute for Applied

Systems Analysis (IIASA), the International Cell Research Organization (ICRO), the International Federation of Institutes for Advanced Study (IFIAS), the International Association of Microbiological Societies (IAMS), the International Institute for Environment and Development (IIED), the Society for International Development (SID), etc., play a significant role in this regard, but regional or even national bodies might be helpful. Certain areas like microbiology and chemistry can also play an important catalytic role in various transdisciplinary efforts. In such cases it is tempting to visualize that they will follow the lead given by the Consultative Group on International Agricultural Research (CGIAR) which now supports nearly a dozen local research centres. This development has in fact already started in microbiology which seems to be moving in the direction of a Consultative Group on International Applied Microbiology (CGIAM).

Recommendations

(a) Increased efforts should be made to explore new bioresources and to optimize the use of those that are already recognized. The International Biological Programme (IBP) and the Man and the Biosphere Programme (MAB) have begun transdisciplinary studies, in these fields, but current threats to the environment and the opportunities for basic research in fields like biological nitrogen fixation and photosynthesis underline the need for extended cooperation between the industrialized and the developing countries.

(b) Training and research relevant to improved bioresource utilization for the benefit of poor people, particularly in rural areas, should be stimulated.

(c) The establishment of networks of national or regional bioresource development centres should be accelerated and their activities coordinated by appropriate consultative groups having the resources necessary to identify problems, to set priorities and to initiate appropriate research.

ROLE OF SCIENTISTS AND TECHNOLOGISTS IN THE DEVELOPMENT PROCESS

By

Y. Nayudamma

The subject under discussion is not what others should be doing, but, what is it that we ourselves as scientists and technologists should be doing:

a) Make your presence felt - establish a scientific community - have an opinion to be heard and treated with respect by all concerned.

b) Win the confidence of your clients - industry, government, leadership and people.

c) Make friends with your clients, understand their needs and demands; put your suggestions in the language they understand and demonstrate practically how science and technology can be used with advantage as deliberate tools for development.

d) Recognize their social responsibility.

While doing the above:

Scientists should recognize development as a continual developing process; development and technology choices are related to focal social values; social values differ from society to society and, therefore, new or alternative sciences and technologies are needed.

Higher productivity through technology has no meaning if the people have no purchasing power and if the net gains are not equitably distributed.

There can be no better focal social values than self-reliance for a man to live with a sense of values of human dignity and in harmony with his environment.

Scientists should recognize their own limitation, recognize they are as irrational as others, conditioned by and not to be on tap or on top but to work with all concerned.

Scientists should develop indigenous competence:

a) to collect information, assess, and choose the right technologies - indigenous or imported: the ability to discern is most important in decision making;

b) to generate, mobilize, transfer, utilize technologies relevant to development goals.

Improve the environment to promote and to catalyse creative, innovative, inventive attitudes within the learned institutes and among the people.

If technology and development is for people, then people should be involved in the process. How to motivate them to form this process should be examined. Technology needs to be coupled with social technology.

Development is a continuing and dynamic process. It is absolutely necessary to distinguish between purely material development as opposed to development based on the value system of a country. The latter kind of development is to be preferred. Only when the basic value system is respected will the development structure have a solid foundation and not totter on unsound groundwork.

While it is true that technology can increase productivity it does not automatically increase the purchasing power of the population in general in a country. It is only when the increased productivity is associated with an equitable distribution of the benefits thereof that it will result in overall development leading in turn to self-reliance.

It is a peculiar situation that in many developing countries, poor tradesmen skilled in particular trades are more self-reliant than even graduate students who are generally at a loss when they begin to work. This brings sharply into focus the inadequate training of the educated youth and the unfortunate lack of links with real life situations in the education system.

In the developing world in particular scientists and technologists have not yet gained the confidence of the politicians and the people. This is partly due to the elitism of science. It may be necessary for the scientist to 'demystify' science so that there is a greater understanding of scientific methodology and of the scientist himself. The S&T community should avoid taking up the role of the 'big brother' and of preaching to the non-scientist. A more understanding and sympathetic approach will result in much greater acceptance of the scientists as an integral part of the community as a

whole. If this is not done, the scientists will only cause distrust and rejection.

The scientists and technologists have a significant role to play in the process of technology transfer. In order to provide for a smooth transfer of technology, the S&T community must be in a state of readiness and preparedness to absorb such technologies. When the S&T community plays an adequate role in transfer of technology, it will also be capable of sustaining technical entrepreneurship in the country. The technical entrepreneur can contribute a great deal to the overall process of development by providing the necessary broad-based infrastructure.

The S&T community can play a major role by functioning as a link between the politicians who articulate the needs and aspirations of the people and the economists who provide the basis for development planning.

The developing countries can assess different alternatives and options available to them through teams of scientists in which all relevant disciplines are represented. Managers, economists, politicians and other social scientists should also form part of such teams. Such inter-disciplinary teams can play a vital role in using modern science and technology for the discernible benefit of the people.

The need for a positive contribution from the social scientists to the development planning in a country is only recently being understood. It may be said that to some extent the non-involvement of the social scientists (economists, sociologists, political scientists) in such processes has been the cause of the limited impact of science and technology on society so far. A feed back mechanism for keeping people informed about the progress of development projects would go a long way in improving the success of future efforts.

Engineers and technologists have to receive as an integral part of their education and training, an awareness of the possibilities of exploitation of local resources. Today, it is essential that engineers be able to work as partners in multi-disciplinary teams so as to provide solutions best suited to local conditions rather than the best technological solutions. Given such a clear mandate, the engineers will be able to take the prevailing infrastructure into account and modify the options accordingly.

While considering different options for technology, it is imperative that the use of existing technologies should first be considered. If already existing technology is unable to meet the needs, adaptation of the technology can be attempted and if this also is insufficient, research and development need to be undertaken. The organization of resource specific centres merits careful attention.

The transdisciplinary nature of the development process is a fact of life. It requires tremendous organizational skill to create a transdisciplinary team and such a team needs motivated leadership. Since most education and training programmes are discipline-oriented, it is necessary to provide adequate opportunities for a smooth transition from such areas into transdisciplinary teams. The formation of such teams can be catalysed by providing well-defined and clear goals. The participating scientists in such teams should also be offered adequate rewards for such work which will tend to take them away from their well-defined sectoral disciplines.

The scientists and technologists can play a significant role by providing the necessary inputs into revising the curricula and training methods keeping in view the changing environment, developments' needs and available resources.

In any discussion of the role of scientists and technologists in the development process, the importance of fundamental research cannot be forgotten. While the actual extent of support for such research will necessarily depend on the total resources available in a country, a complete negation of the study of basic sciences will have the effect of lowering self-confidence and self-reliance to a very low level.

Recommendations

a) Every country should establish or strengthen national research councils which would lay down priorities, take steps for the conservation and rational utilization of natural resources and guard the interests of the country's scientific community.

b) International centres of advanced research should be established or strengthened, preferably in developing countries with the aid of international donor agencies. Such centres can undertake intensive research programmes on topics related to immediate local problems and also act as centres of excellence where scientists can refresh their thinking by contact with scientists of high calibre, both from neighboring developing countries and the industrialized countries.

c) Strong social sciences establishments should be set up in the developing countries so that the minimal critical masses of social scientists may be created for carrying out their role effectively. Such centres should be linked together on the basis of an international networking principle.

d) 'Hobby-centres' should be created at schools to provide an opportunity for children to learn from a very young age, to work with their hands because this provides an excellent base for later engineering and technological education.

e) Transdisciplinary teams drawn from a horizontal or diagonal mix from the vertically oriented individual diciplines should be created with well identified goals and pre-determined award/reward systems.

f) Centres for alternatives should be established in the developing countries which would be manned by groups of scientists from all disciplines and will be charged with the responsibility of assessing and recommending suitable technological options against the backdrop of the development scenario in the country.

g) A cadre of engineers, economists and, where relevant, other social scientists should be created, which would be capable of advising the governments on technology needs and options. Linking of such cadres on an international basis would be a necessary and desirable feature.

NATURAL SCIENCES

By

D. A. Bekoe

In the technical aspects of using technology for development (i.e. upgrading of indigenous technology, the transfer and absorption of technology and the creation of new technology) the role of the basic sciences cannot be overemphasized. Training in the basic sciences helps us to keep an open mind and provide the fertile soil in which technology can grow. Research in the basic sciences keeps training programs alive and contemporary and provides the basis for developing the technological capability necessary for the application of science and technology to development. In many instances it can provide essential information for direct application particularly in such areas as identification of indigenous plant and microbial resources of potential agricultural and industrial importance.

Development is a national issue, and each country must have the capability to make its own decisions. Each country must therefore do some basic research, otherwise its sovereignty will be at risk.

The resources available vary considerably from one country to another: human, financial and natural. Each country must tailor its basic research to the unique set of resources available to it. Where financial and human resources are too meager to deal with identified basic science problems (e.g. astronomical research in high altitude locations, seismology, etc.) collaboration with other countries should be sought. Where these constraints are not so severe, it is still considered necessary that basic research in the LDCs should be oriented in some way to support work on urgent problems of development, althought it is recognized that some outstanding scientists need not be restricted in this way. The presence of these outstanding scientists in the country, whether they are engaged in oriented or entirely free research, provides a national intellectual resource which helps to retain the country's scientific manpower; they are also crucial in the creation of new technology and in many aspects of the transfer of technology.

The justification whether to do basic research or not is not always obvious. It is relatively easier in the biological sciences than in the physical sciences. But whatever the case, many of the best scientists need to do oriented research because there are so many problems to solve and so few scientists to deal with them.

One continuing problem of scientific manpower is the drain into administrative and managerial positions in the same country or to scientific opportunities outside the country. The former can be beneficial where the numbers involved are relatively modest and where it results in greater scientific input into the political decision-making process. The external drain has two aspects: the pull of opportunities abroad and the push of lack of prospects at home.

The following recommendations emerged:

1) These councils must provide a mechanism for harnessing the talents of the national scientific community for tackling urgent problems, and planning for the future. The council should determine research priorities in the light of the unique mix of resources and environmental characteristics, and provide funding accordingly.

2) The national research council should concern itself with the welfare of the nation's scientists and help reduce the brain drain.

3) The Council should pay particular attention to the conservation and rational utilization of natural resources. Special interest must be taken in the damage being done by the careless dissipation of tropical forests.

4) In tackling critical world wide problems of the depletion of energy resources, desertification and other environmental consequences of human activity, international collaboration must be actively sought. In some areas, particularly tropical helminth diseases, active national programs of basic research should be stimulated, since they are unlikely to receive adequate attention elsewhere.

5) International (regional or world wide) centres of advanced research should be encouraged and strengthened as a way of combatting the brain drain.

SOCIAL SCIENCES

By

S. Szalai and R. Lambert

The Group examined the role of social scientists as professionals in development-related activities, with special emphasis on those aspects that have an important international dimension. With these constraints and emphases in mind, the Group reached the following conclusions and makes the following recommendations:

The domain of social science in development activities is all-encompassing. Development itself is a social science concept. We are surrounded by examples of the importance of characteristics of the society, the economy, the polity, values and attitudes on the trajectory of development: missing prerequisites, unanticipated obstacles, the consequences, both disastrous and benign, of simple inventions. Hence science and technology must be interpreted to include social science. This will become increasingly apparent as attempts are made to bring specificity to the notion of "appropriate" technologies. Social scientists will be needed to help inform the public about what is and is not appropriate in a particular society. It will also become increasingly important as attention shifts from planning to the effect of that planning on the people to be served. At the stage of implementation, the cutting edge of change, the contribution of the social sciences is crucial. In spite of the often stressed importance of social and economic matters the Group noted that social science is rarely included in or given prominence (including in UNCSTD itself) in considerations of science and technology.

While there has been a substantial amount of work done on development policy by social scientists, their involvement, with the possible exception of the economists, has been spotty, sporatic, non-cumulative, and of uneven scale and quality. This has meant that the planning process has often lacked important dimensions that the various social sciences might contribute and that the growth has been stunted of those segments of the social science disciplines which might be specially concerned with development.

Hence, in view of the enormity of the problems, of the short time span within which answers are required, and the young but encouraging growth trajectories of the social sciences as they relate to development, a major emphasis will continue to have to be

placed on research. Research serves as the great training school for scholars in the field of development as well as contributing to the advancement of knowledge. In any case, it is essential that social scientists increase their participation in development planning and its implementation. A wider spectrum of social scientists must be brought into development planning as early and active participants, not just ex post facto critics.

The growth of the development-relevant technology of social science would be especially enhanced by the participation of social scientists as part of a team focused on a localized, specific project from the initial stages of planning through the implementation stages. Examples of the educational effects of such an experience were drawn from the planning for human settlements and the improvement of rice-growing technology. The Group felt that such experience would be especially useful to improve the contributions of social scientists, particularly in those areas of change which require many people to act in a desired way in contrast to developments which can be accomplished by central decisions. In addition to the possible contribution of such experiences to the success of individual projects, they must also be harnessed to strengthen the parent disciplines. Unlike many of the natural sciences, the basic unit in the social sciences is still the individual and not the centre or the laboratory or the institute. This fact, combined with the emphasis upon experience in particularistic, localized projects puts a heavy premium upon the creation of: i) efficient interlinking communication networks; ii) mutual sharing of experience; and iii) periodic consolidation of experience to make more cumulative the contribution of this experience to the discipline and to the creation of a truly international social science. International agencies must be especially alert to the promotion of this cumulative growth process and to ensure that the widest range of social scientists in the most varied development situations can contribute to the dialogue. The role of the professional associations and the existing coordinating bodies for social sciences research are natural vehicles for some of these activities. One of the main concerns of such a network would be to supplement experience in individual situations by comparative research, and to link the localized, micro-studies to the overall theoretical superstructures of the disciplines.

While all of the above considerations hold true for social scientists in both the industrialized and developing worlds, the Group was concerned with problems that were special to developing areas and/or to relationships between them and their colleagues in the industrialized countries.

The first priority has been and should continue to be the development of strong social science establishments within the developing countries. In many countries, the immediate need is to

create the minimal critical mass of social scientists to carry on effective work. In others, social science is well enough developed to begin to create a national or an ethno-social science attuned to the special needs of the group or nation. There were many expressions of concern about the imperfection of the fit of Western-based social science technology to the immediate needs of social scientists in developing countries and of the inadequacies in the training given to students from the developing countries in universities in the metropolitan countries. Examples were given of the disfunctional effects of the ever narrowing focus in education as a student moves from an early generalist training to the pinpoint specificity of the doctor dissertation particularly because the developing countries need more research generalists. Other examples given were the lack of preparation for participation in a team endeavour as contrasted with individual work and the inappropriateness of the level of research technology taught in graduate schools when compared to the field situation in developing countries.

It was felt, however, that there is still an immense contribution to be made by social scientists in the industrialized countries, that for the forseeable future a major part of the advanced disciplinary training would take place there, and that the developing countries have a stake in helping to orient training institutions more closely to the needs of developing countries by providing mechanisms for the feedback of their own experiences of development into the international scientific community, including the training institutions in industrialized countries. Since this type of feedback goes against the grain in the flow of most current development information transfers, special attention will have to be paid to encouraging it.

In closing the Group reaffirmed its commitment to making social science more participatory, more relevant and better equipped to serve the needs of development.

TECHNOLOGY and ENGINEERING

By

J. Pickett and B.C. Sekhar

Engineers have a particularly important role to play in the application of science and technology to development because of the operational (practical) character of their work. It is desirable, therefore, to improve the social recognition given to engineers compared with that given, for example, to doctors and administrators.

It was suggested that the professional training of the engineer - whether received in an industrialized or in a developing country - led him or her to recommend the technically most efficient technologies for use in developing countries, even when these could not be fully justified on economic and social grounds. This suggestion led to two reactions: recognition of the need to infuse engineering training with a critical element which would lead engineers automatically, for example, to be conscious of the possibilities of local resource exploitation and to educate decisiontakers in the range of choices open to them; it was argued that engineers work to a specification, so that inappropriate design reflected inappropriate specification for which managers, engineers and customers (i.e. government agency or private firm) are responsible. Specifically, it was claimed that if engineers clearly understood that they were being asked to solve an employment problem as well as an engineering one, the outcome of their work would be different.

A plea for realism was widely supported. It was suggested that the time horizon to be entertained should not go beyond the end of the century, and that emphasis should be placed on things that could be done quickly - even if this meant neglecting fundamental education initially and aiming for the quick "conversion" of existing engineers. In the same spirit, it seemed logical (and economically desirable) to order the approach to technology policies sequentially by first aiming to improve choice from among existing technologies, then turning to adaptation and subsequently to research and development.

The importance of longer-term measures - including actions in the schools to enable children to acquire manipulative skills and in the universities to improve the "relevance" of the curricula - was also urged. It was agreed that, resources permitting, short and long-term objectives should both be pursued. Since, however, the

future comprises the outcome of a series of short-term decisions, it was recognized that the short and long-term aims should be mutually consistent. In this regard it was pointed out that lack of agreement on development goals could be a complicating factor.

A distinction was drawn between that part of the engineer's training which was in the field of science and that part which was an art. The science (principles) part should be uniform and rigorously taught; the art part offered scope for re-orientation. In this regard:

a) the need to make and potential for making the engineer "environment" conscious was described in persuasive detail with respect to Malaysian rubber, which has won acceptance as an engineering material;

b) reference was made to strategic planning as a method for ensuring, in the light of comprehensive evaluation, that objectives were really desirable even when obtainable (e.g. such evaluations might reveal that difficult technical problems were soluble but the cost of the solutions unacceptably high);

c) the need to give engineers experience - vicariously through manuals and directly by field work - before and at the end of their university training was stressed; and

d) it was agreed that developing countries should have faith in their own engineers, since they necessarily obtained "relevant" experience.

The need for engineers to work in multi-disciplinary teams was recognized; it was proposed that several such teams should be constituted internationally to review selected engineering projects in developing countries to discern and make recommendations for using the lessons of experience.

In discussing further provision for re-orientation, reference was made to regional centres and the question raised as to whether agricultural centres offered relevant models, although some doubt was expressed on this point. It was also suggested that institutions could be organized on a resource-specific, specialized basis.

Recommendations

These are set out baldly, seriatim and not necessarily in order of priority:

a) Arrangements should be made for an internationally organized provision of relevant "kits" for use in developing

country schools which would promote manipulative skills and engineering imagination;

b) Resource-based activities should, whenever they do not now efficiently exist, be organized in selected centres for such things as cotton, jute, wool, other fibres and industrial raw materials. Such centres should have an international character, funding and management and their staff should be drawn from developing and developed countries alike. Where possible, the centres should explicitly require industry-government cooperation and should involve universities in their work. Given the importance of markets and marketing, the centres should reflect consumer and producer interests;

c) Provision should be made to improve the training of engineers. In the universities this could be done by adding an appropriate class on development issues to the regular curriculum. For already trained engineers short (say 12 week) courses could be designed. Where these could now be offered by developed country institutions, international provision should be made for linking such centres with developing country counterparts in order to develop an indigenous training capacity. In this regard also appropriate manuals should be prepared and distributed to consultants, etc.;

d) In recognition of the importance of bringing engineers actively and explicitly into the development process, international provision with national agreement and support should be made for the creation of a small cadre of engineers, economists and where relevant other social scientists capable of advising government and others on technology and development. Members of these cadres should receive international conditions of service and should be drawn from different countries as well as different disciplines to get maximum benefit from cross-fertilization;

e) On the basis of a critical examination of technical education in selected developing countries, ways of improving technical education should be devised particularly by developing explicit training links with industry including notably multinational corporations. Part of the aim would be to create courses based on the "sandwich" principle;

f) It should be recognized that the sympathy and contribution of industry is as important to the harnessing of science and technology for development as that of universities and government, so that steps should be taken to evoke and exploit this industrial potential, initially by involving industrialists from developed and developing countries; and

g) An engineering group should be kept in existence.

TRANSDISCIPLINARY PROBLEMS

By

Lee Kum Tatt

The meeting agreed that all development processes, whether at a local or universal scale, are transdisciplinary. It is essential to bring together scientists and technologists of different disciplines to do transdisciplinary work. The following necessary ingredients to achieve this objective were discussed:

a) Organizational skill;

b) The need for a challenging problem to be identified;

c) The need for top leadership, which is difficult to find or develop;

d) The need to attract the best people to be the team so that there is an excellent disciplinary home base to build upon;

e) Team members must have specific and clearly spelt out tasks to perform;

f) The transdisciplinary work must take into consideration the social, economic, cultural and value systems of the environment.

The problems for transdisciplinary work raised by scientists from the developed countries are:

a) A network of interdisciplinary groups should be established some of these are already in existence - to foster transdisciplinary work;

b) There must be critical reviews of transdisciplinary research programmes by competent individuals or bodies;

c) As funds are normally allocated for monodisciplinary work, it may be necessary to find means of obtaining funds for transdisciplinary work;

d) Incentives and rewards for scientists engaged in transdisciplinary research work must be sufficient;

e) The perception and integration of knowledge in transdisciplinary work, taking into account the philosophy and value system of the environment, must be developed.

On the other hand, members from the developing countries felt strongly that the following fundamental problems exist:

a) Identification of transdisciplinary problems requiring solutions;

b) Lack of research funds;

c) Lack of the appropriate manpower to do transdisciplinary work;

d) How to form the critical mass necessary for transdisciplinary work;

e) Developing countries cannot afford to set up transdisciplinary institutions.

The meeting unanimously agreed that a motivation and incentive scheme is very necessary for workers of transdisciplinary research programmes. The following views were specifically expressed:

a) Recognition should be given to people working in transdisciplinary fields, either in the form of financial rewards, publications, recognition by peers, etc. The present reward system is largely focused along monodisciplinary lines. Researchers engaged in transdisciplinary research work should not be treated as "second class citizens";

b) There should be greater transdisciplinary mobility. Researchers who move out of their disciplines into transdisciplinary fields should have the option to go back into their own specialities and enjoy the same prospects of promotion;

c) The field of transdisciplinary work should have greater scope and continuity so that researchers will have long term employment prospects;

d) The present educational system must offer more scope and recognition for studies in transdisciplinary field, for example, degrees should be offered for transdisciplinary courses.

The discussion concluded that perhaps transdisciplinary work should be made a discipline itself so that it will be recognized and respected by all scientists and technologists.

SOCIAL, POLITICAL, ECONOMIC, CULTURAL AND OTHER CONTEXTS OF DEVELOPMENT

By

P. Piganiol

The division of human activities into separate domains could be dangerous if the phenomena at the interfaces between domains are ignored. More attention must be devoted to the nature of the flow of information and of stimuli going through the "membranes" that surround these domains; and also to the responses of each domain to the stimuli coming from the others; it seems that social innovation is the relevant response.

Success in development depends upon the quality of dialogue that can be established between scientists and politicians. The scientists should be more audacious and initiate the dialogue. Good institutional arrangements where they exist can facilitate the contacts: Unesco has always pleaded that science and technology have to be treated at the highest governmental level.

But the audacity of the scientists and engineers could be improved if they were better aware of the social environment of their technical innovations. In one sense the obstacles are the same for the politicians as for the scientists: lack of information, bureaucracy, conservative attitudes and psychological blocks amongst those whose life we try to improve.

The following points concerning the role of psychological and cultural obstacles were raised:

An awareness of the social environment could be achieved by:

a) special training for scientists and engineers. (Here, there is a new role to play for NGOs and in particular ICSU, as well as for Unesco);

b) working as often as possible in multidisciplinary teams;

c) working in close cooperation with the people directly involved in the application of the technology to be developed;

d) disseminating information about the reactions to and effects on society of the technological changes. The cases of failures are as important as the cases of success. Newspapers,

seminars, radio, television, etc., must be used to develop this kind of understanding.

The essential conclusion is that all available methods must be used and new means created to avoid what has been called a "monochromatic vision of progress".

To facilitate the emergence of social innovations it is necessary to improve the communication of information about science to people in the street, not only by scholarly education but by many other means. It was suggested that greater use be made of traditional channels of communication, and in particular mass-media, and an accent was put on the necessity of involving women in this process of socio-technical understanding. Moreover, it was said that their socio-technical problems must be the topics of large public debates.

Scientists should unite in order to improve their participation in and influence on the political decision-making process. Why should scientists and engineers not become politicans too? In this connection, we have perhaps to study deeper the differences in the ethics of scientists and technicians coming from abroad as compared to indigenous ones.

Twenty years ago the problems of the relationship between science and society were presented in a simple and naive way:

What can Science do for Society?
What must Society do for Science?

Today we know that the situation is much more complex. Science has to understand and to discover. Technology has to create tools. But the ways we use these tools are not neutral. To bring into play a new technology is a social process that often requires social innovations matching technical innovations.

Technical progress is not a blind machinery going its own way; it has to be integrated into human progress in its broadest sense. The success of this integration is perhaps the main prerequisite of human dignity.

Although no new solutions have been devised we have suggested an evolution of the ethics of scientists, social scientists and politicians. I asked the members of the sessions to make some concrete proposals and I retain this one, that I submit to your attention.

It is recommended that national delegations seek answers to the following from UNCSTD up to August 1979 and thereafter from appropriate United Nations Organizations and other bodies:

> What specific social innovations (new laws, organizations, professions, codes of conducts, patterns of behaviour, intelligence systems, patterns of incentives and combinations thereof) should the developing countries make in order to import, adapt or create domestic technologies so that they contribute the maximum possible to their development needs and goals?

But even before we come to answer such a question should we not think first about the real needs, not only material but also social, cultural, etc., of the people, consider the resources available and then how to use these optimally to improve the future well-being of humanity.

INTERNATIONAL SYMPOSIUM ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT
SINGAPORE 22nd-26th January 1979

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Terms of Reference of the Steering Committee

1. The Steering Committee created by the Liaison Group on the Contribution of Science and Technology to Development shall have the following tasks:

   i. To organize a Colloquium at which Members of the scientific and technological communities shall identify ways in which the scientific and technological communities can currently and in the future focus better their efforts to generate and to apply scientific knowledge and technical know-how to the solution of problems currently restricting sustainable development.* The Colloquium shall consider the major problems facing humanity so as to provide inter alia an input into the U.N. Conference on Science and Technology for Development. It shall be held at a time which will permit the results to be submitted to the Secretaries General of the United Nations Organization and of the Conference at least three months before the commencement of the Conference.

   ii. To explore institutional and other innovations in the creation of endogenous scientific and technological capacities and in the organization of the international and national scientific and technological communities which would enhance the contributions of science and technology to the improvement of the human condition.

2. The Steering Committee shall keep the Chairman of the Liaison Group informed of the progress, will report to the Liaison Group immediately after the Colloquium and will present within six months of the termination of the U.N. Conference a report on actions it considers necessary to ensure a continuing contribution of the scientific and technological communities to sustainable development. After the presentation of its final report the Steering Committee shall be dissolved.

* Sustainable development involves two main principles:
  (i) replacement of renewable resources as used, for example by natural or artifical reafforestation or maintaining animal populations at levels which permit natural regeneration of vegetation and avoid soil degradation;

  (ii) provision of suitable infrastructures to ensure creation and maintenance of sufficient trained indigenous personnel.