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Symposium on collaboration between the Countries of Africa and Asia for the Promotion of Science and Technology

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Shrimati Indira Gandhi, Prime Minister of India arriving to address the delegates of the Caaust Symposium

CAAUST SYMPOSIUM

The Symposium on 'Collaboration between the Countries of Africa and Asia for the promotion and utilisation of Science and Technology' was held in New Delhi on 25th April 1966 to 2nd May 1966. It was attended by about 80 foreign delegates from nearly 40 counties, 12 Observers from the International Agencies and representatives of the WFSW. Number of Indian delegates was over 200. Abstracts from the welcome address by Dr. N.P. Gupta and introductory remarks by Dr. S. Husain Zaheer, and the inaugural address by Dr. Zakir Husain, Vice President of India, some of the selected papers and recommendations of Commissions for the Symposium are published in this issue of Vijnan Karmee.

Abstract from the Welcome Address
by DR. N.P. GUPTA
President, Association of Scientific Workers of India

Unity of African & Asian Countries

Many nations represented here today have contributed much to human thought, science and civilization. During her ancient past, India, too added her share to the treasure house of knowledge in various sciences and philosophies. The peoples of these regions lived happily for centuries learning from and teaching each other. The richness of the East attracted invaders and treasure hunters. A decay set in. The division of the world by the colonial powers completely broke up the life and structure of society in our region. We became isolated from each other.

The struggles of the people of Asia and Africa for freedom reunited the separated souls. We drew inspiration from each other's fight for independence. In this very city, on March 23, 1947, was held the first Asian Relations' Conference. Jawaharlal Nehru inaugurated this great gathering of delegates from Asian countries many of which till then were in the throes of the battle for freedom in a new world emerging after the second world war. Much has happened since then. Bandung saw the further consolidation of the spirit and desire of the people of Africa and Asia to come together. Powerful Afro-Asian solidarity movements grew up. Over 60 former colonial countries became independent. Political consolidation was followed by plans for economic development. The worst days seemed to be over for the people of Asian and African countries.

New Stresses and Strains

But, of late, despite progress, new stresses and strains have appeared and the Political independence was only a precondition for unfettered development and utilisation of natural resources. 'Aid' from the advanced countries had to be sought. This 'Aid' brought many political strings and alien influences, visible and invisible, reappeared in new form. By the beginning of the sixties a new realisation had dawned on all of us. We realised that Science and Technology were also key factors in the development of the poor countries of the world. In fact

these are the crucial factors in the long-term development plans of any nation. And there are no slogans or tricks available to develop science and technology in a short time. These are factors which take time to mature.

New Situation

The disparity between the advanced and the poor countries is too frightening to be believed. Thirty advanced countries account for 85 per cent of the world's total income. Nearly 95 per cent of scientific research is monopolised by them. Sixty-eight per cent of world's corn, 82 per cent of meat and 80 per cent of protein is contributed by these countries. Over 70 per cent of the world's population lives in poor countries. The poor countries have meagre experience and their problems infinitely more complex. Over 80 per cent of the world's expected population will still be undergoing the rigours of the growth process in the year, 2000.

The rate of scientific and technological advance has been considerably speeded up due to the new scientific revolution. Advances in nuclear energy, electronics, automation, scientific chemicals, genetic code and space research are straining the structure of science even in advanced countries.

The rate of economic advance, because of their highly developed science and technology, is naturally higher in advanced countries. The investments for science are also higher in advanced countries both in relative and absolute terms. The per capita national income has been increasing at the rate of only one per cent per annum in developing countries. The rate in advanced countries is about twice higher. What are the main causes of this situation ?

Parts of Asia and Africa still continue to be under direct colonial rule, under white racist regimes, or under alien military occupation.

A 5 to 6 per cent rate of increase in national income will be required if the developing countries are to reach the current European levels in 80 years. They will need 120 years to obtain the present level of U.S.A. But the economic and scientific gap between these two parts of the world will be even wider 80 or 120 years hence.

Accumulation of capital is a difficult process. Any forced pace at this low level causes political inbalances and unrest. The agricultural economy of Afro-Asia is at a subsistance level; and Industrialisation in the true sense is yet to take place.

Conditions for economic investment are absent. A poor infra-structure and undeveloped construction industry, insufficient planning capacity, a narrow domestic market all hamper this process. Development proceeds hand in hand with inflationary pressures which at time become serious.

The rate of increase of raw material exports of developing countries has been the world average since the second half of the fifties. The world average is 4.6 per cent; in developing countries it is only 1.9 per cent. Since 1953, 33 per cent of the increase in the export of industrial raw materials is in the field of synthetic substances and aluminium from individually advanced countries. Transport costs create further difficulties. Only 6 per cent of trading vessels belong to developing countries.

A steady fall in prices of the agricultural produce and a rise in prices of manufactured goods is leading to increased impoverishment of the peoples of developing countries. The share of developing countries in world export is falling. It was 31 per cent in 1950; it was 20 per cent in 1962. Capital from other sources is scarce. In 1913, Great Britain exported finance capital 1½ times her national income. U.S.A.s' investments

in foreign countries constitute 12 per cent of her national income. The larger part of this capital goes to Europe, Canada, Australia, New Zealand and South Africa. The outflow of capital profits is considerable. The balance between input of capital and outflow of profits during 1950-61 was only 2000 million dollars.

The economy of many underdeveloped countries is tied to stockpiling of weapons and raw materials by big powers. The underdeveloped countries themselves are forced to spend 6 to 7 billion dollars per year on armaments.

The heavy military budgets of rich countries are an important factor in preventing the development of Asian and African countries. The belief in military strength, brinkmanship, head-long clashes and wars is still very much part of the international scene. Aid under such circumstances often becomes tied up with over-all military considerations.

The ancient cultures, traditions of many peoples of Africa and Asia are a source of inspiration to all of us. We face the common problem of creating scientific temper among our peoples. Prejudices, superstitions and backward-looking trends still dominate the minds of men. The spread of scientific objectivity, knowledge and education among men will have a far-reaching impact on the economic development of our countries.

The role of science and technology as a factor in national development is yet to be recognised by many. The political parties and groups have little knowledge of it. The scientists themselves are busy in their laboratories. Ivory tower attitudes amongst them are not uncommon. The desire for rapid economic and industrial development very often leads to import of 'turn-key' industrial plants from advanced countries. For those in power, scientific institutions are often mere show-pieces. The scientists, at best, appear to them as efficient clerks; at worst little more than the magicians of the medieval courts. Science, truly, is a revolutionary force today because through its application, technology changes production methods. Social relations change. Society itself undergoes transformation both in its structure and its outlook.

The resources of the so-called 'poor' countries are enormous. Then man-power is industrious and intelligent. Their forest resources, their hydro-power, little surveyed mineral wealth, have tremendous potentialities of development. Only a few hundred years ago many countries of Asia could compare favourably with the countries of Europe. Why did the scientific and industrial revolution first occur in Europe ? Can one achieve the same type of revolutionary change *de novo* on the basis of self reliant indigenous effort?

The world is shrinking fast. Faster means of communication & transport, the enormous powers that science & technology have placed at man's disposal, the disparities between the rich and poor nations and the numerous economic factors make international and regional co-operation an immediate necessity.

Mention may be made here of international co-operation efforts organised by UN agencies—the International Geophysical Year, the biological programme, the upper mantle project, the hydrological decade, the year of the quiet sun, joint satellite launchings, the study of the biological basis of human welfare, the proposed establishment of international research centres for computers, cancer, high energy particles, heavy element chemistry, macromolecular biology, sea farming, desert irrigation and manufacture of proteins from fibrous plants.

The scientific effort in Western Europe, as also in other regions of the world, is being pooled on an increasing scale. Joint research and collaboration is carried out under European Economic Community, European Free Trade Association, Organisation for Economic Co-operation and Development, and Nato. Regional collaboration is also a feature of the working of the European organisation for nuclear research. There is urgent need for similar collaboration among the developing countries. The problems faced by these countries are different. But most important of all, we have to collaborate to prepare our own plans of scientific and technological development on the basis of mutual and international assistance.

The problems of the developing parts of world are of such magnitude that they will require total international effort for several decades. The world Trade Conference in Geneva reached the conclusion that by 1970 the deficit in balance of payment of developing countries would touch the 20 thousand million dollars. Simultaneously, we have to consider if during the developing process we can avoid the problems which are plaguing the affluent societies. Pollution of air and water, increased radioactivity, and mental tensions are some of the major problems of advanced countries. We have to keep these problems in mind as we march on the path of economic progress.

As scientists, we have a special responsibility towards world peace. The world's expenditure on armaments today is more than the total national income of all the developing countries put together. One indeed wonders if the race for reaching the moon could not be linked up with the welfare of millions of people on this planet. International understanding and collaboration could certainly reduce much of the expenditure that is being incurred on the race to the moon.

Indian Science

Indian science has registered remarkable growth since, 1947. Nearly 60 Indian Universities and 27 advanced centres of science have an overall science enrolment of 31 per cent. In addition, professional science courses account for a sizable portion of the total enrolment. To provide higher education to the needy, a beginning has been made with some evening colleges, correspondence courses, summer institutes, vocation courses and radio instructions.

India's scientific research institutes are organised under the Council of Scientific and Industrial Research, the Atomic Energy Establishment, the Indian Council of Medical Research and the Defence Science Organisation. In addition, numerous organisations work directly under the various ministries of the Government of India.

Indian science faces many problems, such as relatively poor allocations of funds for scientific research, limited trained personnel, the lack of full integration with industrial development. Foreign aid in this sector has so far failed to make any significant impact on making science and technology independent. Indian intellectuals are seriously examining the whole question of foreign aid to finance education and research. There is an obvious lack of "proper atmosphere" for work. We hope to share with you these and many other problems during the symposium.

The Association of Scientific Workers

Founded in 1947 with Jawaharlal Nehru as its Founder-President, the Association of Scientific Workers of India has been trying to promote the social, economic and other interests of scientific workers. At

the same time, the Association has been working for the most effective use of science and scientific methods for the welfare of the community as a whole. The Association seeks "to promote the development of science in all its aspects and to maintain the honour and interests of the scientific profession. It aims to ensure that the national resources of the country and also the results of scientific research and development are utilized in the best interest of the community as a whole."

The Association of Scientific Workers of India is proud of its international outlook. It is affiliated to the Indian National Commission for co-operation with UNESCO and the World Federation of Scientific Workers. We in the Association are conscious of the need for collaborative international effort. Today we are very happy indeed to see the representatives of so many countries here. We are keen to establish contacts, to build new bridges, and learn from other people's experiences and pool our own.

There are some in this land and elsewhere who raise their eyebrows at our organisation. To them I offer a partnership in the ceaseless struggle to guard and promote the interests of scientists, of technologists and teachers who constitute the priceless treasure of any nation. A stable and happy human society based on willing co-operation of the peoples is difficult to achieve. Science has given so much to man. Yet the vast humanity has so far been cheated of its right to the joys of a decent, purposeful living.

Abstract from the Introductory Remarks
by DR. S. HUSAIN ZAHEER
Director General, Scientific and Industrial Research

May I take this opportunity to share with you the origin and purpose of this symposium. In 1964, the Association of Scientific Workers of India organised a magnificent symposium on "Science and the Nation in the Third Five Year Plan". To this symposium came hundreds of Indian scientist delegates and also over 40 scientists from many countries of Asia and Africa. Nearly 150 papers were presented and discussed. Intense and frank discussions took place on the role of science on problems of power and irrigation, petroleum, chemicals, steel, mines, heavy engineering, food and agriculture, transport, communications, health, town planning, buildings, planning of science, organisation of research and relations of science to government. A special session was devoted to science and international relations. Scientists from foreign countries had an opportunity of visiting India, and also scientific and industrial establishments. Before dispersing they met once again on August 11, 1964.

Deeply impressed by the progress India was making in the sphere of science and technology, scientists from African and Asian countries unanimously agreed to recommend to the scientists of Asia and Africa to organise a symposium to promote collaboration between scientists of Asian and African countries. A preparatory committee of scientists from ten countries was set up to organise the symposium. The Association of scientific workers of India agreed to be the hosts in the first instance.

This meeting issued a policy statement and affirmed their faith in application of science and technology as a prerequisite for

material welfare of their people. They agreed that each country or nation had its own path of development but science and technology was common to all. The meeting also expressed itself for peace in the world and for distribution of savings from disarmament for aiding developing countries.

The scientists from Asia and Africa gathered on that occasion in 1964, considered it to be of "paramount importance that scientists, technologists, and planners from countries of Asia and Africa should come together to discuss and solve common problems faced by them. The Symposium, they suggested, should provide opportunities to discuss common problems, work out a machinery for frequent contacts, promote the commitment to science and technology in developing countries, exchange information on patterns of international assistance and finally to prepare joint programmes for seeking international assistance in the field of science and technology.

In recent years many symposia and conferences on this subject have been organised in different parts of the world and under different agencies. One of the largest was held in Geneva in 1965 under U.N. auspices. Nearly 2,000 scientists from all parts of the world participated. But it achieved little. There was no operational part of the symposium. Many delegates from developing countries even called it a super market. They could appreciate what marvels science and technology could do. But they could not buy anything because of limited resources. UNESCO is now engaged in organising similar conferences. The Lagos conference for development of science and technology in Africa and Sydney conference for South East Asian countries have already produced reports. Another conference for Asian countries, is on the Unesco agenda. In 1964, a large conference of scientists from four continents was held in Peking. The World Federation of Scientific Workers held a similar conference in Budapest in September, 1965. The Pugwash Conference in Addis Ababa in early 1966 and the conference of International Union of Scientists last year discussed science and technology in developing countries.

Why Another ? The sceptics ask ?

First of all, there is little progress despite numerous conferences. Only a general awareness of the problems has been created. Some of these conferences have even been used as political platforms for virulent attacks on other countries and their governments.

The CAAUST Symposium, I must emphasize, is based on the declaration of a faith that each country and nation has its own path of development. The Symposium therefore, makes efforts to suggest not to impose readymade formulae for solving difficult problems.

The CAAUST Symposium attempts to break the isolation of neighbours from each other. Too long, we have learnt about each other via the advanced countries. Instances, when the scientists from developing countries met and even worked together in a science establishment of an advanced country, are indeed numerous. But the contacts are broken. Each goes back to his own country. Many a times, they meet again but only at an international conference. This isolation of scientists from neighbouring countries from each other is rooted in the political history of Asia and Africa. This isolation was in a way imposed by colonial powers.

The CAAUST Symposium hopes to build new bridges and contacts between scientists and technologists of Asian and African countries. It seeks to initiate the process of collaboration between scholars of this region. In a way it tries to re-establish what

was common place in ancient and mediaeval times when Asian and African countries were centres of learning, scholarship and civilisation.

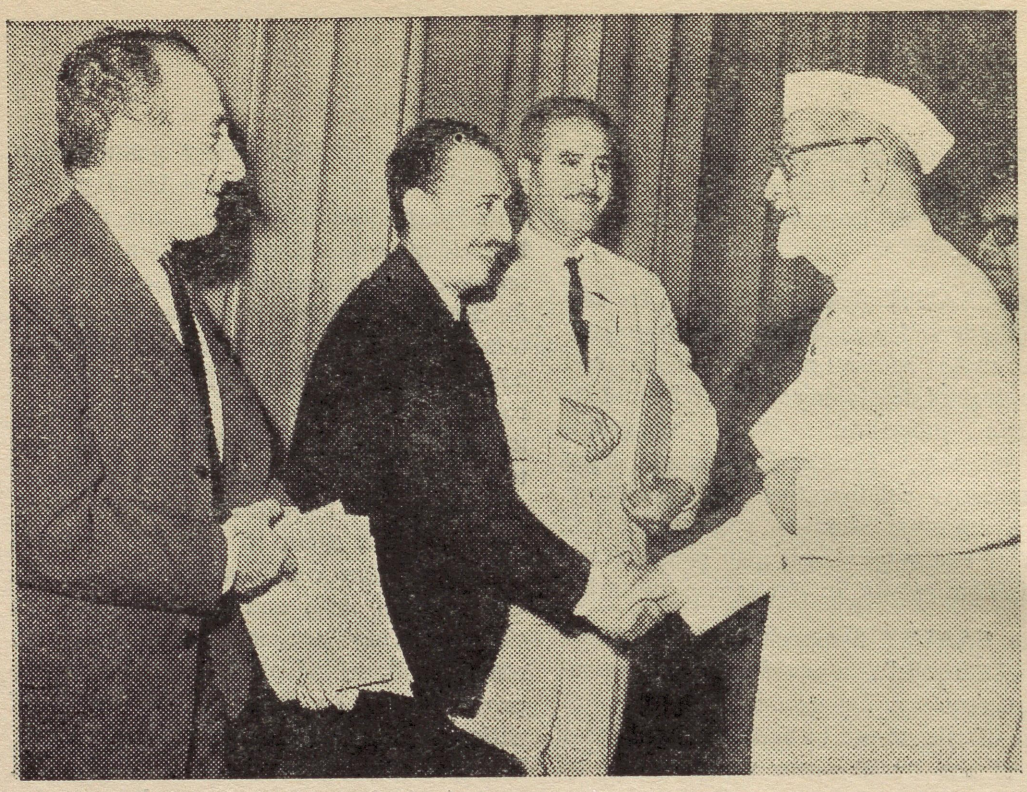
The CAAUST Symposium seeks to help in methods and procedures which may result in a rapid advancement of science and technology of developing countries by making concrete proposals. While advocating 'self reliance', CAAUST does not reject international collaboration and assistance. The Symposium seeks to suggest the best form of assistance which may generate and not inhibit growth in developing countries.

The CAAUST Symposium is also based around the belief that world peace is an essential prerequisite for effective utilisation of forces of science and technology for the poor part of the world where vast majority of humanity lives. Even a small diversion of funds which are now getting increasing locked up in armaments can make a significant change in the lives of the people of developing countries.

CAAUST Symposium thus tries to be distinct and different in its approach and understanding. This alone fully justifies the organisational effort for this Symposium.

I must also at this moment mention what we think about the past CAAUST period. This Symposium is only initiating the long blocked process oi collaboration between scientists of Asia and Africa. There is a need for the CAAUST Symposium to the possibilities of continuing organisational efforts in this direction. The CAAUST Symposium will be appointing a number of commissions for the Symposium. It is for the Symposium to recommend and these commissions are to function on a more or less continuing basis until we meet again to review the progress and tasks after a few years of work. The Countries of Asia and Africa are facing a challenge. They have recently started on high road of political independence and economic prosperity. Their enormous reservoirs of national resources are waiting to be exploited. The rate of scientific progress in advanced countries is faster than that of developing countries. This is an additional challenge. The threat of our being left behind grows daily, hourly.

The CAAUST Symposium is a determined effort to face these challenges. I have no doubt in my mind that the wheels of history can not be reversed and we shall succeed in our tasks.



Dr. Zakir Husain, Vice President of India and Chairman of Organising Committee for Caaust Symposium being introduced to delegates

From Left : Dr. Samir Thabet (Lebanon), Mr. Abdel A. Sabet (UAR), Dr. Mehdi Berkeshly (Iran), Vice President, Dr. N. P. Gupta, President, Association of Scientific Workers of India

Shri Swaran Singh, Minister for External Affairs with delegates.

ADDRESS

by

DR. ZAKIR HUSAIN
Vice President of India

Friends,

I deem it a privilege to be able to join this distinguished gathering of scientists and technologists from various countries of Asia and Africa. On behalf of the Organising Committee and on my own behalf I offer you a most cordial welcome to this Symposium and wish and pray that your deliberations and your get-together may initiate a new chapter of mutual understanding, cooperation and collaboration between our several countries.

It seems to me to be only in the fitness of things that scientists and technologists should have taken this welcome step. For science is pre-eminently international. The loyalties to family, tribe, country, community are, indeed, up to a point, valid loyalties. Where a narrower loyalty clashes with a wider one, or a lower with a higher one, the wider and the higher must prevail. Man's overriding loyalty is to mankind and to truth. Its custodians are those who use their power over a section of humanity as a trust on behalf of all mankind and direct the effort of their part of it to assure the survival of mankind and the advancement of its material and spiritual life. The scientists appear to me to be the spearhead of this great endeavour for human survival and rebirth, destined to pull us out of the confounded confusion and desperate danger of sectional loyalties inspired by sectional interests, fed by hate and distrust, to pull us out of this to a sense of mutual involvement and mutual responsibility of everybody towards the fashioning of a good and gracious life, a life of abundance and justice, a life of peace, freedom, beauty and mutual helpfulness. It is a happy augury, therefore, that scientists from so many Asian and African countries have come together at this Symposium.

Recent developments in science and technology are changing the realities of the human situation. They have given, on the one hand, to sections of humanity the power to annihilate each other, to destroy civilisation and to mutilate the portion of the human species that may escape total annihilation. They have, on the other hand, also opened up possibilities of general abundance in which it would not be necessary to deprive others of scarce means of satisfying human wants in order to satisfy one's own, in which it would not be necessary for the freedom of any country that any other country should be enslaved. These developments have made possible a life of prosperity for all in the matter of material goods. These developments need be accompanied by a change of consciousness, a change of attitude towards human relations and international solidarity. That change is unfortunately slow in coming and it seems to me that scientists will be the most potent section of the human community to help bring about

this change to assist humanity to jump over the hump of traditional national prejudices and stupidities on to the broad vistas of a good life for all in international society based on co-operation, understanding and intelligent work. I cherish this hope of the scientist because science is one and the scientists of the world are, indeed, a single community sharing all that their intellectual energy has succeeded in discovering. No one knows so well the dangers which their achievements have created. No one knows better how the knowledge they have brought to light can help create a society of abundance which passes our present dreams. They know, as no one else does, the alternatives with which their efforts have confronted mankind: the alternatives are establishing a veritable paradise on earth and the alternative of total annihilation, the alternatives of happy fulfilment and helpless suicide. They, more than anyone else, know that peace and prosperity are indivisible. Irrespective of where they come from, they can be presumed to share an awareness of and a respect for facts, a commitment to objective, unbiassed thinking and a readiness to put their views to test by observation and experiment. The force that these shared common qualities can signify in the total community of world scientists, can be trusted to contribute significantly in bringing about a general change of attitude among the nations of the world. In the words of an eminent scientist, "It is the task of the scientist to increase the chances of mankind winning its race against death, however small this chance may appear at the present time and however weak their direct influence on political development may be. We obviously need the international cooperation of scientists to attain various worthy objectives: the advancement of scientific knowledge, furthering of the welfare of scientific workers, study of the social problems, of worldwide importance and dissemination of information on scientific developments of major importance to mankind. But above all this, we need an international community of scientists to develop a positive programme of international control of atomic and other weapons of mass destruction and to lead national groups in a concerted effort for the realization of the programme."

To play this role with some reasonable chance of success in the countries of Asia and Africa, scientists, in my view, should keep in view three points. The first of these is that science and technology should hold together. Modern technique and modern science are indeed two sides of the modern view of nature, in its practical and theoretical aspects. Scientific discovery and technical invention are twin sisters. Many a discovery is made possible by some previous invention and practically all inventions are based on previous discovery. Why do I then emphasise that in our developing countries science and technology should hold together ? I do this because the problems of changing the material conditions of life in our countries are of such urgency that we cannot afford to wait. We are understandably in a hurry and the situation makes it very difficult, if not impossible, for us to make haste slowly. We are anxious to buy modern technology and may in this haste forget that technology without a basis of living and advancing scientific knowledge in our several communities, can easily cease to improve and become static, for without the supporting science it would be a borrowed empirical technique. It would be rational, for it would be designed to achieve certain ends. But scientific knowledge and scientific technology based on it grow and change at such unbelievable speed that what is the best today is no longer good tomorrow. Without our own flourishing and growing

science we are likely to stagnate in a static situation. We should guard against such a contingency in our rush to buy technology and knowhow and should spare no effort to base technology on an ever widening base of living science in our own countries.

The second point I would like to make is that the cultivation of science should not by any means be limited to the top echelons of scientific and technological competence. Science may not remain the exclusive possession of an esoteric coterie, a privileged caste. Modern science is becoming an all pervasive influence and if we wish to shape the lives of our people in a worthy manner we should see to it that science—the scientific outlook, is shared by all citizens and the problems of the teaching of science as a formative influence through the entire educational setup of our countries should be a matter of urgent concern to us. Here also a great deal of thought will have to be given to the manner in which this is done. Science education in our school systems tends to become the transmission of the facts of science to the pupil, as many of them as possible. But the results of scientific enquiry are increasing at such terrific speed that this seems to be a very doubtful enterprise. Something else must be tried. This is not the place to dilate on how science might be taught in our schools. But I have no doubt in my mind that the usual encyclopedium of the curricula by throwing in as many results of investigation in the diverse fields of scientific enquiry is educationally unsound and socially sterile. More important than storing in one's head the facts of science is the familiarity with the method of science. Even with a strictly limited portion of the subject matter the habits of scientific thinking and problem solving can be engendered in the pupil and this would ensure, educationally and socially, more useful than the walking encyclopaedia. The understanding of the basic principles of science, an appreciation of the usefulness of the scientific method in solving problems, not only in some narrow specialised field but in most of the problems of social existence, the consciousness of the basic human values inherent in this method should be the main aims of the teaching of science to the people. It should be made to succeed in producing a critical open-mindedness, a readiness to examine without prejudice alternative solutions to a problem, a sceptical rationalism against the close-minded obstinacy of absolute answers, the readiness to test one's views by observation and experiment and to gladly give up untenable positions, the habit to view things and issues objectively without bias. We should in our various lands seek to make these qualities the distinguishing features of their intellectual and moral climate in order to usher them with assurance into the new scientific age of peace and prosperity. I beseech you all who are gathered here to work assiduously for this consummation.

The last point I wish to make concerns the moral and social orientation of the work of the scientist and the technologist. The twin sisters, modern science and modern technology being morally and culturally netural can lend their services to the good and to the bad, to the desirable and the undesirable alike. They can help uninhibited exploitation of human beings and they can serve as instruments of social justice. The scientist cannot, in my view, remain indifferent to the choice. All our countries are today poised to the great enterprise of fashioning for themselves a just, free and graceful national life. We may not learn the advancement of science and technique to be indifferently helpful in devising and perfecting means

for the attainment of an assortment of aims, wise and foolish, virtuous and vicious, socially beneficial and socially indefensible. Scientists and technologists may well acknowledge their responsiblity, as such, with reference to the life of the people. A sense of social responsibility is one of the essential equipments of a modern scientist. They may join hands to harness their knowledge to the satisfaction of the real wants of the people in a non-exploitative, cooperative society of mutual helpfulness.

The objective may perhaps be facilitated by a much needed change in the higher programmes of scientific education. The rapidity with which scientific knowledge has been growing in recent years makes specialisation in some fields inescapable. But it is important how early or how late the specialisation begins. It is also important to realise the urgent need of supplementing scientfic knowledge by a fair deal of familiarity with the social sciences and the humanities. The socially responsible scientist and technologist will need, together with his highly developed orientation in the world of physical facts, a degree of orientation in the world of values, and combine his familiarity with physical nature and its behaviour, a degree of familiarity with social processes and the behaviour of human beings. Understanding and command of the physical nature are to be the instruments of desirable social objectives. If this is done—and I fully realize that it will take a lot of doing to get done—the scientist and the technologist will not be the partial men that they are not infrequently taken to be. A poet like the Russian Baratynsky will not have to be assigned the dismal task of vainly awakening his generation 'coldly devoted to industry and profit' by composing 'simple songs praising love and beauty and revealing the emptiness and variety of science that flouts them,' nor would a French poet accuse his generation of having 'congealed nature with the icy finger of measurement.' Science would instead reveal a newer and deeper beauty in nature as it once did to Leonardo da Vinci and to Goethe. This will, I guess, be greatly encouraged by the latest developments in science itself in which, to quote the words of a great scientist, "the dominant theoretical structure of the 19th century Newtonian mechanics (which was largely responsible for the picture of science as a cold, analytical tool, mechanising and despiritualising the world) has been complemented by other breath-taking generalities suggestive of deeper interrelations and unities in the sensual world: Maxwell's electrodynamics and Einstein's relativity, quantum statistics and electro-dynamics and—just outside our present reach—a unified field theory incorporating all these concepts" (Rabinowitch). Science seems well on its way to be a legitimate source of general ideas concerning the world and man and this is bound to reflect itself in philosophy, poetry and arts and in the understanding of the relations of man.

It is this enrichment of the human mind and this realization of human understanding growing into a force strong enough to build a new world of peace and prosperity, of justice and beauty, of health and abundance and of good human relations which should be the objectives of our scientific education and the sustaining inspiration of every scientist. I do hope that our coming together here from different countries of Asia and Africa will help in considerable measure in paving the way for such an enchanting goal. I again offer a most sincere welcome to you and wish your deliberations success.

Objectives of Science and Technology

P.C. MAHALANOBIS*

1. This symposium has been convened for collaboration in the utilisation of science and technology in developing countries. We know the ultimate objective is the improvement of the level of living in developing countries. This means having a bigger and bigger supply for each person of food, clothes, housing and such other things, and also greater facilities for travel, medical care, education, etc., and cultural amenities. The aim must be a continuing increase in the per capita production of consumer goods.

Science and technology for economic growth

2. We have to think in terms of four levels: First, to increase the supply of consumer goods which is the first level. To do this, we must expand the production of capital goods; this is the second level. Both of these will require an increasing utilization of science and technology; this is the third level. Engineering and technological developments call for increasing applied research which in its turn requires a sound foundation of basic research. Results of research must then be used to make new innovations for a continuing improvement of productivity. This is fourth level.

3. I have used the two words science and technology in their accepted sense in the advanced western countries. Science is knowledge of nature and natural processes. Technology is the use of scientific knowledge for some given purpose. Science and technology are intimately connected. Both are connected with scientific and technological education and also general education. The word science is sometimes used in a more general sense for all these three aspects, science, technology and education.

Research and development

4. During the last 15 years, and more intensively during the last 5 years or so, increasing attention is being given to certain aspects of science and technology, namely, scientific research and technological development, which is called, briefly, research and development, and is known in the now familiar abbreviated form 'R & D'.

5. Research, consisting of basic research and applied research, is described as "systematic, intensive study directed towards fuller scientific knowledge of the subject studied." Basic research is "research in which the primary aim of the investigator is fuller knowledge or understanding of the subject under study, rather than, as in the case of applied research, a practical application thereof".[1] On the other hand, "applied research is directed towards practical application of knowledge". And, "development is the systematic use of scientific knowledge directed towards the production of useful materials, devices, systems or methods, including design and development of prototypes and processes.[2]

Motivation

6. Some thought is being also given to motivation for R & D in the advanced countries, for example, "the needs have been divided roughly, and somewhat arbitrarily into four main groups:

—first, the spontaneous human need for wider and deeper knowledge, which

* Statistical Adviser to the Govt. of India.

animates institutions for fundamental research, especially the universities;

—second, the need for the solution of certain social problems, such as those related to health, nutrition, air pollution, road safety, etc.,

—third, the needs of national defence and—sometimes of a policy of prestige, needs which have greatly increased since the second world war;

—fourth, the needs related to the promotion of economic growth." (OECD. seggp 1963, 49).

Motivations for undertaking R & D are not independent of each other. Also results of research may have consequences which are at the same time social, economic, political and military, besides satisfying the thirst for knowledge. In the developing countries the focus of attention must be on rapid economic growth because it is only through a rapid growth of the economy that it would be possible to raise the level of living or to expand facilities for education, care of health, cultural amenities, etc., and, utimately also to strengthen defence, national security and independence.

Special needs of developing countries

7. The scientific tradition has been taken for granted in the conceptual framework described above. This is proper in the case of the advanced countries where the scientific tradition is well established. In the developing countries, however, the scientific tradition has still to be established and continually strengthened. What then is this scientific tradition which demarcates the advanced countries from the developing countries?

The scientific tradition

8. Before the emergence of science there were only two types of human decisions. In one type there is freedom of individual choice iñ such things as food, clothes. etc., or in games, recreations etc., all within the limits of physical availabilities or social permissibilities. The second type of decisions is regulated by the "principle of authority" in which sanction is determined by the level or status in a hierarchial system of authorities in all organised human activities; in military, police, and administrative systems; in public and private enterprises; in church and religious organisations etc. A system of law is conceivable only when there is a possibility of an appeal from the verdict of a lower court or authority to a higher court or authority —at least from 'Phillip drunk' to 'Phillip sober'—and, also, if a complete reversal of the verdict of the lower court or authority is permissible,. This principle of authority must be accepted for the very existence of society itself.

9. Individual freedom of choice and the principle of authority must, however, be completely rejected in the field of science. Cause and effect have been the subject of enquiry from time immemorial but only in respect of isolated events. A crucial change occurred with the emergence of the concept of natural phenomena as interconnected and amenable to rational and unified explanation. Modern science consists of a patient accumulation and critical study of observations and experimental results and their interrelations, based on the uniformity or regularity of naure, which can be discovered by the human mind and can be unified and integrated by theory. Science introduced for the first time the concept of nature as objective reality and of the validity of the knowledge of this reality, which has its foundation in nature itself and which is not subject to individual choice depending on taste or preference, and which can not be changed or upset by any human authority however high.

10. The scientific method based on observations and experiments is essentially revolu-

tionary in nature and must continually challenge established belief based on authority or superstition. In the developing countries most urgent task is to establish and strengthen the outlook of science, and the experimental attitude of mind so that deeper knowledge of natural phenomenon and of social forces may be acquired through research, and such knowledge may be used to invent new devices, methods and techniques to bring about material and social changes. This is the only way to replace superstition and obsolete customs or dogma by rational decisions.

11. The scientific outlook and the experimental attitude of mind is then the scientific tradition, which is vested in a community of scientists enjoying complete equality of status for free exchange of views and criticisms in all scientific matters. In the developing countries a most important aim of science education and research must be to build up, as quickly as possible, a community of scientific workers with equality of status in scientific discussions, to foster the growth of the scientific tradition, to promote the social appreciation of science among the general public, and to help in bringing about a rapid transformation of a society based on authority into a modern industrial economy based on science and technology. Without such transformation sustained economic growth is not possible and political independence is not viable.

Technical services

12. There are many scientific activities which are taken for granted, in advanced countries, such as, the regular collection of meteorological and hydrological observations; systematic field surveys of various kinds (topographical, geological, botanical, zoological, etc.,); socio-economic, statistical and surveys; also testing of raw materials or manufactured products, calibration of instruments and equipment, chemical analysis, clinical tests, biological assays, etc., which are being carried out as normal activities which, of course, increasing sophistication in the advanced countries. In addition, during the last twenty-five years or so, new techniques and technical methods are being increasingly used in the advanced countries, such as, industrial standards; SQC (statistical quality control); design of experiments; operational research; electronic computers for processing analysis, and programming; systems analysis, and controls etc.

13. For convenience of reference, I shall call the above and similar activities 'technical services' which supply the infra-structure of science and technology in the advanced countries. There can not be any doubt about the need of rapid promotion of such services in developing countries. I should, therefore, suggest the addition of the word 'services' to 'research and development' to supply a wider concept of 'research, development and services' (R, D & S) which is more suitable for developing countries.

Expenditure on research and development

14. In this paper I shall consider briefly some aspects of the planning of research, development and services (R, D & S). Planning usually starts with the allocation of funds. In recent years much attention is being given to expenditure on R &D in the advanced countries; such expenditure increased appreciably only from the time of the second world war, that is, during the last twenty five years or so. There was also a rapid rise after the release of the sputnik in U.S.S.R. since then the additional expenditure has been mostly defence-oriented with special emphasis on missiles, anti-missiles, and space vehicles in U.S.A. and U.S.S.R., and to some extent also in U.K., and France. The rise in expenditure on non-military industrial

R & D has also been particularly rapid in recent years in a number of science-based industries, such as, chemicals, electrical equipment and communication, electronic computers, etc.

15. *Research ratio*: The R & D expenditure is often expressed as a percentage of the gross national product (GNP) and is called the research ratio. In the U.S.A., the research ratio reached the level of about 3 per cent in 1963. It was somewhat smaller and about 2.2 and 2.3 per cent in U.K. (1962) and U.S. S.R. (1964); about 1.7 and 1.8 per cent in Sweden (1962) and Netherlands (1962); 1.5 or 1.6 per cent in France (1962-63); 1.4 per cent in Japan (1963); 1.3 per cent in West Germany (1962) and also Switzerland (1963); 1.0 per cent in Belgium (1962); and lower than 1.0 per cent in other advanced countries like Canada(0.9 per cent in 1963-64). Norway (0.8 per cent 1963); about 0.4 or 0.5 per cent in Austria (1963) and Denmark (1962), and possibly only 0.3 per cent in Italy (1963).

16. *Distribution by type of activity*: Basic research accounts for roughly 10 or 11 per cent of the total R & D expenditure in U.S.A., U.K., U.S.S.R. and France; most of the basic research is done in the higher educational institutions. Applied research has a share of about 22 per cent in U.S.A. and 25 per cent in U.K. while development has the very large share of 68 per cent in U.S.A. and 64 per cent in U.K. while development has the very large share of 68 per cent in U.S.A. and 64 per cent in U.K.; within industry, development absorbs 78 per cent of R & D expenditure in U.S.A.

17. *Source of funds*: Practically all military R & D is financed by Government. A good part of non-military R & D is also financed by Government for basic research mostly in higher educational institutions, and some exploratory type of applied research mostly in non-profit institutions which includes research on health, education agriculture, etc. Oriented applied research and development, which is done mostly within industry is financed by industry itself.

18. *Cost per R & D scientist*: The cost per qualified scientist and engineer engaged in R & D was of the order of $ 35,000 per year in the advanced countries of the West such as U.S.A., U.K., France, Canada, West Germany, etc., in early nineteen-sixties. It was appreciably lower and something between $ 12,000 and $ 14,000 per year in U.S.S.R. The cost was still lower in Japan and of the order of about 7,000 dollars per research scientist per year in 1961. In India the average cost per scientist in Government institutions was roughly $ 7,000 per year or about the same as in Japan.

19. It is of interest to compare the cost per scientist in terms of per capita income. In U.S.S.R. the cost per research scientist was possibly something like 12 times the per capita income (adjusted for western concepts). In Japan, Canada or U.S.A. it was somewhat higher and of the order of 15, 16 or 17 times the per capita income. In Western European countries the cost was higher and of the order of about 25 times the per capita income. In India it was very much higher; of the order of about 80 or 90 times of the average income per person. U.S.S.R., Japan and U.S.A. are in a relatively favourable position to increase the research ratio. It is somewhat more difficult to do so in the advanced western countries like U.K., France, etc., and far more so in India.

20. *Selectivity within industry*: Within industry, there is a very high degree of selectivity of R & D expenditure by type of industry, and by the size of the firm. Manufacturing industries have a proportionately larger share of R & D expenditure than non-manufacturing industries such as construction, transport, agriculture, commerce etc. Again, wihin

manufacturing industries, five or six groups of industry, such as, aircrafts, electronics and electrical equipment, chemicals, metals, machinery, motor cars and transport equipment, absorb a large share, of the order of 70 or 80 or 90 per cent, of the total R & D expenditure in the advanced countries (such as, U.S.A., U.K., France, Sweden, Netherlands and Japan).

21. R & D expenditure has a strong association with the size of the enterprise being much higher in the case of larger firms. For any particulai type of product there is usually a minimum size of the R & D staff below which the results of R & D would be ineffective. To start even a small R & D unit is expensive. The cost of the R & D unit must be recovered from sales; and has to be, therefore, generally a small fraction of sales, say, of the order of 10 or 5 per cent or less. That is, sales must be large enough to make it possible to start R & D. As larger firms will have a larger production and larger sales, they will be in a more favourable position to incur R & D expenditure.

22. Progress of industrialisation would tend to increase the size of the firm, and the share of manufacturing industries in the national economy, and would create increasingly favourable opportunities for the emergence of more sophisticated, science-based industries which have larger shares of R & D expenditure. The research ratio may be expected normally to increase with the growth of the economy and increasing per capita income. On the other hand, in the early stages of industrialisation the size of the firm would be comparatively small; also it would be difficult, though not impossible, to take up sophisticated, science based industries generrally. It would be, therefore, difficult to bring about a rapid rise in the R & D expenditure within industry, in advance of the general progress of industrialisation and economic growth.

23. *Non-military research ratio*: India and most of the other developing countries do not have much military research and development. It is, therefore, of interest to consider the research ratio based on, not the total R & D expenditure, but of the non-military or civilian part only. The position in 1962 or thereabout was as follows: Japan and Netherlands had the highest non-military research ration of the order of 1.4 and 1.6 per cent respectively. U.K. and U.S.A. had an appreciably lower level of 1.3 and 1.2 per cent respectively and France a much lower value of 0.8 per cent. Five most advanced countries in Western Europe (Belgium, France, Germany, Netherlands, and United Kingdom) taken together and also Sweden had a non-military research ratio of about 1.1 per cent. Definite information is not available for military R & D expenditure in other countries in Europe; allowing a minimum of 10 per cent for military R & D expenditure in such cases, the non-military research ratio would be for Switzerland about 1.2 per cent, Norway 0.7 per cent, Canada 0.6 per cent, Denmark 0.4 per cent, and Austria 0.4 per cent.

24. *Non-military, non-industrial research ratio*: A second point to be noted is that most of the R & D expenditure is incurred within industry, the proportion varying from 50 to 75 per cent in different countries with two-thirds as a representative figure. If industry is excluded the research ratio would be of the order of about 0.5 per cent or a little less in U.K. (0.53), Japan (0.47), and Netherlands (0.45); at the level of about 0.4 per cent or a little less in five Western European countries taken together (0.41), West Germany (0.39), Belgium (0.38), Norway (0.37); of the order of 0.3 per cent or less in U.S.A. (0.31) Sweden (0.27), Canada (0.26), and at the level of 0.2 per cent or less in Switzerland (0.21) and Austria (0.16)..

Research and development in India

25. *Research ratio in India:* In India reliable estimates are not yet available about the total R & D expenditure. Information from one source gives an estimate of expenditure of Rs. 45 crores ($ 95 million) with G.N.P. of Rs. 231 billion ($ 48.6 billion) and a research ratio of 0.19 in 1964-65, and an estimate of expenditure of about Rs. 54 crores ($ 114 million), G.N.P. of Rs. 235 billion ($ 49.9 billion) and a research ratio of 0.23 in 1965-66. According to another source the R & D expenditure was much higher and the research ratio was about 0.33 per cent in 1964-65; a difference of over 40 per cent between the two estimates may be due partly to expenditure on what I have called 'technical services'.

26. The Indian expenditure refers to non-military research and development. Also, in India there is very little research and development in industry whether in the public or the private sector. The share of industry is possibly only about 4 or 5 per cent of the total R & D expenditure compared with 50 to 70 per cent in advanced countries. The appropriate comparison of the Indian figure of research ratio would be, therefore, with the non-military, non-industrial research ratio in the advanced countries, which we have seen is at the level of 0.4 or 0.3 per cent in many advanced countries, and lower in other advanced countries. The position in India is not unsatisfactory from the point of view of R & D expenditure even if the lower estimate of about 0.2 per cent is accepted; the higher estimate of 0.33 would make the non-military, non-industrial research ratio in India as large as that in most of the highly industrialised countries in the world.

Number of Qualified R & D Staff in India

27. It is extremely difficult to make international comparisons in respect of the number of qualified R & D staff bacause of the wide variations in definitions and standards arising from differences in the structure and quality of education in different countries. In India a minimum estimate of the number of qualified persons engaged in non-military R & D who have the master's or a higher degree or a university degree and good research experience, would come to about 15,000 persons in 1962-63. A second estimate would place the number at 27,000. If those persons with a pass B.Sc. degree who are associated with R & D are included, the number may go up to 44,000. The actual number would be something between 15,000 and 44,000 (a range of nearly three times), depending on the standards of acceptable qualifications adopted for research workers.

28. The number of qualified R & D staff in some of the advanced western countries is as follows: Belgium 12,000; Canada 10,000; Denmark 2400; France 37,000; Germany 40,000; Netherlands 13,000 and Sweden 19,000. These are figures for the whole staff engaged on both military and non-military R & D ; the number engaged in non-military R & D would be appreciably less. It is seen that the number of R & D staff in India (whichever estimate is taken) is of the same order as that in France or West Germany and larger than that in many other highly industrialised countries. Only U.S.A., U.S.S.R., U.K., and Japan have appreciably larger R & D staff than India.

29. It is worth mentioning in the present connection that the stock of scientists and engineers in India with university level education is estimated as 215,000 (of whom 108,000 were scientists, 80,000 engineers and 27,000 agricultural scientists in 1963) which is larger than the stock in most of the advanced countries with the exception of U.S.A., U.S.S.R., U.K., and Japan. If the diploma level personnel are included, the number would be nearly 600,000 which places India, on paper, in a very favourable position.

30. If a comparison is made for the same type of activity, the expenditure which is being incurred in India at present for non-military, non-industrial research and development, or the number of persons engaged in non-military R & D or the stock of scientists and engineers in India, would compare favourably with the advanced countries of the world with the exception of U.S.A., U.S.S.R., U.K., and Japan. Paper qualifications, however, are not enough. Experience of R & D activities and quality of work are the really important factors. In the U.S.A., out of 214,940 scientists (excluding engineers) whose names were in the National Register in 1962, 24 per cent had more than 10 years experience, 20 per cent between 5 and 9 years and 18 per cent less than 5 years of experience (with 8 per cent not reporting).[3] Among persons with a doctorate degree, 62 per cent had more than 20 years experience and only 11 per cent less than 5 years experience. Corresponding figures are not available for India but it is almost certain that the proportion of younger men with little experience of R & D work, would be much larger in India. Rapid expansion of staff in such a situation would result in a good deal of ineffective work. Lack of experienced worker, and not money, would be the real limiting factor in expanding R & D activities in India and other developing countries.

Evaluation of R & D in India

31. *Impact on economic growth*: Has there been an adequate impact of research and development on economic growth in India? This is the crucial question. There is a view that the impact on economic growth has not been adequate as the results of research do not seem generally to have led to any appreciable improvement of the quality of the products or of any reduction in the cost of production in practice. There are no doubt many complex reasons which call for careful and continuing study.

32. *Need of R & D in Industry*: To have a real impact on economic growth the urgent need in India and in other developing countries is to bring R & D close to production as in the advanced countries. R & D expenditure within industry has an in-built system of evaluation in terms of the cost of R & D in relation to sales, that is, the benefits which may be considered to be accruing from such expenditure. Also, there is an in-built system of feed-back. In firms in which R & D is successfully used to improve the quality of the products or to lower the cost of production there is continuing incentive to plough back a part of the profits to research and development. Benefits accruing from R & D would also promote economic growth which would facilitate making more funds available at the national level for research and development.

General Considerations

33. Sustained economic growth can be achieved only with industrialization, which in its turn would call for the emergence and the continual strengthening of the scientific tradition. The two main objectives of research and development in India and other developing countries must be, firstly, to foster the growth of the scientific tradition through basic research; and secondly, to promote rapid economic growth through industrialization.

34. The transition from an agricultural society to a modern industrial economy, is an extended period of crisis in social, economic and political affairs. Scientists and technologists must look upon the period of social transformation as a continuing emergency like war, and help in improving the efficiency of production using all forms of activity, whether they fall within or outside the conceptual framework of research and

development in the advanced countries. What I have called the technical services, are of great value in increasing productivity. Such activities should not be despised or considered to be below the dignity of qualified scientists and technologists, but must receive proper attention together with research and development during the period of the crisis of industrialization.

35. I would go further. It will be useful in a country like India to copy faithfully such instruments, equipments and hardware which are in urgent demand but which have to be imported from abroad. Qualified scientists and technologists can guide such imitative fabrication, and study ways and means of making improvements in the design or adaptations of the imported hardware for domestic raw materials or local conditions of work.

36. Qualified scientists and technologists have a special responsibility to associate themselves with the design and development of instruments and equipment for scientific and industrial purposes. The highest priority should be given to applied research and development necessary for the manufacture of such scientific instuments and equipment for which the demand is sufficiently large to make domestic manufacture economical, or for which domestic manufacture would be advisable to save the foreign exchange which would be otherwise required for imports.

37. Research and development have at one end, basic research; and at the other end, development; with applied research as a connecting link between the two ends; and technical services as the infra-structure. During the period of the crisis of industrialisation greatest attention must be given to the two ends, basic research at one end, and development with production at the other end, and also to the expansion of technical services. In underdeveloped countries it may be advisable to start with technical services and development close to production, to improve productivity with the help of already available technological knowledge, and to take up applied research only when necessary for clearly identified purposes. Applied research may also be taken up from the other end of already available results of basic research but only when necessary to meet clearly identifiable purposes.

38. During the period of the crisis of industrialization, applied research must be purposeful, programmed and formulated on a project basis, for concentrated effort over specified periods of time, in accordance with national priorities for food, defence, export promotion, import substitution and economic growth generally. It is important to guard against thinking of applied research as an end in itself. It is necessary that the results of basic research should be published in the form of papers. There is no such clear need in the case of programmed applied research the objectives would be fully realized even if the results of the applied research remain unpolished but are successfully utilized, through necessary development, in promoting the production of useful things, or in improving the efficiency of production. All projects of applied research must be, therefore. periodically reviewed on considerations of a cost/benefit type. Programmes which are not promising, or are not likely to be completed within a specified time, must be discontinued to enable the R & D staff, who would be released by such termination, to be deployed on other high priority projects.

39. Basic research may be considered to be a good thing in itself which satisfies the intellectual curiosity of the human mind and is also indispensable for the training of research personnel for the future. In the developing countries basic research has a special value of its own for the strengthening of the

scientific tradition. In contrast, applied research is only a means to an end and is useful only when it leads to development. Development, in its turn, is also not an end itself but a means to an end, namely, the production of something which is useful or some improvement in the efficiency of production.

40. I have been pressing for a very long time for more funds for science, for R, D & S, in India and in other developing countries generally. We need more funds and more facilities for science. But expenditure is necessary but not sufficient. We must also think of the reality behind the expenditure, of the research personnel and the research programmes. We must undertake the planning of scientific research essentially in terms of physical programmes and requirements of personnel, equipment and facilities; requirements of funds would then come out as the monetary counterpart. Once attention is focussed on the physical realities, priorities and limiting factors would gradually become clear, such as, shortage of experienced research staff, lack of instruments and equipment, need of bringing applied research and development closer and closer to production, and the expansion of the technical services. We, as scientists and technologists must also ourselves undertake the responsibility of evaluation of our programmes, and strive continually to utilize available funds and facilities in the most effective way for the fulfilment of the objectives of science and technology.

REFERENCES

1. NSF. 65-11, May 1965, p. 2.
2. NSF. 65-11, p. 10.
3. NSF 61-16, pp. 8, 10

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Scientific Development in the Afro-Asian Countries Vis-a-Vis New Scientific & Industrial Revolution

Dr. S. Husain Zaheer*

The world, as a whole, is passing through one of its most glorious phases of human achievement. Advances in science particularly nuclear and space research have exceeded in fact the most imaginative creations of science fiction. Countries which are leaders in the field of science and technology, such as the U.S.A., U.S.S.R., West Germany, U.K., Japan have achieved rates of growth of the gross national product and the standard of living for their citizens which have made drudgery of human labour a thing of the past. The gap between discovery and its utilisation has been shortened. Discoveries in the field of medical research, polymer chemistry, engineering and metallurgy have been translated into cures for diseases, industrial products, consumer goods and articles of human consumption which have created an altogether new concept of social living, human welfare and culture. There is, however, a great imbalance in the world situation, because 60-70% of the humanity still lives under medevial conditions, suffering from acute scarcity of goods and materials and on the verge of mal-nutrition and starvation. This section of the human populace happens to inhabit the Afro-Asian continents. It is most apt that scientists from Asia and Africa should assemble together in India—one of the earlier amongst the countries in Asia to attain political independence.

The most important feature of the post-Second World War era is the emergence of a large number of countries in Asia and Africa as sovereign nations. Till about twenty years back, most of them were colonies or dependencies of western nations. Their status was that of suppliers of agricultural products, ores and minerals and other raw materials. Their industrial and agricultural developments were suppressed and their economy stagnant. Political domination served to hold them down against any independent efforts to exploit their resources for the good of their own people to enable them to join the world's trend of scientific achievement and progress. Their struggle for the political independence was thus to establish the essential pre-requisites for their national growth. Most of the Afro-Asian countries have now attained this first stage. These Countries are backward in the field of science, and the general level of industrial and economic development. Their backwardness can be examplified by the fact that all the countries in Africa put together publish 650 scientific journals which is one-fifth in number of the journals published by one of the comparatively smaller countries in Europe. The less developed countries have, however, one advantage. It is like building a new house where you can

*Director General, Scientific & Industrial Research, India

experiment with patterns and designs entirely suited to your own requirement. These countries also have access to the storehouse of world experience in science and technology and need not have to recreate technology from a scratch. They can create conditions for an accelerated growth and obtain greater returns from a comparatively lesser investment of resources. Given optimum conditions of growth, development and resoures, it is conceivable and possible to bridge the gap between the developing countries and the advanced countries.

The first pre-requisite for progress is a period of political stability and peace for the developing nations. Art and culture, science and technology, industrial and agricultural development grow best in conditions of peace. It may be contended that the rate of discovery is faster under conditions of war but here I am not talking of discoveries and inventions, but of what is more important to the developing countries, utilisation of known inventions and discoveries and the application of science and technology to industrial and economic development. An equally important requisite is an enlightened leadership at the national and State levels, who have a firm belief in science and technology as the instrument of industrial development. My country had the rare good fortune of being gifted with such leadership in the personality of Jawaharlal Nehru who gave peace, stability and enlightened eadership for nearly two decades to this country.

Under Jawaharlal Nehru's leadership, India adopted a Science Policy through a Resolution in the Parliament in 1958. The Resolution declared India's faith in adopting science, technology and scientific method as the means of industrial and economic progress. Every country in Asia and Africa should have a Science Policy to generate the accelerated pace needed for rapid industrial development. The Governments in the developing countries should declare their support to science and technology and give scientific personnel, scientific educational institutions and scientific societies and organisations ample resources to enable them to build up the infra-structure for industrial research and development. In the initial stages, some wastage of effort and under-utilisation of scientific and technical personnel and resources is inevitable. It should be the task of the governments to shelter the growing institutions from misinformed and short-sighted criticism. Conditions must be provided for quite a time, for sheltered growth of science and technology in these countries till a scientific climate and temper is created. Given time, scientific and technical organisations will be able to forge links with industrial institutions and begin to have the necessary impact on industrial and economic growth.

The most essential requirement of development is the availability of scientific and technical personnel. It should be the effort of all developing countries to build up a system of education with deliberate bias in favour of science and technology so as to have the necessary personnel resources for industrial development. Some countries have sent, their younger scientists for training in scientific and technological institutions in the advanced countries. In this process, a certain amount of brain drain has taken place, by some of the trainees staying behind, tempted by the higher emoluments and standard of living of the advanced countries. The more difficult problem however has been the differing conditions of research and development work. Research and training in the advanced countries do not and cannot have the requisite relationship with the resources and requirements of the developing countries. The countries in Asia and Africa where the

levels of development do not vary so greatly could work out a system of inter-change in regard to training of personnel, while not completely cutting themselves off from advanced countries for higher training in chosen fields of science and technology.

An equally important problem for the developing countries is the absence of knowledge of their own natural resources. The shortsighted policy of intensive exploitation of ores and minerals unaided by extensive survey and exploration have resulted in denuding of the colonised countries of their valuable assets. To build up their industries, it is essential for the developing countries to find out qualitatively and quantitatively their mineral and agricultural resources. The first to be set up should be the survey organisations, with bands of geologists, geophysicists, mineralogists, botanists, zoologists and scientists in other disciplines to assess the resources potential on which to base their industrial and economic super-structure. This phase would perhaps merge into the next phase of setting up of multipurpose and specialised laboratories manned by scientists and technologists and equipped with essential instruments and equipment for investigation and utilisation of the proven resources.

State Planning of the economy for rapid progress is far more necessary for developing countries which have a low industrial level, stagnant state of agriculture and rising population. These countries have to husband their limited resources with utmost economy and create conditions for development. The governments in most cases, will have to come forward to set up capital intensive and strategic industries to lay the basis for healthy industrial development. Private entrepreneurs may not be able to raise resources for industries such as fertilizers, steel, petroleum refineries, cement machine-building, heavy engineering needing heavy investments. The State governments would have to come forward to play the industrialist and the manufacturers' role particularly in the fields of low returns and heavy investment. The desire for rapid industrial development and attaining standards of living comparable to the advanced countries on the one hand, and the paucity of resources on the other create conditions where developing countries may be tempted to take the easy way of dependence on the more advanced countries. Rather than letting their scientists make some initial efforts by experimentation to generate technical know-how or copy out and duplicate instruments and equipment, the governments may choose the path of inviting foreign collaborations with capital participation, import of equipment, know-how and technology as turn-key jobs. This may be particularly attractive because shortage of resources is a major hinderance in the way of obtaining capital equipment essential for the setting up of industries. It is here that I would like to sound a word of caution. The nations of the world have not yet developed to the stage of disinterested philanthropy which may permit a poorer country to obtain everything it may need without sacrificing its economic and political independence. There may be no visible strings but it may result in complete dependence of the developing countries on foreign skills and technology to the detriment of its own natonal interest. For the developing countries, it would be wise to follow the path taken for its industrial development by Japan, which has in recent years, outstripped in some fields of technology the more advanced countries by a careful direction of its relations in science and technology with the advanced countries. The Ministry of International Trade and Industry in Japan is known to be very careful in importing foreign technology which is permitted only in cases where it cannot be developed easily within the country or is definitely

superior. Japan pays higher price for outright purchase of design and equipment which may be copied again in the country. By this means the country is permitted to catch-up at a higher stage of development and integrate the experience of the advanced countries with the genius of its own scientists and technologists. On the other hand, there have been examples of countries which have taken loans and aids, made heavy imports of equipment, know-how and technology and have come dangerously close to a stage of continued dependence. Such a situation is likely to create political pressures which may make the industrial and economic development dependent upon policies of other nations and jeopardise national independence.

Machinery must be created by all developing countries which is capable of discriminating and choosing areas of industrial development where maximum national effort should be concentrated and resources deployed for maximum effect. This machinery should also be capable of deciding on the technologies to be developed within the country or imported from advanced countries and the price to be paid for it. It is difficult to be dogmatic but it will be a safe decision if the countries in Asia and Africa decide that foreign aid and assistance should only supplement the national effort without in any way effecting adversely the goals of their national policy of self-reliant industrial and economic development. International agencies such as UNESCO, FAO, WHO and Centre for Industrial Development of United Nations have periodically made studies of these problems, have through their forums encouraged discussions and deliberations on the problems of the developing countries. They have provided experts, equipment for equipping the research institutions, scientific and technical books, fellowships and training facilities in advanced countries. A recent study carried out by the Council of Scientific & Industrial Research of India has revealed that these resources could have been more useful if the guidelines on which they could be utilised by the recipient countries were more clearly defined. Indiscriminate acceptance of aid, loans and technologies from the advanced countries may result in reintroducing a system of exploitation which may really be a reincarnation of technological colonialism by the advanced countries.

Since the world is still divided into power blocs with mutual jealousies and hostility, the temptation of winning over the poorer developing countries by giving aid and technical assistance for political advantage is not unknown. The developing countries may consider acceptance of such assistance as an easier path to industrial development but this will only be illusory. The other alternative for rapid development would be for the developing countries of Asia and Africa to develop a system of inter-dependence in their programmes of training of personnel, exchange information on equipment, instrumentation and technical know-how and learn by their mutual experiences in operation of Science Policies and planning and the application of science and technology for industrial development. Having attained a degree of self-dependence and self-reliance with their own efforts, they would be in a better position to pick and choose even from the advanced countries as to what will be to their maximum advantage and make optimum use of the aid provided by international agencies and organisations. The path of industrial revolution in the developing countries is not an easy one and needs leadership and talent of the highest calibre at national and scientific levels.

Scientific Cooperation among The Afro-Asian Countries for The Development of Research in the Field of Hydrology

A. SHATA*

The aims, objectives, programmes and other aspects of the International Hydrological Decade (IHD) sponsored by the Unesco for the promotion of coordinated development of research in hydrology in various countries are discussed. A scheme of cooperation among Afro-Asian Countries, within the overall framework of IHD, with emphasis on the national and regional problems of hydrology, particularly with reference to its bearing on agricultural and industrial development is presented.

The National Committee concerned with the Organization of the first Afro-Asian Scientific Conference, has asked the writer to prepare a report on the cooperation among the Afro-Asian countries for the development of research in the field of Hydrology. While preparing this report the following aspects were considered: (1) personal experience in a good number of countries both in Africa as well as in Asia; (2) data available about the activity of the UN's Agencies in the region during the past decade; (3) the present International Programme on scientific Hydrology (IHD); and (4) data available about the activity of the Scientific Council of the Organization of African Unity.

With regard to the first point, two primary remarks would appear to be considered. Firstly, the writer noticed that well trained scientists are lacking in the field of hydrology. Secondly, there is appreciation, particularly within the countries situated in the arid and subarid Africa and Asia, to develop knowledge in applied hydrology and hydrogeology.

About the second point there has always been the expression of the urgent need to establish regional institutes and research centres. Their responsibilities have been defined as follows: (1) coordinating the collection of information on water resources and their use; (2) analysis of experience gained under the different UN Research Programmes; (3) endeavour to collect all relevant information that can be supplied by non-governmental organization and bilateral technical assistance programmes; (4) training of local and regional personnel; (5) conducting research work in hydrology and (6) publication of information and preparation of local and regional hydrological maps.

Concerning the third point, i.e., the international programme on scientific hydrology, a good number of the Afro-Asian countries are now participating in its activities. Out of the 21 member states represented in the Coordinating Council of the International Hydrological Decade, seven countries are from Africa and Asia. This international programme aims to improve man's ability to use and to conserve water resources. It also aims at the advancement of Hydrological Sciences through international cooperation.

* Desert Institute, Cairo, UAR

Eventually, the activities of the Scientific Council of the Organization of African Unity include much about the Natural Resources. Special emphasis has been given to water resources. During one of the meetings organized by that Council, and held in Addis Ababa in early January 1966, the following recommendations have been made in connection with water resources: (1) expansion of facilities for the accelerated education and training of water resources personnel at all levels. For this purpose, it also recommends that the Commission for African Secretariat invites the appropriate UN agencies to meet in Addis Ababa to evaluate regional needs and facilities and to work out a coordinated programme for accelerated personnel training; (2) acceleration of investigation for the evaluation of water resources, with particular reference to arid and semi-arid zones; (3) intensification of measures for evaluation of surface water resources and losses due to natural phenomena; and (4) accelaration of research into the technology and economics of desalinization of sea water and brackish water.

Subject to the above mentioned consideration, this report will consist of an introduction concerned essentially with the elucidation of the subject and the reviewing of the activity of the IHD. The second part will be devoted to the presentation of the scheme of cooperation in connection with hydrological research work in the Afro-Asian Countries. Emphasis will be given to national and regional problems of hydrology particularly with regard to its bearing on agricultural and industrial development.

Hydrology is "the science of the waters of the earth, their occurrences, circulation and distribution, their chemical and physical properties and their interaction with their environment and with various forms of human activity. Thus, the domain of hydrology encompasses the full range of water phenomena on and in the earth, including surface water, soil moisture, ground water, glaciers and ice caps, and atmospheric moisture". The bearing of oceanography to the subject is only emphasized from the point of view that oceans are regarded as "the source from which evaporated water is transported to the land masses". Likewise, "atmospheric water" is mainly the concern of meteorology.

Among all natural sciences, hydrology has received special attention during the past five years. Two reasons stand for this: (1) pessimistic cry that the earth is subjected to an increasing desiccation phenomenon; and (2) tremendous increase in the consumption of water both due to rapid growth of population and the higher standard of living.

This means that the problems of the shortage of water will be acute all over the world and will be more pronounced in arid and semi-arid areas. Further, the problems concerning the various aspects of water, are not only particular to such arid regions, but they occur also in humid areas where destructive flood water-logging of land and poor quality of water are common phenomena.

Activity of the International Hydrological Decade: An important step towards the solution of such problems has been taken by the UNESCO in initiating the IHD aimed at "the promotion of a coordinated development of research in the field of Hydrology." This includes appraisal of our state of knowledge of world hydrology, the establishment of a basic network to provide fundamental data on different hydrological systems, research in selected hydrological systems and representative basins, research in special problems that call for international effort, training of specialists, technicians at all levels in different fields of hydrology in developing countries, and eventually exchange of in-

formation. The scientific programme includes the following points: (1) water balance studies; comprising precipitation, surface water soil moisture, ground water, snow and ice, etc.; (2) geochemical studies of natural waters; (3) studies about erosion, stream bed evolution, transport and deposition of sediments; and (4) studies on the influence of man and hydrological phenomena.

During the past three years, the IHD has achieved the following: (1) stressing the need to establish National Committees for hydrology in a good number of countries (±50); (2) establishing the coordinating council with the membership of 21 countries; (3) establishing the following working groups on: (a) network planning and design; (b) representative & experimental basins; (c) hydrology of fractured limestone terrains; (d) nuclear technique to determine water content in the unsaturated and saturated zones; (e) floods and their computation; (f) exchange of information; (g) education; (h) influence of man on hydrological cycle; (i) water balance; and (j) hydrological maps,; and (4) organization of the following symposia and training courses: (a) symposium on the hydrology of fractured limestone; and (b) course on the hydrology of water in the unsaturated zone.

A Plan for Cooperation

The number of Afro-Asian countries participating in the activities of the IHD constitute less than 50 per cent of their total number. This may mean that more than 50 per cent of such countries, have apparently no special activities in the field of hydrology. Among the several reasons standing for this, is the lack of well-trained scientists, who are, of course, considered the initiators of interest in the subject, both from the point of view of research work, and development work. If such is the case, then the first step towards initiating and/or accelerating hydrological work, would be to seek for an effective scheme of cooperation among the Afro-Asian countries. This cooperation must take place on the national level, on the regional level and eventually on the continental level. Advanced countries, having reasonably large number of specialists dealing with hydrology must have a leading role to; (1) make the results of their experience in this field, generally available to less advanced countries; (2) lend the services of their eminent scientists and technicians to other countries; (3) offer fellowships, for post graduates and under graduates of other countries; and (4) contribute in financing national and regional projects.

On the national level, countries which do not have at present national committee of hydrology and/or national committees for water resources, are requested to establish such committees. In general, the form, the national committee takes in each country, will depend, of course, on local conditions. In countries where the problem of personnel is acute, careful measures must be taken. The following proposals may warrant considerations: (1) select the members of such committees from specialists in other branches of science nearer to hydrology, e.g., geology or engineering; and (2) if such specializations are not available, the help of neighbouring countries is requested according to bilateral agreements.

The task of such committees is as follows: (1) selection of the research projects in priority areas particularly where development of water resources is vital; (2) stimulate solution of related problems through conducting scientific research, either by use of national facilities, or through cooperation with neighbouring countries, or even through the aid of UN agencies; (3) give facilities for publication and exchange of information and also to stimulate the translation and publication of general documentation, particularly

those having a direct bearing on such problems; (4) arrange for the training of specialists and technicians needed to participate in such projects; (5) on the long run, such committees could disseminate, suitable teaching material in universities or schools and encourage seminars and study tours for young researchers, promote discussions, lecture course, etc. Special attention must sometimes be given to technical schools; (6) give the advice to the governments concerned as to how and when there is need to establish specialized Departments and Research Institutions or research centres concerned with water resources; (7) co-operate with the neighbouring countries in the study of regional problems pertaining to water resources; and (8) cooperate with the UN agencies in the activities of IHD.

Before giving the elements of cooperation on the regional level, definition of the term regional will be given. In connection with water resources, the term regional applies to a hydrologic, "basin", as for example, the "great Artesian basin of North Africa", the "Nile Basin", the "Mesopotamian Basin" etc. Such basins have in addition to their common physiographic and geologic features, problems which necessitate adequate solution through regional cooperation. These include the problems of scientific and technical, financial, organizational, political and social, and eventually shortage of well-trained staff. The term regional can also be applied to a wide area of a zone having similar climatological conditions, e.g. the "Arid-Zone Belt of North Africa and Central Asia." Such conditions are among the important factors which determine the occurrences of water in that area or zone. For each basin and/or a climatological zone, it is suggested to establish an advisory committee. In such a committee, the national committees concerned must be represented by at least one member.

The task of the advisory committees will be initially to call for a general meeting of experts from countries within each basin or zone. The aim will be to determine the salient features of such basins and the operations for future activities. Consideration of the previous experience of the UN agencies with regard to similar basins or zones, must be made, in order to avoid causes leading to some kind of failure or disproportionally small success. In this connection, reference to the UNESCO project for the "Over-All Study of The Artesian Basins in Northern Africa", will be made. This study was convened in a meeting held in Tunisia during 1964. Although such basins are elements of a large and unique artesian basin, having almost the same hydrological properties, the attitude of the meeting was to split it into divisions. This attitude was based on weak view points, which were not acceptable to all experts attending the meeting. For that reason, the adequate execution of the programmes of research made for the local divisions, were not appropriate. If instead a short term plan, say for five years, has been established, for an over-all synthesis of that basin, it would have been more effective. This plan must cover the most urgent needs and problems, and we must propose remedies which take into account the practical possibilities of the different countries such as scientific staff, facilities, laboratories and the like. This plan must be very precise and subdivided into annual steps. An annual report must provide a realistic means of checking the progress of the work and making the necessary adjustments.

The task of the advisory committees includes also the following to: (1) determine pilot research projects in priority areas within a basin or zone; (2) make plans for the cooperation of the national committees to stimulate research work in such priority areas; and (3) find out when and where

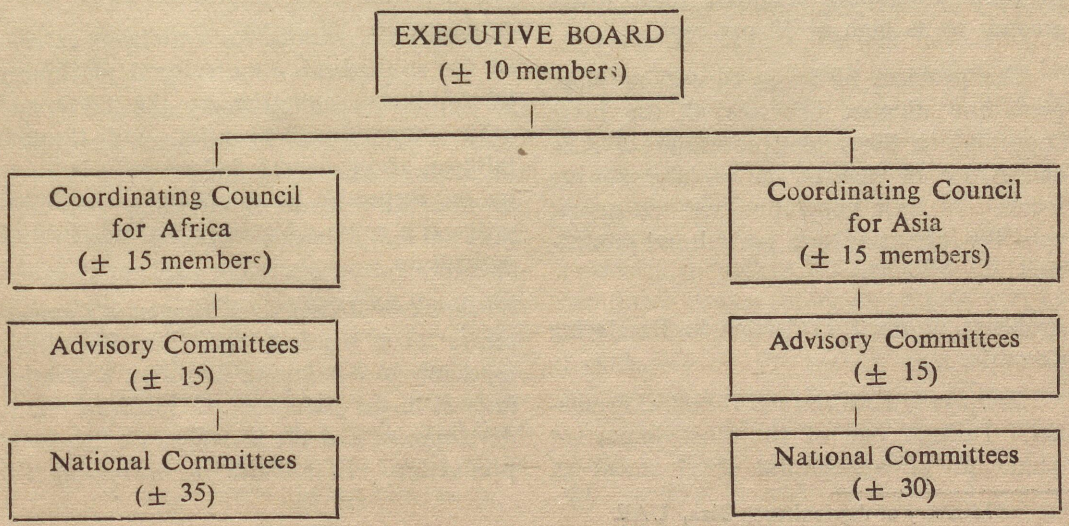
there is need to establish the following centres at the regional level: (a) Research Centres; (b) Documentation Centres; (c) Training Centres; and (d) Consulting services. The problem of financing such centres can also be considered by the advisory committees and proposals can then be submitted for approval to the Coordinating Councils of Hydrology for the Afro-Asian countries; (4) make suggestions with regard to regional symposia, training course, fellowships, bibliographies and reviews of research in the basin, cartographic problems, problems of terminology, etc. These suggestions can also be submitted to the Coordinating Councils; and (5) follow up the activities of the UN Agencies within the different basins or zones.

On the continental level, cooperation in the field of hydrology can be achieved through the establishment of two Coordinating Councils, one for Africa and the other for Asia. Each council shall be composed from among the members of the advisory committees established for each basin or zone. Each committee shall be represented by at least one member. The main duties of such councils will be to coordinate the activities in the different basins. Emphasis must be given to financing research projects and also the different centres concerned with research, documentation, training, consultations etc.

Other duties include consideration of the programmes of the IHD in Africa as well as in Asia, particularly with regard to water balance, advanced research in hydrological phenomena and eventually exchange of information and standardizatoin of data.

For the coordination of the work of the two councils, an executive board can be established. Members can be selected from among the representatives of each council for two years period. It is essential that the Scientific Council of Africa, belonging to OAU, the economic commission for Africa, the economic commission for Asia, and possibly also other non-governmental organizations, take action in the meetings of that executive board.

SCHEME FOR THE COORDINATION OF ACTIVITIES WITHIN THE AFRO-ASIAN COUNTRIES IN THE FIELD ON HYDROLOGY



Cooperation among Afro-Asian Countries in the Field of Plant Protection

A.K. MOURSI*

The problem of serious losses due to plant pests and diseases in developing countries of the Afro-Asian region is challenging. Plant protection activities in this region face various difficulties including shortage of facilities and technical personnel. The threat of the foreign pests and diseases due to implementation of modern techniques is increasing. There is need for cooperation and coordination at least in certain phases of plant protection activities in Afro-Asian countries is emphasied. Certain suggestions in this regard are made. Special emphasis has been laid on training in research and pest control operations and it is suggested that training would include research fellowships, research training fellowships, training centres in fields of particular interest for research workers and technical staff, exchange of technical personnel and visits by experts to demonstrate new techniques and for training local staff.

INTRODUCTION

Plant pests and diseases play a very important role in world agricultural economy. One estimate plans the value of the world's total agricultural production at the village level at £ 50 to 70 billion, while the losses attributed to pests and diseases is at £ 10 to 20 billion or 15 per cent to 25 per cent. In some developing countries these losses amount to as high as 50 per cent.

The problem of losses caused by plant pests and diseases becomes all the more important in developing countries of Asia and Africa in view of the rapidly growing increase of their population and the urgent need for increasing their agricultural production.

Problems of Plant Protection in Developing Countries

Shortage of Facilities and Technical Personnel: Perhaps one of the most important handicaps of agricultural development in developing countries is the lack or shortage of facilities and proper agricultural institutions, *viz.*, educational facilities, libraries, research laboratories and equipment, credit, extension, cooperatives, trained personnel etc. In almost every country, therefore, there is a need for the strengthening of agricultural machinery and for the training of technical staff.

Facilities of various sorts are being extended for strengthening agricultural machinery in developing countries by the FAO and other international agencies, and through bilateral arrangements; but more to be done by the respective governments if significant progress is to be achieved in the wide field of agriculture.

Problems Arising from Economic Development: Since the last war, there has been, especially in developing countries, a growing interest in the promotion of rapid economic development and the increase of agricultural production. In addition to increasing the

*Ministry of Agriculture, Giza, UAR

yields of crops on their presently cultivated lands, many countries are reclaiming and including new areas of land under cultivation of expanding the culture of certain food or export crops.

It must be realized that the application of some modern techniques and practices which aim at increasing agricultural output such as the use of fertilizers might favour the increase of the population of certain pests and the incidence of some plant diseases; that adding new lands under cultivation or planting wide areas with a particular crop might result in the disturbance of the balance of nature and as a consequence some hitherto unknown or harmless insects might increase in numbers such as to become destructive and dangerous pests.

The increase in the volume of trade which becomes a sequel of economic development, coupled with the increased speed and range of transport, poses a serious threat to agriculture in many developing countries by increasing the likelihood of foreign pest and disease introductions. On the other hand, the increase in the volume of agricultural exports adds to the responsibilities of plant protection and quarantine services in exporting countries, since exports have to conform with plant quarantine regulations of importing countries.

In this connection it must be pointed out that under the present circumstances of world trade, a perfect plant quarantine is impossible and that the best we can hope for is to reduce the number and rate of foreign pest introductions to the least minimum level. In attempting to do so, we must realize that the system of international certification however valuable in reducing the dissemination of pests and diseases cannot be relied upon in their exclusion and that success in keeping out these undesirable guests must depend chiefly on the local system of guards against their entry.

Problems of Pesticides Use: Because of the lack of adequate information on plant pests and diseases and in view of the urgent need for their control, there has been an increasing reliance in many countries on the chemical method of control which offer easy and quick, but hazardous and never lasting, means of control. The use of this method under the socio-economic conditions prevailing in developing countries is beset with difficulties as will be indicated in the following few paragraphs.

One of the main features of land tenure in many Afro-Asian countries is the smallness and multiplicity of land holdings. Under these circumstances field crops are generally planted in small parcels and small areas of different crops may exist simultaneously side by side causing difficulties in the efficient performance of chemical control operations and presenting a special drift problem.

The limited means and education of the majority of the small holders and the limitations imposed by agricultural conditions should shape to a very large extent pest control recommendations and would at times hinder recommending simple and more effective control measures. Lack of appreciation of the dangers inherent in inhaling or getting into contact with pesticides on the part of pest-control workers, would for instance impose upon specialists their recommending the use of comparatively safer though not necessarily cheaper or more effective chemicals. This is all the more important especially in view of the fact that the use of protective clothes under many countries hot summer conditions, is well nigh impossible. Indifference on the part of farmers to the indiscriminate use of highly toxic systemic and other pesticides on vegetable crops, many of which are eaten raw, should limit the use of such useful chemicals.

The indiscriminate use of pesticides on food and feed crops, besides presenting a public health hazard, would also impede their free movement in international trade. Data on residues and permissible levels seem therefore necessary if hazards to consumers arising from pesticides residues on food and feed stuff and hindrances to the free movement of these commodities in international trade are to be avoided. In this regard the work of the FAO committee on pesticides in agriculture and the WHO expert committee on pesticide residues seems to be of special interest. It must be realized, however, that determining residues on food and feed stuff requires technical personnel and analytical laboratory facilities that are not always available.

Most of the Afro-Asian countries are, and will continue to be for some time to come, pesticides importers. Under the circumstances there is always the likelihood of having in these countries carry-overs of pesticides which, more often than not, have to be stored under tropical conditions that favour their rapid deterioration. Because pesticides have become one of the essentials of agricultural production and in order to reduce to a minimum carry overs of these chemicals many developing countries might well consider, whenever practicable, at least the local formulation of their pesticides. It is well realized that the developing of pesticides, manufacturing or even a formulation industry depends on the availability of raw materials, developed chemical industry and sound production economics.

Whether locally manufactured or imported pesticides have to comply with standard specifications which should ensure best performance, they have also to reach farmers in unadulterated form. It is gratifying to learn that the FAO is now taking keen interest in the question of pesticides specifications, but it still remains for governments to promulgate the necessary laws and relations governing pesticides movement and trade. It is to be recognized that the proper enforcement of pesticides laws requires technical personnel and laboratory facilities that are not always available.

Fields and Means of Cooperation

The Need for Regionalization: When the problems of plant protection in Afro-Asian countries are considered, it is noticed that some of these problems are of local nature and of limited interest while others are of interest to many countries in one or more than one region, still others are of rather general interest. The red locust of Africa, *Nomadacris septemfasciata*, is of concern to seven or eight neighbouring countries in central Africa; the desert locust, *Schistocera-gregaria*, attacks vegetation in a large number of countries over a wide belt in Africa and Asia while the specifications of pesticides and their application machinery and the problems of residue and storage of pesticides are of concern to all countries.

In view of the limited resources of developing countries in Asia and Africa, for the sake of making the most efficient use of these resources and because of the nature of many pest and disease problems which do not seem to recognize national boundaries, it is deemed necessary that there should be some kind of cooperation and coordination of at least certain phases of pest research and control programmes. Indeed, in many cases pest control problems of mutual interest to the countries of one or more than one region might best be solved if the concerned region or regions are taken as one unit.

In our approach to pest and disease problems on regional basis, it is realized that similarity of environmental and agricultural

conditions and pest and disease problems in a geographical area should be the basis of regionalization. While the FAO current system for regions and sub regions does not conform exactly with the above standard, it is felt that there are other merits in that system to justify its adoption in regional pest and disease research and control.

The division of Afro-Asian countries into regions with respect to plant pest and disease research and control does not imply that activities in any one region shall be in isolation from activities in other regions. On the contrary regionalization shall in effect bring about a greater degree of harmony and coordination of plant protection activities, a more effective cooperation, an easier exchange of information and a more ready access to pest and disease research and control activities throughout Asia and Africa.

Regional Plant Protection Commissions: Taking the present FAO regionalization as basis, a greater degree of cooperation among Afro-Asian countries in the field of plant pest and disease research and control might be realized with the establishment of the FAO Plant Protection Regional Commissions (PPRC) along the lines of the recently established the FAO Near-East Regional Commission (NERC) in the different Afro-Asian regions where such commissions have not yet been established. In line with NERC, the terms of reference of the new regional commissions, whose membership shall comprise member governments or the countries of the respective regions, shall in particular be: (1) to review the current situation of major pests and diseases in the region; (2) to advise on recent methods of control and survey techniques; (3) to advise on plant quarantine measures including standardization of procedures and techniques; (4) to consider problems requiring cooperation on a regional basis and measures for mutual assistance; and (5) to review and advise on coordination of research on plant protection so as to obtain maximum benefit with minimum cost.

The RPPC would, therefore, serve as media for regional and inter-regional cooperation and coordination of plant protection activities and for imformation exchange.

Coordination of Research Through Regional Research Institutes: Because of the shortage of facilities and of trained researchers, many developing countries, having common problems in a particular field of research, have found it useful to establish a regional institute for that field through the assisance of the UN Special Fund for Economic Development or through other arrangements. Since, however, many problems of agricultural pests, diseases and weeds, though common to large parts of any one region, would have to be primarily studied in different and specific areas, it is believed that Regional Plant Protection Institutes would most effectively function if they were composed of research units each dealing with special aspect of plant protection. The units would have to be established physically as national projects, though maintaining their regional character.

Besides their research responsibilities, the regional institutes, which would have to be open to nationals of different member governments, would serve through the facilities they offer as training centres for researchers in the region.

Coordination of Control and Quarantine Operations: Many plant pests and diseases do not recognize national barriers and would best be controlled if the whole area of their distribution is taken as one unit since development in any one part may have their repercussions in other parts. For the effective control of such pests a high degree of cooperation among concerned governments is needed. The desert locust, *Schistocerca gregaria,* offers perhaps the most noted example

of cooperation in the control of a single pest, not only among the governments of one but of many regions.

In the Near-East where wheat is grown the year round, the crop is attacked by the black stem rust, *Puccina graminis*, of which there are many physiological races. Barberry which serves as alternate host is widely spread in certain countries of the region. Because the spores of the rust can be transmitted over long distances across national barriers to attack wheat varieties in far away areas, it is imperative that epidemiological studies of the disease be undertaken in the whole area of the Near-East as one unit. Much progress has been accomplished in this regard through the cooperation of governments of the region in the identification and testing of the physiological races of the pathogen under the FAO wheat and barley improvement project. This has been to the advantage of wheat breeders of the region who have to breed for resistance against all races. A survey of the distribution of barberry with the ultimate goal of its control or possibly its eradication in the countries where it occurs will certainly diminish the threat of the disease.

With other pests and diseases, which though occur in more than one country are usually limited to the countries where they exist, such as the Mediterranean fruit fly, *Ceratitis capitata*, the pink bollworm, *Pectionophora gossypiella*, and the corn stem borer, *Chilo simplex*, a great degree of cooperation in the control of these pests might be accomplished through the free exchange of information on their control and through the exchange of technical personnel to observe and study or to demonstrate new techniques and methods of control.

The chance introduction of a foreign pest or a disease in any one country of a region is considered a threat to its neighbours, there is a great need for the countries of any particular region to cooperate in the exclusion of pests and diseases that are alien to their region. This might best be accomplished by the conclusion of a regional plant quarantine agreement. It is well recognized that the effective implementation of such agreement requires the existence of efficient plant protection services and adequate plant quarantine laws and regulations in the countries concerned.

Exchange of Information: Exchange of information on plant protection activities represents an important aspect of cooperation among countries. Reference was made earlier to the informational responsibility of regional plant protection commissions. In the field of information, the commissions would have to collect, compile and to circulate lists of major pests and diseases in the countries of their respective regions and of names, addresses and fields of interest of plant protection workers, research institutes and organizations, research publications and periodicals. They would have to promote the free exchange of scientific journals and research findings. Also, they have to be able to collect, compile and circulate regular reports on plant pest and disease situation.

Training: Reference was made earlier to shortage of trained personnel in the field of plant protection in Afro-Asian countries. This should emphasize the need for training in this particular field and for governments to take full advantage of all facilities offered in this regard through multilateral and bilateral arrangements.

Training would have to cover training in plant protection research and pest control operations and would therefore include the following: (1) research fellowships for high calibre research workers for extending their research studies at foriegn institutions; (2) research training fellowships for more junior research students for extending

(*Contd. on page 55*)

Problems of Science and Technology in the Present Context of Evolution of Underdeveloped Countries

D. D. KOSAMBI*

Some of the basic problems related to the state of development in the underdeveloped countries, with particular reference to science and technology are discussed. Some of the methods adopted for obtaining statistics are mentioned and their salient features discussed.

The Context : The background is all-important. Most of us are so deeply concerned with science and technology that we forget the context in which both science and technology must be applied. The context may be divided into three parts viz., political, economic and sociological, each deeply interconnected with the other. After all, we have no special science or technology of our own. Arabic science or Indian algebra, once the leading disciplines in the world, are both out of date. One cannot speak of African chemistry or South-East Asian engineering. Science and technology know no national frontiers. Therefore, the background before which they must function becomes a prime consideration for us.

The political situation is all-important. Most under-developed countries have been under foreign domination for a long time. That is, in fact, the primary reason for their being under-developed. So, freedom must come first. We cannot speak of science and technology for Angola and Mozambique, for example. The South African situation is even more complex. The land has a few outstanding technological developments; their laboratories and engineering works are by no means to be despised. But the real Africans are not even citizens in South Africa which remains for them under-developed while being in a quite satisfactory stage of development for property-owning whites and for the investors in London who stand on back of them. A similar situation is true, with lesser development of Rhodesia.

In such cases, we have no solution to offer, for our conference restricts itself to science and technology. However, the context tells us that the special problems in such countries cannot even be discussed here. There may be some exceptional possibilities. Perhaps, Hong Kong may claim to be one of those exceptions. But it would be difficult even here to consider the problems of Hong Kong without a solution of the obvious political question.

The second point, which many tend to regard as the main problem, is economic. In fact, the very word 'under-developed'

* Scientist Emeritus, Council of Scientific and Industrial Research, India

has this connotation, namely economic underdevelopment. Most of our countries lack the necessary resources for development, along with the actual manifestation of development: electric power supply, factories, railways and shipping, roads, motor transport, aeroplanes, and of course consumer goods and decent housing. The lack of resources is fortunately not there in all countries. Several Arab lands have discovered in oil and natural gas a commodity which can be exploited sufficiently well to solve their economic problems. However, whether the oil and other resources are properly used or not, depends once again on the context. First, the foreigner must not take away the lion's share, as happened in Iran for so many years. Secondly, those in power must feel the need for developing the country rather than for building palaces for their own families and living a life of Arabian Nights style. This remains, therefore, again an internal political matter, namely who plans and for whose advantage. It is not sufficient to announce grandiose plans; one has to convince the people that they stand to gain and to secure popular support. Developments in Ghana and Indonesia show what happens otherwise. Going deeper into this question would cause unpleasantness.

However, we reach one important principle here : *underdeveloped countries need a planned course of development, which necessarily implies a planned economy.*

Merely admitting this principle is not enough. The context once again thrusts itself upon your attention. Who does the planning, and for whose real advantage? The solution generally offered is to invite foreign experts to offer advice and draw up schemes. With the best will in the world, this will not succeed. The foreign expert has been used to planning for an entirely different purpose, in totally different surroundings. He pays little attention to local needs during the course of development. Oftener than not, the foreign expert is interested in selling the products of some companies with which he might be connected. Here, we could learn a good deal from Chinese experience. Is it not for the political problem, once again, which makes it impossible to secure cooperation from that country at such a meeting? But let me give some simple examples to illustrate what I mean.

In our sugar-producing cooperatives, bagasse was burnt for fuel. One brilliant and remarkably honest foreign expert suggested that this wasted most of the contents of the bagasse, except what remained in the ash. The cellulose could be used in paper manufacture, the wax and oils extracted for other purposes, and so on. In fact, Indian chemists had actually analysed the possibilities so that no foreign expert was needed. It was suggested that the proper factories be set up, by the cooperatives or sugar companies themselves, and the bagasse used to proper advantage. But in the event, this could not be done economically for two reasons. First, the factory machinery would all have to be imported. Secondly, the amount of baggase withdrawn from the fuel used in sugar manufacture would mean greater outlay for other fuel. Oil is too costly, we have no natural gas in the sugar-producing regions, and coal meant additional strain on the transport. In any case, the extra fuel costs would have made just the difference between a successful cooperative and one running at a small deficit half the time. The solution *in the present context* was given by Hungarian experts. They suggested, and worked out in detail a scheme for using the bagasse as fuel without losing all its value in other ways. The stuff was to be fermented in vats, and the gas used as fuel, converting one or more furnaces completely to gas burners, as the total amount of bagasse would

not suffice to stoke all furnaces. Then the wet sludge could be put directly on the fields, with very substantial savings in fertiliser. In fact, there was an added advantage in lightening the soil, which would be ruined by steady application of chemical fertilisers over a number of years. Finally, I pointed out that there would be an educational advantage. The peasant members of the cooperative could use the method for their own surplus bagasse, and also for cattle dung. At present, the cattle dung is dried into cakes and used for fuel, again destroying its value as fertiliser. Gas generated from such waste products would save all the fuel value without affecting the fertiliser value, and make for easier cooking as well.

The scheme has not been adopted, after all. The reasons were political and sociological, for the people who were to make the final decision had other ideas of their own. We still go on wasting the bagasse, though a factory or two for paper will eventually be set up—with foreign expert advice, of course.

The sociological context · Hitherto, I have only pointed out the difficulties without suggesting a solution. As a matter of fact, I hold very strong views on the proper political structure and the correct foreign policy for underdeveloped countries; but this is nor the time nor the place to develop those views. We are not here to offer political advice nor to suggest political courses. Similarly for the economic situation, most countries want and ask for capital. This conference cannot provide it, nor can it suggest means of raising funds. The scientific approach, on the other hand, tends to be rather vacuous and devoid of application unless these primary difficulties are solved. At least, we have proposed one main principle, namely that the economy must be planned, and the course of full development charted in outline, rather than left to individual initiative—which means leaving it to private greed. Most of us fail to ask why our countries are underdeveloped, when we go begging abroad for financial aid and technical experts. The reason for underdevelopment is precisely that our raw materials and our great markets were exploited by the foreigner to his own advantage. Our products were taken away for the prize of the cheap labour needed to take them out of the earth, and we paid the highest prices for the finished goods. In a word, the developed countries with very few exceptions are developed precisely because they made profit both ways from us; we were never paid the actual value of the things taken away. It is our resources that have helped in the development of the great industrialized nations of the world: yet we have to go to the same nations as suppliants, not as people demanding return of what is rightfully our own. Naturally no such demand could be enforced, even if it were made.

The foreign domination, whether in the form of colonialism or by other spheres of influence, has left an unfortunate mark on the society of our countries. The very languages we speak at such meetings are those left to us by the foreigner. This would not be bad, were it not for the insidious foreign way of thinking that too often goes with the languages. Most of us become honorary Englishmen, or Frenchmen, or the like. The models seen in New York, London or Paris don't seem out of reach in Bombay, Calcutta or New Delhi. But go a few miles away into the unaffected countryside and you will feel that you are in a different land altogether. Our development is not uniform. Attempts at catching up with foreign lands should not, but always do, accentuate the differences that already exist between towns and country.

Illiteracy, lack of technical education, lack of transport, paucity of telephones, cinemas, radio sets, absence of televisions—

all these seem impossible hindrances to any foreign-trained expert. Very few people see the need for and the possibility of development by getting the common people interested and by using the techniques available in the countryside. Let me again give an example of what I mean.

During the Japanese occupation, when all major industrial areas of China had been taken over and the Kuomintang armies pushed into the backlands, the problem of supplies became desperate. Chiang Kai-shek needed two million blankets for his armies, with no way of importing them from abroad. The blankets were supplied by a remarkable man and a remarkable movement, the Gung Ho (Work Together) cooperatives formed under the direction of the New Zealander Rewi Alley. He knew China well, having worked with its common people for over twenty years. The blankets were made by handicraft methods, were of satisfactory quality and capable of standing up under rough wear. Moreover they were supplied in less than a year. The methods by which the work was organized, with the overwhelming majority of workers illiterate, scattered in small units over nearly two thousand miles were undoubtedly the most astounding feature of the entire project. I only wish the history of Gung Ho were written, published and made available to all underdeveloped countries. In this case, Alley worked out a system of accounting that did away with almost all clerical work. The workers organized themselves in such groups as they liked, whether by families or by local craftsguilds, with Alley guiding them in each case at the beginning. The wool was produced by the shepherds of the backlands. Per bale of wool supplied to the spinners, one coloured bead was put in a bag. When a bale was used up on the spinning wheels, one bead was taken out of the bag, so that the residue could be tallied with the stock in hand. Per unit of yarn produced (large hanks), a bead of a different colour was put into another bag, similarly for the yarn supplied to weavers and units (blankets) woven. This system worked without a hitch and without a penny lost, with almost no paper work. It furnished employment to the neglected areas, and blankets for the soldiers.

I wish the story could end here. Unfortunately, the blankets delivered to Chiang's officials did not all reach the soldiers. Not a few went into the black market. Other corrupt officials managed to get themselves jobs as managers of district cooperatives or of the larger factory units, and stole as much as they could. At the very top came Chiang Kai-shek, [the CC group, the Kungs, Sungs and their selected henchmen, stacking away gold in the USA and letting the war take care of itself. The Academy of Sciences (Academia Sinica) had been evacuated to Chungking and Kunming. I recall making and sending copies of scientific papers from India for them, to help research that had no connection with the war or national needs; in some cases, I had also to arrange for publication. A few noble scientists and scholars were studying in India on generous subventions. One captain in the army had taken long leave to study Indian philosophy, while his company was fighting in the front line; he managed to get through the war years without difficulty. In other words, the social and political context was, after all, the determining factor.

Nevertheless, let me draw one more basic principle from this: In technological matters, particularly in consumer goods manufacture, *use local technique, organized by drawing in as many of the loca producers as possible.* Naturally this means *primary* producers not the money-lenders, nor landlords. It also means *organization without bureaucracy.*

I have to make clear the fundamental difference between this method and the philosophy of hand spinning on the hand wheel, *charkha*. The charkha is inefficient and uneconomic as a full time implement of manufacture. The late Mahatma Gandhi discovered mystical qualities in the art of hand spinning which raised it above yarn manufacture on power-spinning machinery. Having gone rather thoroughly into the statistics of the resultant *khaddar* cloth, I can assure you that its effect was political, but nothing to speak of in national production as such. This is in strong contrast, however, with handloom products which provide excellent patterns and have been a valuable aid to India's export drive. The handloom which means mill-spun yarn can be used as a part-time tool of production, especially in seasons when agricultural operations are slack. It saves transport of cloth and can break the shopkeeper's black-market monopoly—if used with proper care. It is also of considerable help in drawing partially disabled and otherwise unemployed people into useful production. Finally, it is simple in operation and easy to manufacture with local tools and materials. I would say—Use whatever local methods you are able to produce consumer goods, while heavy industry is being built up.

Planning : If science and technology have any use at all, they must fit into a plan. This does not infringe on the freedom of science, nor of the scientist in underdeveloped countries. There is an essential difference between the scientist in backward lands and his teacher in those parts of the world where science had long been developed. The latter is amply supplied with the costliest apparatus, good libraries and reference material, and a large number of auxiliary technicians. Such a scientist in advanced countries has often to fight for his freedom. His funds may come from some government project, dictated by third rate bureaucrats who insist upon secrecy for discoveries that ought immediately to be made public. Often, top scientific talent is wasted in 'defence' projects. This cannot be the case with underdeveloped countries. Mostly, they have no scientist of the first rank in world science, not even of high second class. To speak of freedom of such scientists, to do what they like at someone else's expense is to allow them to waste public funds in duplicating bad work done by second rate technologists in Europe or the USA.

Let the scientist be free, but let him earn his living by doing something for his country that comes in the category of vital needs. For example, many of you here are bound to be impressed by India's advance in science and may even persuade your own governments to copy us. But in what particulars? We have top class physicists, for example. Our Department of Atomic Energy is spending several hundred millions a year on an imposing establishment. But how much atomic energy is this country actually producing? The plant that should have been in commission in 1964 will not be operating till 1968 at the earliest. The delay has passed without criticism, while some politicians demand that we should produce the A-bomb to put us on par with the big powers. In effect, the establishment, we have, was built by foreign 'experts', is outdated already, and will produce atomic power—if run as designed —which is costlier than such power elsewhere and costlier than conventional power in India. Even then, all the basic cost will have been written off under the heading of 'research', science, or some such beautiful title.

Again, don't misunderstand me, India, like every underdeveloped country on the road to industrialization, needs every sort of power it can get. Costly as it is, atomic power will be cheaper than human muscle power or the power drawn from bullocks.

But is it the best source under our present economic conditions? Almost all the countries represented here have a much better and cheaper source of power available for their development—*solar energy*. This has the defect of being irregular, but can be put to uses where regularity is not in demand. For example, pumps for irrigation, of 5 to 10 horsepower capacity, run by solar energy would help our agriculture immensely. This would not need centralized administration and a fantastically top heavy basic establishment. If mass produced, the pumps would be cheap; their fuel costs nothing at all, and the irrigation they provide would be a real godsent. Maintenance would be easy and would also help mechanize the population in the most backward countries. Similarly cooking by solar energy will not only save such fuel as oil, but (in most of lands) the firewoods thus saved means reforestation of a countryside now denuded. Without such reforestation, no real agricultural reform is possible, as we all know. The desert can be reclaimed, using the very sun that now blasts it. I say all this only to point to a further principle: *In Planning, work out the complete economic cycle at each stage*. With solar energy, the cycle naturally includes reforestation and development of agriculture, just as in the use of bagasse the land crop cycle is to be restored. Science does not mean working with a few test tubes but for a whole country on a country-wide scale.

The last point can be driven home a little better. The cashewnut brings such high prices on the world market that many countries, including India, plan to increase cashew plantations to the utmost. I know something about this, having owned one of the best cashew-producing farms in Goa, years ago. The tree grows with virtually no care, n the deepest jungle. But it kills the undergrub completely. The water table is immediately reduced and erosion sets in. Where the cashew fruit-pulp is dumped not even grass will grow for year afterwards. The proper utilization of cashew plantations would require a strong chemical industry which would utilize the powerful phenolic byproducts of the tree, fruit, and nut-shell now entirely wasted. This again means a better developed country than most of us have the good fortune to live in. Should we give way to immediate greed, as some of our State forest departments are doing? It will ruin what is left of the forests, for relatively small gain. The cashew plantation must be properly terraced, so as to retain the water even when the cashew trees have killed off other vegetation. I could multiply these examples forever. The coconut trees that are so striking a feature of our coastal strip have yet to be properly exploited. Most of what can be done is known to our coconut research institute, but hardly anyone knows that the institute exists. The husk (coir) can produce rayon, the trees improved by genetical selection, the oil processed by more efficient methods and factories for the final product scattered through the plantations. But this implies an efficient and effective method of planning which we do not seem to possess. Our Planning Commission writes excellent philosophical discourses, completely futile when it comes to effective translation into useful practice. The private sector wants immediate profits, and the public sector prefers large-scale enterprises which photograph well and get newspaper headlines.

Let me give an example of inefficient planning in which I was personally involved. The problem was one of a dam construction. If the dam be too big, money is wasted; if too small, there is the risk of running dry too often. Suppose that we want dams which on the available rainfall and run off figures, will not run dry oftener than once in twenty

years, in the long run. What is the correct formula for estimation of capacity ? The experts quarrelled, so the problem was put up to me. It was a simple matter to give the right formula, based on R.A. Fisher's test. But when I looked closer into the data, it was clear that many of the figures had been faked. Actually, the water run-off for certain years had not been recorded at all. The entries had been made by fitting a linear equation from the rest of the data, against the rainfall figures which were accurately known. Finally, looking into the map of the area, it was possible to show that large dams would be of no use as compared to many very small dams which would help terracing and would retain monsoon water more efficiently. Small dams are of no use for power supply, but much more useful in a monsoon country with eroded lands, for agricultural purposes. Moreover, the labour supply and most of the materials are local; very little cement and no machinery would be needed. This has not only the further advantage of economy but of easing distress among the villagers by allowing them to earn some money while improving their own lands. Very little crop land is flooded by such dams, though the total amount of water conserved is nearly the same as a large dam. In the event, my formula was adopted because the expert could propose it as his own (he secured a promotion thereby). The remaining suggestions made by me never came before the meeting to which I was naturally not invited.

Statistics : Hitherto, all my suggestions have been critical and to a considerable extent negative. Let me speak of one special technique in order to make a positive contribution. This is statistics, and would be useful for any sort of planning, whether by indigenous or foreign experts, or simple allocation of resources. In fact, no planning can be successful which does not use good statistics correctly.

Statistics means the census type of complete enumeration, to most people who hear the term. However, counting everything is rarely possible and often not even practicable in most underdeveloped countries. The necessary staff is not available; clerical services remain slipshod or inefficient. Worst of all, people give wrong information because they feel that the figures they offer would in some way be of benefit to them, say in saving taxes or getting some government grants in aid. Finally, the processes of getting accurate statistics of this type is slow, while inaccurate statistics is worse than useless. It is all very well to suggest that areas under various crops could be quickly measured and even the crops identified, by air photography. I know that this is true. But how many countries can afford air photography and have the expert staff for evaluation? India has first-rate statisticians, but they are afraid that air photography may mean lack of jobs and retrenchment, so label it as 'unpractical'. Let me add that for all the fame our statisticians have secured abroad (and the large number of theoretical papers which form an impressive background for an even larger number of blue-book reports) our statisticians have failed in their main job, through no fault of their own. They have not been able to say exactly how much food is available from last year's harvest. As a result, we have several different sets of estimates of how much food India needs to import, whether as loans, gifts, or by purchase. I have seen it in print that five, seven, ten, fifteen, even twenty per cent of our grain is eaten by rodents and vermin. No one knows how the figures were obtained. If so basic a problem as that of food cannot be handled by really able men, there is something wrong in the way in which the men are used. We are led back again to the social and political context.

Granted the will to use statistics properly, there are now better methods than the cen-

sus, quick as well as inexpensive. These are labelled sample surveys; the technique is very well known. One counts a small percentage and estimates the total. Besides, there exist methods for showing the limits of accuracy of this estimate, so that a suitable margin may be allowed. I do not mean to go into details, which will bore most of you. But if enough is known of the various types of villages, then a sample of not more than 5% of the villages, and often one of less than 1% would suffice to give all essential information. The sample has to be scattered properly and every type of village must be proportionately represented. Some common sense has to be used. The actual sample must be studied efficiently and information about it obtained with complete truth and accuracy.

This type of sample survey gives data within a couple of weeks which would take over a year to obtain the complete enumeration. Its main uses are two: in industry and mass production for control of quality and uniformity of the product. For example, cement from different kilns in different places differs in quality. Even different runs of the same kiln show a substantial variation. But the engineer can allow for this in his construction work if, with each run, he is given a test figure of the average strength and the standard deviation. These can be calculated by one person, with a double handful of cement from each batch, properly sampled. One such statistical assistant could easily be employed by every cement factory, sugar combine, or similar industrial enterprise. The total output of such enterprises, of course is easily counted; in such cases one has both the census type and the sampling type of statistics.

With the agricultural raw materials, the situation is entirely different. Without a good forecast of the crop in advance, it is not possible to plan for expert, for processing of the raw materials, or for that matter even to avoid famine. This forecast can easily be provided in spite of great local variation by crop cutting experiments before the complete harvest is in. There are, naturally, even more efficient methods. Given the variety of seed, if machine planting is practised, simply counting the number of plants actually growing in uniform squares and taking a few ears from each square gives a surprisingly accurate estimate. I have seen this in the Dobruja, in Rumania, 400 plants were put down mechanically in each square metre; and the counting frames were one metre square. The reports were sent in by the wheat cooperatives in this case, and the central institute gives the crop estimate well in advance, allowing for natural disasters, such as flood and drought. Not all of us are so fortunate as to have such large cooperative and machine planting of wheat. In that case, I suggest that local experience could be used.

Local experience means that the peasants who have been on the same land for some years must know the particular variety seed used, and must have farmed with the same technique. In that case, the Indian peasant can give an estimate within 6.5 per cent or better. The Chinese peasants, to my great surprise, could give estimates closer than 3.5%; the trouble in China (as of 1960) was an inefficient and bureaucratic central statistical organization, which could give nothing accurately till the harvest was over and half-eaten. All their forecasts were revised again and again, so often as to be useless. They were gathered by the slowest possible methods namely filling out forms and everything, sending them to local headquarters, and eventually to Peking. Neither the statistical man nor the leading scientists had bothered to ask the peasants how they estimated the crop, nor even to compare estimates in routine yield. With our peasant, the trouble is to

make him believe that giving a truthful estimate will not lead to extra taxes. The difference between the illiterate peasant and the trained statistician is that the peasant cannot make large calculations, but has to give estimates field by field; on the other hand, if the peasant is wrong in the estimate he makes for his own use (whether he tells it to government agents or not), he may starve. The statistician doesn't have to live by eating his estimate or his standard deviation. The difficulty in the field is always of getting a truthful figure from the peasant. In China this difficulty did not exist, but no one bothered about the peasants' estimate before I tried to evaluate it. Money lenders, landlords, middlemen, purchasers and other interested parties,including the profiteering grain dealers from the big city see to it that the truth is hidden when it is to their advantage to hide it. Once again, we come back to the context. There is a clean limit beyond which you cannot go by ignoring the social and economic conditions prevalent in the country.

One type of sample-statistics is a valuable adjunct to democracy, namely the opinion poll. In developed countries this is oftener used by business firms to estimate the success of their advertising campaign and the popularity of their products (soap, tooth-paste, etc.) and such profit-making ventures. The politicians use it to see which way public opinion is veering. The number of people sampled even in so large a country as the USA need not exceed 700 to 1000, so that a small trained staff can give the result (from the start of the sampling to the final figure) within a week at most. But this is not practicable in most underdeveloped countries. Let me suggest the use of another technique, to be used with sampling, but on different principles. This is called Mass Observation, and was first developed by the famous anthropologist, B. Malinowski. It was very useful in wartime England. The main idea is to let a few selected people express their own opinion on some points in their own way, instead of asking specially framed questions that could be answered either yes or no, or in some other specific manner. The result in Mass Observation is less easily calculated than by the sample-survey, but gives much more information to the trained anthropologist or to any intelligent administrator. It reveals unsuspected needs that cannot be brought out by the western opinion poll. But once again, truthful and frank expression by the person questioned is absolutely essential. He or she must be guaranteed and convinced of complete secrecy; and must be free from fears of reprisals for speaking too frankly. Such observation has been used with great effect in Poland, by the Wroclaw Socialogical Group. Let me suggest that those of our countries that struggle towards democracy would find it a useful way of ascertaining democratic goals and popular wishes.

Research and Development in the New Universities in Developing Countries

MUSTAFA N. PARLAR*

The necessity of research and development work, and the basic means to carry out such work in the newly developing universities are discussed in this paper. The paper gives special weight to the development of research capabilities in the newly developing universities. It also discusses the possibility of establishing a new way of thinking, which should be adapted by the developed countries, which are supporting the new universities in the lesser developed countries.

Introduction

The new universities everywhere have a common problem, that is, to select suitable candidates for training, and to acquire qualified scientists on their staff, at the same time providing the working conditions and atmosphere, in which the scientist can produce more and can work happily. This is the major task of the administrators and founders of a new university. Similar problems exist in the newly established universities in the developed countries. However, in the developing countries, in view of the lack of experience in university administration, lack of facilities and lack of a basic infra-structure which automatically produces healthy growth of the universities—much more routine work will be required from the teaching members. Unfortunately these are sufficiently convincing points in favour of academic personnel to show lack of effort in research work. Once the academic personnel use these reasons as an excuse for not doing research, and, they are accepted by the administrators and academic leaders of the institution, then it will be very difficult to return from that poor state to an acceptable academic level. Therefore, as a first and major principle, in the establishment of a new university, every effort must be made for launching research and development work. The rapid expansion of science and technology with the publication of countless reports, scientific articles, books, etc., forces the modern scientist always to be on the forefront of his field.

If a person confines himself to the heavy burden of administration and ceases to take an active part in research work he will force himself out of his time and he will be left behind the rapid development of the rest of the scientific world. This is one of the reasons why many persons from developing countries, who can do excellent research work in developed countries will fail to do so in their home country. They have difficulty in finding that environment, which is considered to be the natural breeding ground for new ideas and digesting scientific observation and synthesizing from accumulated facts.

But if these scientists do not take as their prime concern the eradication of those causes

*Middle East Technical University, Ankara, Turkey

wh'ch discourage them from acting as proper scientists, they will fail in their duty.

Once a scientist fails in his duty to provide this environment it will also be extremely difficult for him to acknowledge the fact that he is becoming scientifically backdated and that he has lost contact with his own particular scientific interest. When this dangerous stage is reached., he will try to maintain his position by unacademic means. He will use trivial academic points for their political significance to his position and suppress young and more competent people beneath him. He will try to reinforce his position by acting the "big man."

The stagnation of the scientific potentials in developing countries is due mainly to the existence of the above fact. The author feels very strongly, that the prime objective in establishing a new university in a developing country should be the creation of capabilities for research and development right from the start.

The stage of development, especially of applied science and technology in developed countries forces scientists to look ahead and not to look back at previous work —which means, they will take for granted that some of the problems which have been solved, and the solutions which they have been using for several years, do not need further consideration. Such practice may yield endless amounts of development and research problems for those scientists, working in new universities. Also it can be seen that the powerful industrial organizations would rather develop new products, and rarely go back to further development of those things which they themselves have engineeered several years ago and which they could improve. In fact, by inventing new ways and means for doing similar jobs, the scientists in the newly established universities could tax industrial countries on this very point producing more successful operation and performance. The history of the development of Etikur AM Carrier Receiver and Transmitter, by Middle East Technical University for the State Power Company of Turkey (Etibank), is an excellent example of this fact (see Turkish Patent 11149).

On the other hand it is vital that the quality of the formal education, and research and development, carried on in the newly developing universities, basically cannot, and should not be much different from that of the standard maintained in the well established universities.

Lastly, the new universities in the developing countries require large amounts of money for training staff, for buildings, new facilities, and for getting necessary teaching and research laboratory apparatus, for which they must have all the support, that government and other organizations can give to them. For this purpose they must prove by their efforts in research and development, that they can contribute to the economic and industrial development of the country (1) by training properly qualified personnel who will serve in government and civilian organizations with success; and (2) by developing and inventing new things for creating new jobs and thus contributing to the economic development of the country.

In order to achieve these objectives the government of the country of the developing university, and the supporting organizations must be firm from the start to encourage the highest possible standard. It must be realized that this cannot be brought cheaply, but it is well proved that the investment in universities has the richest national return.

Following this it should also be remembered that the psychologic impact of the research and development, results in the new developing countries plays a significant role in getting the required political support, which

can be converted into a financial support with ease.

Development of Research and Development Capabilities in the Newly Established Universities in the Developing Countries

The establishment of new universities in developing countries should be an integral part of the economic and industrial development programmes—free from all political influences. Once the necessary parliamentary decision for the establishment of a new university is taken, a working team should be organized, with the appointment of an executive officer responsible for the execution of decisions taken by a committee formed in accordance with the Charter. The committee should make a plan for the growth of the university giving top priority to acquiring and training suitable staff members.

Some staff members may be recruited from institutions of higher learning already existing in the country. However, in an underdeveloped country this source will be totally inadequate. In addition to this if the new university is founded on an entirely different basis to the established institutions then such staff members would find difficulty in integrating into the new environment. Such recruitment in senior positions is therefore not to be encouraged.

On the basis of the target set for the number of students to be trained in the university, the staff training programme should be planned in consideration of available sources of support. In this respect it is advisable to find an established university developed on similar principles, or preferably a department in a given university to work jointly with the new university for staff training purposes.

In fact, it is advisable that all problems of the development of the new university, including staff training, establishment of research lines, designing and equipping of new laboratories for teaching and research purposes, should be discussed in cooperation with the established university. For this purpose, a plan of operation should be agreed upon between the established university and the developing university. It may be necessary that several such plans are made for each department because it is seldom possible that an established department in a given university can be strong enough to provide help and advice in every subsection of a given discipline. This means that, implementation of the so called subdepartment projects may be carried out at different periods of development. This automatically implies that the research and development capabilities will not be developed at the same time for all departments of the university; in other words, the speed of development will be different for different departments. However, the rule "seeing is believing" will be applied and the stimulation of the research and development capabilities in a section of a given department will force the others to acquire a similar standing.

The integrated programme planned in cooperation with well developed universities in developed countries, should provide the following features: (1) to provide means for the development of a faculty, which will be able to take an active part in the region, by progressive research and development work; (2) to acquire proper abilities to teach and to undertake research, up to and beyond the limits of science and technology existing at the time as well as to provide means for the faculty to train its young graduates to obtain their Ph. D. degrees in their university in order to take up teaching positions as early as possible; (3) to develop laboratories needed for modern teaching and for particular research work, which may require special attention in the region; and (4) to provide healthy contacts between the

faculties of the two departments for exchange of high level advice from the department of the university in the developed country to the developing department.

The success in the implementation of such an integrated programme depends largely on how the Government will support the new institution. Excessive rigidity in the enforcement of archaic national academic rules may well destroy the benefit to be gained from these programmes. Every effort should be made to allow the by-laws of the new institution to be as flexible as possible. The tenure rights should not be considered as the principal problems. Rather it should be made clear that results achieved, and contribution to the development of the university will be weighed justly in academic promotion and retention of service.

The details of this programme should be largely as follows:

(1) Staff Training Programme: (a) for this purpose qualified junior members of the developing departments should be given fellowships to provide them with the means to obtain advanced degrees or research experience in the cooperating departments; and (b) means should be provided for short visits of the senior staff of the developing departments to the cooperating departments for consultation on specific but well defined problems.

(2) Staff Support: the cooperating departments should send some of their best scientists to the developing departments for establishing new courses and laboratories, and for initiating some research projects as well as for advising the graduate students and post-graduate students in their reseatch problems.

(3) Development of New Laboratories and Research Facilities: the programme should provide the necessary funds for the establishment of new laboratories and purchase of new apparatus needed for the implementation of the research problems selected in accordance with the established research lines for the department. This fund, by its nature may be limited, and it is assumed that the developing university will have the necessary basic apparatus for fundamental teaching purposes. The programme should have sufficient flexibility, so that the post-graduate work done in either the developing or co-operating departments could be used in partial fulfilment for the advanced degrees offered by either institution. Every effort is justified in shortening the post-graduate training period for young staff members from developing universities. Experience, which we have been able to collect shows that, in general, the urgency of staff training for the developing universities was not fully appreciated by established universities. It is obvious that the rapid expansion in the industrial and educational institutions of the countries, developed or developing, forces educators everywhere to search for ways and means for rapid, but properly designed and balanced programmes.

(4) Financing of the Proposed Programme: any programme of this type requires financial support for implementation. At the moment there exist many possibilities for developing countries to obtain support for the development of educational institutions.

Principal sources are the international organizations, and bilateral agreements. The international organizations may not be favourable sources for programmes described in this paper because they essentially operate internationally. This means a general programme prepared for a new institution will provide advice from experts with varying backgrounds. Such experts must be prepared from the start to accept the system which is being established for the new university. They must refrain from trying to

enforce their own systems in their new positon. Of the available educationel systems, it is obvious that only one may be selected and must be enforced. Bilateral agreements offer a better means of implementation of this type of programme by bringing properly selected cooperating departments together. The policy of the supporting organization should give at least equal rights to the administration of the developing university. Decisions regarding academic development of the university should be taken by mutual agreement, rather than with the use of a long stick. Existence of different opinions among the people working in the same institution, can be, and should be considered a healthy sign, and only with the use of proper scientific facts and pedagogic persuations, sides should try to foster their ideas.

The supporting organization should also try to provide experts with strong character, who have trust in the project, and who can take an active part in the development, not only by words, but also by deeds. Several times we have met experts, who insisted that their task is only advisory in nature. Therefore they would not take part in the actual day to day work of the developing institute. On the other hand, it is seen that wherever there is successful activity in a developing institution, supported by some outside organization there is the contribution of an expert, who not only has put all his energy into his work, but has also been able to carry many people with him in the project.

A typical bilateral aid agreement for the development of a new university should be based on following general points: (1) the objectives of the university must be fully defined in terms of the disciplines and student numbers as a function of time; (2) assessment of the sources for personnel and physical facilities must be made in the developing country, which yields the amount of assistance required ; (3) every precaution should be taken to ensure complete implementation of the plan; (4) the required amount of counterpart contribution should be firmly established, and no laxity should be shown on the provision of counterparts; (5) the personal relations between expert and counterpart as well as other members of the institution must be defined in detail in order to eliminate unnecessary friction. The problem of offering title should be solved by using single standards for foreign and local staff members or by keeping the title of the expert unchanged, e.g., "A Adams John Joy B.Sc., Ph. D., (CENTO) Lecturer at I.C. London".

Experts should be listed under one category unless they are given rank in accordance with the existing regulations for the institute. The foreign expert and the local teaching members and counterparts should have similar types of academic responsibilities and the point should be made that in every sense they are equal and have the same responsibility and will be accredited according to their performance; and (6) the agreement should give top priority to the development of a workshop, since teaching apparatus and components can be manufactured with ease. Following this the furnishing of the laboratories for teaching and research should be completed as soon as possible.

Any plan could be successful and considered to be a good one, provided that the people taking part in the implementation of the plan put their heart and mind into it. Unless a constructive spirit with a strong influence for coordination, cooperation, and communication exists, it will not be possible to achieve full benefit from the execution of the development programme, however well it may be prepared.

Scientific Drainage Of Developing Countries

The development of new universities could be accelerated if the developed countries

could encourage nationals of the developing countries working in their institutions, to take responsibility in developing universities. The migration of scientific talents from less developed countries to the well developed countries is a formidable problem, about which the United Nations Educational Scientific & Cultural Organization is beginning to show some concern. It is hoped that the efforts of UNESCO to solve this problem will not fade.

The author never ignored the importance of academic interchange and contact; such things could bring new ideas to universities and new ways of thinking, but he also finds it very difficult to understand the behaviour of the well developed countries in regard to transfer of scientific talents from lesser developed countries. It is very difficult to correlate the fact that on one hand the developed countries are trying to help lesser developed countries to build scientific and technological institutions, while on the other hand they are permitting the scientific talents to be transfered to their own countries with ease.

The author's institution has already lost some of its best scientists to the USA and the UK, even though it offers every opportunity for a bright future, academic freedom and the existence of good research facilities. The importance of placing the right man in the right job at right time is well known. Therefore, if the well developed countries are really interested in social justice they should encourage sound and rapid development of the lesser developed countries. For this purpose they should stop encouraging the transfer of scientific talents to their own countries. It is really time to do something about this very important problem.

Conclusion

Universities in the newly developing countries must be planned in accordance with the national economic development programmes free from all politics. The integral joint development programmes with well developed institutions should be prepared in time to have the required initial support and to help the faculty to be able to offer post-graduate study for sound and at the the same time rapid training of staff drawn from the graduates of the faculty. The development programmes should have a mutual consent and include sufficient flexibility for easy operation and implementation.

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(*continued from page 40*)

their research experience at foreign institutions under the guidance of recognized authorities; (3) training centres in the fields of particular interest for research workers and technical staff; (4) exchange of technical personnel. This should allow for selected staff to visit other countries for periods varying from one to six months to study and participate in pest control operations; and (5) sending experts to different countries for periods up to several weeks for local demonstration of new techniques and for training local staff.

CAAUST SYMPOSIUM
Recommendations of Commissions

COMMISSIONS

(1) Science Policy
(2) Scientific & Technical Information
(3) Education and Training
(4) History and Popularization of Science
(5) Technical aid from International Agencies
(6) Medicine and Health
(7) Agriculture, Irrigation and Food
(8) Natural Resources
(9) Power and Atomic Energy
(10) Engineering and Industrial Research
(11) Housing and Town Planning

SCIENCE POLICY

The Commission on Science Policy feels that advancement of science is an essential step towards the economic independence of countries. Consequently, every effort should be made to develop the necessary scientific and technological potential of the countries of Asia and Africa.

In the context of the historical evolution of the Asian and African countries, it was realised that no single model solution would be applicable to all the countries. Each country has to evolve its own model and find its own solution. It was, however, felt that in view of the similar nature of the problems it is possible to have similar approaches towards the main objective of promotion of science and technology, particularly in view of the fact that the problems have to be solved urgently and in shortest possible time.

In order to achieve the above objectives, the Commission recommended:

(1) There is a need to increase the science consciousness of people in general and political leaders, administrators and decision makers in particular, in order to use science and technology as an effective instrument of social and economic transformation.

It was, therefore, suggested that each country should try to persuade their Government to declare their commitment to science and technology through a Science Policy Resolution. The 1958 Science Policy Resolution of the Government of India as a possible draft, with suitable modifications, depending upon the conditions in the countries, was recommended.

(2) Since the gap between the developing and the developed countries is increasing, the Commission recommended the need of a massive effort to create resources for science and technology. The later could be possible only through a major investment in science and scientific research. The Commission recommended that at least two to three per cent of the G.N.P. may be invested in creating a base for science and technology in every country, as recommended by the UNESCO Conference at Lagos.

(3) An effort should be made to develop:

(*i*) a detailed National Science Policy covering research programming, with necessary emphasis on research of national importance,

(*ii*) development of infrastructure for science and technology,

(*iii*) suitable organizations and institutions to create a base for science,

(*iv*) incentives to scientists, the organization should have a proper atmosphere for research and be sensitive to the needs of science and workers,

(*v*) and necessary educational requirements to meet the demands of research workers, teachers and industrial scientists.

(4) The Commission recommended the creation of a National Science Organization with the twin functions of planning of scientific research, including the coordination of research programmes of the existing institutions and universities within a single framework of national perspective, and allocating resources to carry out the programmes. This organization should be responsible to the government at the highest level.

In order to make this Organization fully effective it was felt that it should comprise scientists of different disciplines and form different institutions e.g. universities, laboratories, industries, and scientific and professional societies and the membership limited to a defined period.

Further, the National Science Organization should have a permanent body to study the growth of science, its organizational structure as it develops, and implementation of programmes and the evaluation of the effectiveness of research. This specific scientific studies should be the basis of policy decision and should not be associated with executive decisions.

(5) For the proper growth of science, it was essential to promote scientific community and to help in the democratization of the decision making at various levels. To attain this objective, it was felt that the Government should actively encourage scientific societies and draw upon their Counsels in decision making with regard to science policies, organization and allocation of resources and also effectively encourage those scientific journals which tend to discuss these problems scientifically.

(6) The Commission strongly recommended that each country should develop a well-defined policy of International collaboration. In this context it suggested:

(*a*) that there should be exchange of information with regard to science policies, organization and other related matters between the developing countries.

(*b*) technical assistance between the countries of the same region should be promoted. It felt very strongly that technical assistance is possible between the countries of Asia and Africa at various levels of scientific growth and development as a whole and in specialized areas. That this aim will also help in effectively counter-balancing the political pressure brought by advanced countries through technical aid.

(*c*) a Continuing Committee should be formed. The Committee should undertake to publish directories of scientific institutions, societies, experts in various areas and bibliography of critical research programmes to help develop a greater exchange of information and its utilization in the region.

(*d*) The commission recommended the establishment of bilateral and multilateral joint scientific boards of the countries of the region as has been established, for example, between India and U.A.R.

(*e*) that efforts should be made to organise an Afro-Asian Association for the Advancement of Science to help in the understanding of the problems of development of science and technology

in these countries, exchange of information and also to act as consultant to international organizations.

(*f*) that every possible steps may be taken to encourage joint scientific projects on problems of similar nature in the countries of Asia and Africa.

SCIENTIFIC & TECHNICAL INFORMATION

1. *Responsibility*. It should be the responsibility of the highest executive scientific body in the country to ensure that adequate machinery is provided for effective flow of scientific and technological information to those who need it.

2. *Organization and Resources*. To ensure that such information activity is carried efficiently, the concerned national authority should provide adequate resources and executive direction and control. This could be done by :

(*a*) allocating a reasonable percentage of the research and development budget for scientific and technological information work at national and institutional levels,

(*b*) establishing a Central coordinating agency which will be responsible for information, documentation and library sciences, and allied facilities including external coordination and liaison at national, regional and international levels.

3. *Training*. The facilities for training information scientists for handling problems of publication, translation, organization, etc. shall be provided. Existing national facilities should be developed into regional training centres wherever possible. The assistance of agencies like the United Nations may be solicited for this purpose.

4. *Publication Exchange*. A programme of publication exchange should be initiated among Afro-Asian countries so as to encourage exchange of ideas and information and foster greater collaboration in the various fields of science and technology.

5. *Bibliographical Services*. In order to consolidate research output of the countries of Asia and Africa, some geographically contiguous regions with a close identity of interests and problems or countries with language affinity may be marked for the purpose.

6. *Directory of information Centres*. To facilitate information exchange, directories of information sources in the countries of Asia and Africa should be compiled by the national agency.

7. *Publication facilities*. National Science Publication Agencies should be set up to make available standard, well produced and low cost scientific and technical books and other literature for schools, colleges, universities and research and technological institutions.

8. *Standardisation*. Steps should be taken to formulate standards for production of technical publications at the national level and align these standards with international standards on the subject.

9. An Afro-Asian Centre should be established for promoting and coordinating scientific and technological information activities.

EDUCATION AND TRAINING

Taking into consideration the important aspects of Education and Training in African and Asian countries, the following recommendations were made by this commission:-

I. Each Afro-Asian country be requested to prepare National Registers giving the following information:

(*i*) Scientific and Technological Institutions along with a brief account of the facilities available for scientific and technical education and training in research.

(*ii*) Scientific and Technical Manpower available in the country.

(*iii*) Industrial training centres or organizations dealing with in-plant and in-service training.

II. The Government of the Afro-Asian Countries be requested to encourage and promote the exchange of teachers and research workers and industrial trainers between each other.

(*i*) Each of the Afro-Asian countries be requested to provide for the exchange of trainees in Scientific and Technological subjects and suitable means of collaboration may be organized.

III. It is absolutely necessary for Afro-Asian countries to build up self-reliance, so that they could independently develop in various fields of science and technology according to their own particular specific needs. It is very necessary that indigenous methods of technical training should be encouraged to the maximum extent. This in the long run will help to develop an independent outlook to achieve scientific and technical advancement according to individual needs.

IV. In order to achieve a high degree of development in the field of science and technology special attention needs to be paid to the following:-

(*i*) Provision of suitable schools or institutions for training teachers in the subject of science and technology.

(*ii*) Evening classes to provide opportunities for persons already employed for improving their technical qualifications and knowledge.

(*iii*) Proper planning of technical education according to individual requirement and provision of adequate schools with facilities of stipends of free technical education where possible.

(*iv*) For the promotion of science and making people science-minded, it is very advisable to introduce science in basic education and for this purpose it is considered necessary to revise the text-books suitably to make them properly science orientated.

V. It is recommended that cooperation between the established Universities and the newly planned universities and education institutions dealing with scientific and technological education in Afro-Asian countries should be arranged, so as to achieve intimate contact between them with a view to have a proper and balanced growth of the new ones. For achieving this purpose, it is considered necessary to have a suitable liaison machinery.

HISTORY AND POPULARISATION OF SCIENCE

1. Historical studies on science and technology will be of great value to a proper understanding of the foundations of science in Afro-Asian countries. The more those countries become conscious of their scientific heritage the more confident would they be to participate in the modern scientific movement. In this task, they have to develop their own scholarship and methodology to evaluate critically the scientific ideas and techniques which have remained hidden over a long stretch of time.

It is, therefore, recommended that the history of science, scientific ideas and methodology be established as a discipline, of study including teaching and research, by each participating country at least in one of its universities and that attempts be made to bring to light the source materials of the

country/region and to assess them critically.

2. There is an immediate need for the establishment of Afro-Asian Association for the Advancement of Science and Technology. This organization may have one of the existing scientific organizations of each participating country as a corporate member. Its objectives may be :

(*i*) To organize exchange of scientific and technological information among the member countries;

(*ii*) To seek the possibility of arranging joint research programmes mutually beneficial to the participating countries;

(*iii*) To organize symposia, conferences etc. on specific scientific and technological problems of the region at frequent intervals;

(*iv*) To provide (a) experts from among the member countries and (b) facilities for training of scientists and technologists within the countries of the region by offering fellowships, travel grants etc., and

(*v*) To take such steps or devise ways and means for the promotion and utilization of science and technology in general for the benefit of the region.

3. It is strongly recommended that Afro-Asian countries should give high priority to the creation of scientific outlook and popularization of science. Immediate steps should be taken to (i) produce suitable text books even for elementary schools emphasizing the principles and methods of science, (ii) design popular science kits and allied aids for the propagation of scientific ideas and techniques among the school going children; (iii) encourage the publication of popular science journals and books for the general public in the languages of the region; (iv) organize scientific exhibitions, and (v) establish science museums where feasible.

TECHNICAL AID FROM INTERNATIONAL AGENCIES

The Commission is convinced that the present economic gap between the technologically advanced and less advanced countries is a serious danger to the world peace and that this gap has to be rapidly bridged for ensuring peace in the world. Technical aid from former for economic development of the latter is accepted as an important contributory factor to build up a socio-economic structure ensuring a suitable base for human welfare and the highest standards of living. This aid should also be viewed particularly as a compensation for the exploitation suffered by the countries of this region which have resulted into benefits for some of the advanced countries.

In the light of the proposals and discussions during the session it is recommended that the following principles be adopted in respect of the technical aid for the countries of this region:

1. Aid should not be in conflict with the national socio-economic policies of the recipient countries.

2. Aid should correspond with the requirements so that it fits into the overall pattern of economic development of the recipient country; such requirements have to be thoroughly assessed through systematic studies along scientific lines.

3. A systematic coordination is necessary among the international agencies and also among the recipient agencies within a country in order to have an effective and progressive utilization of such aid.

4. An organized follow-up is necessary to assess the relative success (or failures) of these aid programmes.

5. The aid should consist of provisions for training suitable operational cadres to help the scientists and technologists to carry out their work most effectively.

6. Heavy expenditure on foreign experts should be avoided as far as possible; more funds should be provided for equipment and for training of local personnel.

7. The assignment of experts should be based on the following considerations: (a) experts from within the region as far as possible; (b) A satisfactory lengthy duration of stay; (c) coordination among the experts working in the region and within the country.

8. Provisions for equipment should be made from the points of view of suitability, replacement of parts, maintenance of equipment and training of technicians for the same.

MEDICINE AND HEALTH

(1) Countries of Asia and Africa who can offer training facilities for medical studies (both undergraduate and postgraduate) should offer 5-10 per cent of their admissions in medical institutions to help other countries in the region.

(2) There is urgent need to study the possibilities of evolving a training programme which can produce a reasonably efficient para medical man in 3 years time as a temporary measure. There is also a need to determine how best those who practice ancient systems of medicine can be effectively utilized for medical and health care programmes of the people.

(3) In the absence of adequate number of trained personnel and other facilities, STR (Service, Training, Research) units should be established. The STR Units should:

(*i*) prepare detailed instructions in techniques, based on local experience and make them freely available.

(*ii*) Advise on isolation, typing, diagnosing and keeping a ready stock of reagents for supplying other laboratories.

(*iii*) Organize short term training courses for its own use and for other countries.

(*iv*) Undertake research on disease pattern in the area particularly with regard to diseases caused by infection and/or malnutrition.

(4) Research and exchange of experience in methods of health education is of great importance. This education alone can unleash popular initiative for improvement of sanitation, hygiene, improved water supply, inoculation campaigns and for accurate collection of health statistics.

Collection of data on hospital records, formation and exchange of information from registry of diseases and pooling such data to form a statistically significant sample form another group of priorities for joint research.

(5) The countries of Africa and Asia should work out the possibilities of regional research, training and reference centres. The WHO should assist in setting up such advanced research centres. The WHO should establish Asian and African Health Organizations (AHO) instead of its regional offices as at present. Countries of the region should preferably call on the services of experts from the countries of the region as far as possible.

(6) A detailed study of different patterns of rural medical service in different countries is essential. This may enable considerable savings in avoiding experiments which are unlikely to be successful. Funds should be allocated for mass health campaigns which are likely to increase production by reducing ill health.

(7) The Commission recommends that all medical and biomedical publications be exchanged free of cost between developing countries for making libraries adequate.

(8) The countries of Africa and Asia should consider to modify patent laws jointly and simultaneously to overcome the opposition of big drug monopolies. Drug industries be established in public sector on a regional basis so that products can be exchanged and distributed according to the needs of the people of different areas. Efforts should be intensified both in production techniques and research to produce drugs to meet the regional demands by providing necessary technical know-how or substitutes therefor. Research programmes for screening natural products (vegetable and mineral origin) as are reported or known to be of medicinal value should be organized or strengthened.

(9) Post-graduate training be made available in medical disciplines especially endemic diseases at centres in Afro-Asian countries. If need be, such centres of training be established on a regional basis.

(10) Exchange of information on medical and health problems of each other's countries is of vital significance. Several steps are suggested to achieve it:

(*i*) The present Commission should work on a continuing basis and enlarge itself through correspondence so as to include members from other countries of Asia and Africa.

(*ii*) The Commission should examine the possibilities of organizing bulletin giving bibliography of medical and health publication of the region. Jointly operated abstracting services for medical sciences could be started.

(*iii*) The Commission should assist medical scientists through advice and prepare itself detailed country reports on the state of medical and health problems in different countries and take steps to disseminate this information.

(*iv*) Exchange of doctors, public health experts and postgraduate students should be encouraged wherever possible so that a body of men is created who are familiar with problems facing these countries at first hand.

(*v*) Medical text books should be written by teams of experts drawn from countries of Asia and Africa.

AGRICULTURE, IRRIGATION AND FOOD

Africa and Asia has 60% of the world population but produce and consume only 30% of the food. In the light of this, it is essential that all the countries of these regions should take advantage of each other in using the available resources to the maximum degree. To accomplish this object the following recommendations are made:

A Directory should be prepared which would contain the following information :

(*a*) Research centres in the field of agriculture, food, science and nutrition.

(*b*) Research projects.

(*c*) Personnel and facilities available in this organization.

(*d*) Training facilities which are available in different organizations and universities in the field of agriculture, food, science and technology and nutrition.

The work of preparation of this directory should be undertaken by a special committee to be appointed by the Secretariat of Afro-Asian Science Association or Academy of Sciences. It was also suggested that this work could be assigned to one of the existing national bodies from amongst the participating countries or to an international agency. The primary objective of this recommendation

is to utilize the limited resources in an effective manner to solve the problems in the field.

The Afro-Asian region has been lagging behind in soil management, water resources and the genetic manipulation of the crop yields. In the light of this the following recommendations are made:

(*i*) High yielding varieties of crops should be introduced throughout the region according to the suitability, requirement and cultural pattern. For this purpose ecological maps should be developed and used.

The Commission recognized the wealth of genetic diversity which exists in Afro-Asian countries particularly in the Ethiopian centre for the major food crops and remains to be tapped. It, therefore, recommends the immediate constitution of Afro-Asian association for research in plant breeding on the model of Eucarpia in Europe, for organizing collection, conserving and utilizing of the gene pools for crop and medicinal plants.

(*ii*) Production and use of modern fertilizers in properly balanced manner.

(*iii*) Improvements in irrigation facilities and proper management and water resources.

(*iv*) Soil management and improved cultural practices.

(*v*) Control of pests and diseases.

(*vi*) Modern farm machinery and equipment. These should include equipment required for the plantation industry also.

(*vii*) Improvement of live-stock.

In order to obtain high yield of eggs, milk and meat, it is essential that immediate improvement should be brought about in live-stock through organizing gene pools. Also it is essential to introduce proper management of ranges and pastures through the introduction and improvement of forage crops.

(*viii*) In view of the vast sea and inland water resources available to the countries of the region, it was recommended that fishing facilities should be improved through collection, maintenance and improvements in the fishing craft and gear.

The committee noted tremendous losses which occurred from the time of raising the crop to the time of consumption. In several countries of the region, these losses vary between 30 to 50%. It was, therefore, recommended the following steps should be taken urgently:

(*a*) A well organized programme of infestation control should be developed and undertaken in the field during storage, marketing, handling and distribution. A bibliography of the work done in this field should be prepared by the Secretariat or by one of the participant countries for distribution in the region.

(*b*) Steps should be taken to modernize and develop the food process, preservation and packaging industry to minimize the technological losses.

(*c*) Special study should be undertaken for introducing modern quality of hygiene standard, covering all aspects of food.

(*d*) There is an urgent need for the development of high protein foods for the entire region as there is very low protein intake at present. For this purpose the available vegetable proteins should be modified and processed as substitute for milk, especially for the vulnerable group of population including children. It may particularly be brought to the notice that at present available oil seed meals are not being utilized for human consumption. With the improved technology, this could serve the purpose of overcoming mal-nutrition.

Food machinery and equipment should be developed to establish economically viable modern industry in the region.

Information, Research and Training

(1) One of the major difficulties today is that of obtaining proper information. Therefore, the Commission suggests the setting up of an Afro-Asian Information Centre in the field of Agriculture, Food, science and nutrition as a clearing house for the enquiries received from the various participating countries.

(2) Afro-Asian Cooperative Research Institute is to be established in a biologically important location with the cooperation of the countries of this region.

(3) It is realized that training is one of the pre-requisite for improvement in agriculture, development in the field of food, science and nutrition. Such training could be imparted by well established research organization and universities in the region.

The Commission recommends that those countries who have these facilities should make them available to other countries of the region who do not have such facilities and resources. Also arrangements should be made to find out the necessary finances for the trainees including their travel expenses.

(4) There should be a regular exchange of experts between the Afro-Asian countries in the field of agriculture, food, science, technology and nutrition. Such experts will be more useful because they have had experience. This exchange will also bring forth a number of problems on which research work can be undertaken in different existing organizations in the region.

(5) Meetings specifically to discuss the problems in this field should be held at least bi-annually. Such meetings should be held in different countries at suitable location where the problem exists.

A system should be established between the Afro-Asian countries for exchange of information, including supply of reprints of important research papers.

NATURAL RESOURCES

The Commission constituted to draw up recommendations for survey and development of natural resources *recognizes* that natural resources in Afro-Asian countries are in actuality our means for economic development,

Further *accepts* the fact that there is much more to be done in this area of our national development and it is strongly urged that more emphasis should be placed in developing our natural resources—mineral, forest and water. Consideration should also be given to rational land use and preservation of wild life.

The Commission, therefore, recommends the following:

1. MINERAL—For proper development of a country it is not only essential to know the occurrence and extent of the mineral resources but also to make these mineral resources available by most suitable techniques. This is not being done in many of the countries and it is recommended that very early steps be taken to apply the latest techniques for the exploitation and exploration of minerals.

2. FOREST—Although general information about forest areas is available, the ecological survey of the forests has not been carried out adequately in most of the countries. It is recommended that such ecological studies, including wild-life preservation and growth should be given high priority. The correct use of forest resources is also very important. This involves specialised work on forest management practices and forest economics.

3. WATER—There are three aspects of development of power, *viz.*, hydel, thermal

and atomic power. Water resources in these regions, particularly in Africa are abundant. It is recommended that water resources should be adequately developed taking advantage of the experience of some of the developed countries.

4. Knowledge and experience already available in Afro-Asian region should be effectively utilized in the exploitation of the resources. The experience could be made available through collaboration and cooperation. It is recommended in this connection that the countries in the Afro-Asian region should make every effort to make available to their sister countries their experience through exchange of experts, visits, seminars etc.

5. Exchange of information and discussion of common problems including research, collaboration on survey and utilization of resources and preparation of joint programmes of development and research for international assistance is recommended.

POWER AND ATOMIC ENERGY

The participants in the symposium emphasized the importance of ensuring a rapid increase in electric power and commercial energy utilization in the Afro-Asian countries as this is basic to modern development both in industry and agriculture. In the long run all these countries would have to go in for nuclear power in a fairly big way. However, the timing and scale of the introduction of nuclear power depend on the circumstances of every country and the resources which it has access to. In any case every country should rapidly develop electric power in the most economic way available to it, and prepare for the introduction of nuclear power. It should also keep abreast of nuclear technology and pay attention to the other uses of nuclear energy such as practical applications of radioisotopes which may be more widely used immediately.

Collaboration would be very beneficial in the fields of power and atomic energy. However, it is for each country to utilize the opportunities for collaboration in the ways it considers best depending on its circumstances and policies. Some of the methods of collaboration which should be considered by various countries of the region are the following:

(1) exchange of assistance, information and experience in regard to the development of power and atomic energy programmes.

(2) Exchange and training of scientists and engineers in different disciplines required for the programmes.

(3) Collaboration in national or regional surveys for the potential sources of power and fuels (nuclear as well as conventional) and special materials required in these industries.

(4) Exchange of experts in specific phases of the programmes such as evaluation of the economics of different types of power stations, best locations for hydro or nuclear stations, potential uses of radioisotopes, building of facilities and plants etc.

(5) Provision, subject to appropriate intergovernmental agreements, of materials equipment and facilities required for the programmes of the different countries from within the countries of the region.

(6) Setting up of facilities for research, development or production (of power fuel and materials required for the power industry) for joint use by various countries of the region. This could include joint projects for harnessing of river waters or fossil fuel resources.

(7) Making available to countries of the region, subject to mutually acceptable

inter-governmental agreements, facilities built in the larger countries which may not immediately be economically justifiable elsewhere.

ENGINEERING & INDUSTRIAL RESEARCH

The nations of the region may, as a first step,

1. Compile directories giving information on educational, research and training facilities including facilities for digital computation available in the Afro-Asian countries.
2. Compile directories of design consultancy services that each country can offer.
3. Compile directories of machinery, equipment, instruments and materials of all types manufactured in various countries.

Thereafter, this information may be collected in central and common series of directories covering the region as a whole.

HOUSING AND TOWN PLANNING

1. Establishment of Procedures for exchange of information on matters pertaining to Physical Planning and Housing with special reference to techniques and standards.
2. Provision of facilities for education of scientists and technicians in the field of planning and building.

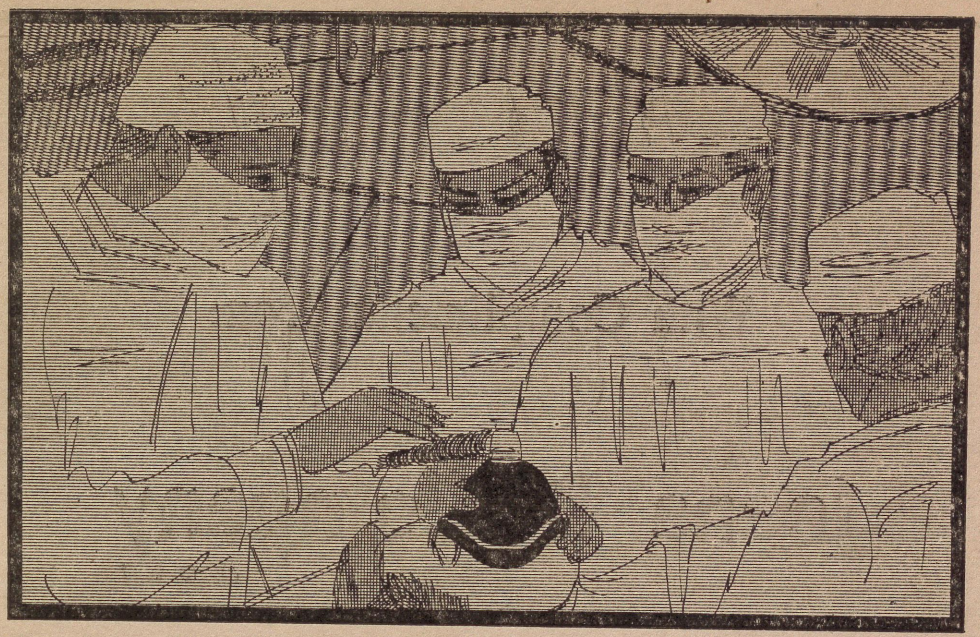
EQUIPMENT AND TEXTBOOKS

This conference recognises the need and importance of active collaboration between the African and Asian countries for providing and developing scientific instruments and equipments since these will be needed before any rapid advance can be made in developing facilities for scientific and technical education and research.

In persuance of this objective this Conference recommends that training facilities for instrument mechanics, technicians and engineers may be developed on a priority basis and member countries may help each other in this development.

Further, it is felt that the interest of the countries may be greatly stimulated if exhibitions of instruments may be arranged in the countries of the region.

This Conference recommends further the need for bringing out textbooks in the language of the country. In this connection it is recommended that UN agencies may further encourage the production of cheaper editions of books published in the Western countries so as to bring the prices within the range of students of Science and Technology.



HE SAID: "THIS IS NO HUMBUG"

"Sir, your patient is ready"

A 27 year old dentist named William Morton stepped forward. The operating theatre at Massachusetts General Hospital was crowded with doctors and students. In the operating chair lay a youth with a dangerous growth on his neck. Through a tube, he inhaled the ether which Morton gave him. He slept. The Surgeon Dr. Warren, cut away the growth and stitched the wound together. The patient's eyes opened.

"Have you felt pain?" asked the Surgeon. "I have experienced no pain" came the reply.

Dr. Warren turned to the audience on that morning of October 16, 1846.

"Gentlemen," he said, "This is no humbug."

Bravo! Dr. William Morton.

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