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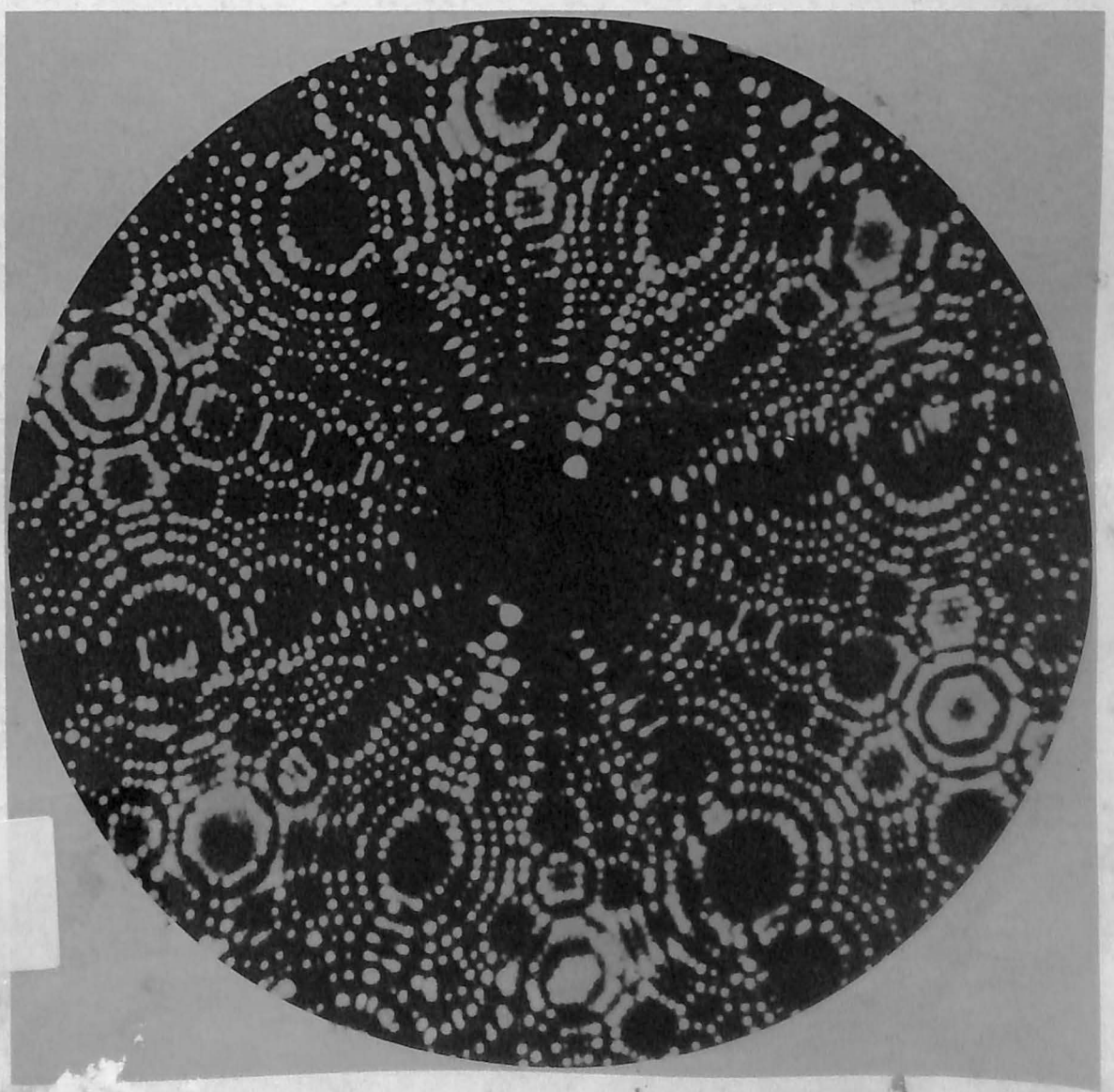
No. 6

Structural and operational schemes of national science policy

Science policy studies and documents



Unesco

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Previous publications in this series are as follows:

No. 1. La politique scientifique et l'organisation de la recherche scientifique en Belgique.
No. 2. Science policy and organization of scientific research in the Czechoslovak Socialist Republic.
No. 3. National science policies in countries of South and South-East Asia.
No. 4. Science policy and organization of research in Norway.
No. 5. Principles and problems of national science policies.

Structural and operational schemes of national science policy

Conclusions and recommendations of the meeting

Third meeting on science policy and research organization in the countries of North Africa and the Middle East

Algiers, 20-26 September 1966

Unesco

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INTRODUCTION

The Third Meeting on Science Policy and the Organization of Research in the Countries of North Africa and the Middle East was convened by Unesco in pursuance of resolution 2.112 adopted by the General Conference at its thirteenth session, authorizing the Director-General "to promote regional co-operation for the development of national science policy". At the kind invitation of the Democratic and Popular Republic of Algeria, it was held in Algiers from 20 to 26 September 1966; it followed similar meetings held in Cairo in December 1960 and Beirut in May 1963. Participation at these meetings was on the same regional basis.

Its object was to study:

changes that had occurred during the three years that had elapsed since 1963 in the national science policies and the instruments of those policies in the countries covered by the Science Co-operation Office for the Middle East (MESCO);

the introduction into these countries of modern methods of organizing and administering research activities and planning them to fit in with the objectives of development;

the prospects of regional co-operation between the science policy bodies of these countries, consonant with the common objectives of their science policy, and the contribution that international assistance could make to such co-operation.

In order to go more thoroughly into the practical approaches to the framing and carrying out of national science policies, the following three main subjects, corresponding to various items of the agenda, were introduced by Unesco consultants for general discussion by the participants:

the institutional structures for the organization of research at governmental level, which can now be classified into a certain number of definite types;

the factors to be taken into consideration in order to establish science planning on a quantitative basis, and particularly in order to assess the scientific and technical potential available to a country and to stimulate the development of that potential;

lastly, the machinery for interaction between scientific and technological research, on the one hand, and economic and social development on the other, and for integrating the policy for science and technology with the general development policy. The Meeting was to tackle this problem with a view to working out methods of planning research activities suitable for the countries of North Africa and the Middle East.

The practical arrangements for the Meeting and its technical organization were the joint responsibility of the Algerian Government - who made available to the Meeting the premises and facilities of the "Club des Pins" - and of Unesco represented in the region by the Middle East Science Co-operation Office (MESCO), Cairo.

The principal participants were specialists in science policy and research organization, attending in a personal capacity and nominated by the Director-General of Unesco from among leading representatives of the bodies responsible for national science policy, on proposals of the Member States covered by the Unesco Science Co-operation Office for the Middle East (MESCO). Specialists from the following countries attended the Meeting: Algeria, Iran, Iraq, Jordan, Kuwait, Lebanon, Morocco, Saudi Arabia, Sudan, Tunisia, Turkey, United Arab Republic, Yemen[1]

Member States and Associate Members of Unesco other than those covered by MESCO were empowered to send observers. The United Nations (Headquarters, New York, and Economic Commission for Africa), Specialized Agencies (International Labour Office, World Health Organization, Food and Agriculture Organization), and the International Atomic Energy Agency were invited to send representatives. Invitations to send observers

(1) The region covered by the Middle East Science Co-operation Office of Unesco also includes Cyprus, Libya, Syria and Qatar.

were also addressed to the following intergovernmental organizations: League of Arab States, Organization of African Unity, and to the following non-governmental organizations: Council for International Organizations of Medical Sciences, International Council of Scientific Unions, Union of International Engineering Organizations.

The Meeting was declared open on 20 September 1966 in the "Club des Pins" by His Excellency Dr. Ahmed Taleb, Algerian Minister of Education, in the presence of Mr. Yvan de Hemptinne, Head of the Science Policy Division, representative of the Director-General of Unesco.

After the opening speeches, the Meeting elected the following officers by acclamation:

Chairman	:	Mr. A. Ouabdesselam (Algeria)
Vice-Chairman	:	Dr. F. Al-Tai (Iraq)
Rapporteur	:	Dr. S. Rassekh (Iran)

The Meeting worked only in plenary sessions. During the first two sessions, the principal participants made exposés on the present state of science policy and the organization of research in their respective countries. These exposés will be found in Annex VI, while factual information on science policy organs existing in these countries and a global analysis of human and financial resources available for science and technology in the countries of the region are given in Chapter I. During the other sessions, the consultants introduced, and the participants discussed, items 5 to 9 of the agenda (see Annex III). Chapters II to V contain the résumés of the discussions and of the conclusions reached by the Meeting. The recommendations adopted during the final session have been inserted in the text at appropriate places, following the instructions of the Meeting.

CHAPTER I

MAIN CHARACTERISTICS OF THE PRESENT STATE OF SCIENTIFIC DEVELOPMENT IN THE COUNTRIES OF THE REGION

A. Governmental structures for national science policy and national development planning

It emerged clearly, during the Meeting, that the countries of the region are becoming increasingly alive to the need for the co-ordination of scientific research and the formulation of a long-term national science policy.

At the time of the first Meeting in this series, held in Cairo in 1960, only one country had a governmental organ for science policy, and only 9 countries belonging to the region took part in that Meeting.

Today, as is shown in Table I, 7 countries out of the 13 which have participated in the Meeting have an institution responsible for formulating the government's national science policy.

These science planning institutions are for the most part attached to the Office of the President of the Council of Ministers - a fact which obviously facilitates the task of interministerial co-ordination and enables them to formulate a truly national science plan. In some cases, however, the governmental science planning institution is still administratively attached to the Ministry which originally created it.

National development planning, formerly termed economic and social planning, preceded science planning in most of the countries of the world. At present, practically all the countries of the region have a national body which is responsible for the preparatory stages and supervision of the execution of the National Development Plan, the duration of which varies according to the countries concerned.

Lastly, it is manifestly impossible to engage in any effective science planning without having reliable data concerning the national scientific and technical potential (STP). Table I shows that this essential stage is still to be reached in many countries of the region.

B. National expenditures and manpower resources in the region, in the field of science and technology

It was stressed during the Meeting that the science policy of the Member States of North Africa and the Middle East should be based on sound quantitative data regarding the scientific activities of these different countries. In order to plan the scientific development in a rational way, it is important to have precise information about the state of science in the past and in the present, so that the various trends can be examined and projections made. This means that the whole field of scientific and technological activities must be described quantitatively in terms of measurable parameters.

The two most important factors involved in the analysis of scientific and technological development are manpower and financial resources. Science statistics constitutes a relatively new field, and it is only recently and in a limited number of advanced countries that measurements have been made in relation to manpower and finance. Thus for the countries of North Africa and the Middle East a detailed analysis is not possible at present. However, in view of the urgent need to provide basic data for science planning, a first step in this direction was made at the Meeting by collecting information on gross estimates of the total number of scientists and engineers, the percentage of this total number engaged in research and development, and the national expenditures on science and technology. Related to these fundamental parameters are the following quantities: number of scientists and engineers per unit of population, total national expenditure on science and technology per unit of gross national product (national research index), and per unit of population.

The preliminary estimates presented at the Meeting will be useful as a comparison reference for a dynamic analysis (time series) when the detailed information has been collected by Unesco's Office of Statistics for use at future meetings.

It should therefore be borne in mind that the data made available during this meeting indicate merely orders of magnitude.

The Meeting decided, moreover, that whereas the data collected by Unesco for the advanced countries are restricted, as regards national expenditure on science and technology, to research and development and associated activities, it would be useful in the case of developing countries(1) to estimate the whole of the national expenditure relative to the application of science and technology to development (of course including research and development but excluding investments and expenditure yielding immediate economic returns by the production of goods and services). The figures obtained were hence too high to permit a valid international comparison, but they nevertheless enabled to sketch out a general picture of the situation in the countries of the region. On the other hand it is not possible from these figures to arrive at final conclusions as to the relative positions of the different countries in 1966, since precise information is lacking at this stage on the coverage of the estimated data and on the degree of their standardization in the countries of the region.

In spite of these uncertainties, it can be seen that the per capita expenditures on scientific and technological activities (including research and development), averaged over the region (see Table II) are of the order of US $0.6. Moreover, the variation in the number of scientists and engineers is considerable (through two orders of magnitude), which is of course explained by the wide differences between the population figures for the countries of the region; however, the percentage of scientists and engineers engaged in research is generally of the order of 5 to 10%.

(1) See Chapter II, Section A (paragraph 4)

TABLE I / TABLEAU I

Country / Pays	I. National science planning institution Institution de planification scientifique nationale II. National development planning institution Institution de planification du développement national	Legal instrument of establishment Instrument de création	Date of establishment Date de création	Controlling body Rattachement administratif	Evaluation of STP Evaluation du PST (1) Date of first evaluation Date de la 1re évaluation complète
Algeria Algérie	I. Conseil de la recherche scientifique	Decree / Décret	1965	Ministère de l'éducation nationale	In progress / En cours
	II. Direction générale du plan et des études économiques	—	—	Ministère des finances et du plan	
Iran	I. Conseil supérieur de la recherche scientifique	—	Expected Prévu 1967	—	—
	II. Organisation du plan	Law / Loi	1948	Cabinet du Président du Conseil	
Iraq / Irak	I. Supreme Council of Scientific Research	Law / Loi	1963	Office of Prime Minister	1964
	II. Planning Council	—	1958	Ministry of Planning	
Jordan Jordanie	I. Jordan Research Council	Ordinance Ordonnance	1964	Ministry of Education	1966
	II. Ministry of National Economy and Social Affairs	—	—	—	
Kuwait Koweït	I. —	—	—	—	—
	II. Development Council	Law / Loi	1961	Office of Prime Minister	
Lebanon Liban	I. Conseil national de la recherche scientifique	Law / Loi	1962	Cabinet du Président du Conseil	1963
	II. Conseil de la planification	Decree / Décret	1952	Ministère du plan	
Morocco Maroc	I. Conseil universitaire de la recherche scientifique	Decree / Décret	1959	—	—
	II. Ministère du développement	—	—	—	—
Saudi Arabia Arabie saoudite	I. —	—	—	—	—
	II. Central Planning Organization	Decree / Décret	1964	Office of Prime Minister	
Sudan / Soudan	I. —	—	—	—	—
	II. National Planning Committee	Decree / Décret	1962	Ministry of Finance and Economic Affairs	

Table I / Tableau I (continued / suite)

Country / Pays	I. National science planning institution / Institution de planification scientifique nationale II. National development planning institution / Institution de planification du développement national	Legal instrument of establishment / Instrument de création	Date of establishment / Date de création	Controlling body / Rattachement administratif	Evaluation of STP / Evaluation du PST (1) Date of first evaluation / Date de la 1re évaluation complète
Tunisia / Tunisie	I. —	—	—	—	—
	II. Secrétariat d'Etat au plan et à l'économie nationale	—	1962	—	
Turkey / Turquie	I. Scientific and Technical Research Council	Law / Loi	1963	Office of Prime Minister	1963
	II. Planning Department	Law / Loi	1961	—	
U.A.R. / R.A.U.	I. Supreme Council for Scientific Research	Decree / Décret	1965	Office of Prime Minister	1958
	II. Supreme Planning Council	Decree / Décret	1965	Office of Prime Minister and Ministry of Planning	
Yemen / Yémen	I. —	—	—	—	—
	II. —	—	—	—	

(1) STP: Scientific and technical potential.
PST: Potentiel scientifique et technique.

TABLE II / TABLEAU II

Gross estimates of financial and human resources in science and technology
Estimations approximatives des ressources financières et humaines en science et technologie (1)

Country / Pays	Year / Année (2)	Number of scientists and engineers / Nombre de scientistes et d'ingénieurs		National expenditures for science and technology / Dépenses nationales pour la science et la technologie		Population in / en millions (6)
		Total (3)	Number of researchers in % of total / Nombre de chercheurs (4) en % du total	In millions of U.S. $ / En millions de $ USA (5)	In / En U.S. $ *per capita*	
Algeria / Algérie	1966	800 – 1 000	6	4 – 6	0.3 – 0.5	12
Iran / Iran	1966	6 500 – 7 500	–	20 – 25	0.9 – 1.1	23
Iraq / Irak	1966	4 000	7	0.5 – 0.7	0.07 – 0.10	7
Jordan / Jordanie	1965	1 700 – 2 500	3 – 4	0.05 – 0.17	0.026 – 0.09	1.9
Kuwait / Koweït	1965	2 000 – 3 000	5 – 7	0.25 – 0.5	0.6 – 1.2	0.43
Lebanon / Liban	1965	2 000 – 4 000	7	1 – 2.7	0.43 – 1.2	2.3
Morocco / Maroc	–	–	–	–	–	13
Saudi Arabia / Arabie saoudite	1965	1 500 – 3 000	7	0.8 – 1	0.12 – 0.15	6.6
Sudan / Soudan	1965	1 400 – 1 500	15 – 20	2.5 – 4.5	0.2 – 0.35	13
Tunisia / Tunisie	1966	1 000	8	2.6	0.6	4.6
Turkey / Turquie	1964	20 000	10	24	0.8	31
U.A.R. / R.A.U.	–	–	–	–	–	29
Yemen / Yémen	–	–	–	–	–	5

(1) When two figures appear, they pertain respectively to the lower and upper limit of the estimate. Absence of figures indicates that the corresponding information has not been made available to Unesco (Science Policy Division) as of 1 December 1966.

(2) In the case of financial resources, 1966 estimates pertain to budget allocations, estimates of previous years pertain to expenditures effectively made.

(3) Number of persons having had a science education in the field of Natural Sciences or Engineering.

(4) Percentage of number of persons defined in (3) engaged in research and development activities.

(5) The following approximate conversion factors were used to express national currencies in U.S.$:

1 U.S.$ = 5 D.A. (Algeria); 80 rials (Iran); 1/3 dinar (Iraq, Jordan, Kuwait); 3 L.L. (Lebanon); 1/3 £ (Sudan); 5/9 D.T. (Tunisia); 9.T.L. (Turkey).

(6) Unesco Statistical Yearbook, 1965.

CHAPTER II

STRUCTURES, INSTITUTIONS AND RESOURCES OF NATIONAL SCIENCE POLICY

A. General considerations

1. A national science policy is essential for all countries, irrespective of their particular conditions. It is no longer conceivable that haphazard and unco-ordinated research be carried out without any governmental links or general directives, in short: unintegrated with government policy.

2. National science policy finds its expression in the body of legislative and administrative measures adopted by the government to ensure that the research effort is fully effective. Effectiveness of research is evaluated in relation to the country's development targets, to the advance in human knowledge and, in certain cases, to the country's political position in the family of nations.

The definition implies that the organization and development by the government of the various elements of the country's operational network of research institutions be effected in accordance with well established principles and in full harmony with the overall policy for the National Development.

3. Generally speaking, national science policy applies to activities in which discovery and invention play the key rôle. This type of activity is characterized by its innovatory nature, regardless of the type of research (fundamental, oriented fundamental, applied or developmental) or of the field of specialization involved (natural or human sciences).

4. In countries where descriptive inventories of natural resources break new ground they should also be included in the sphere of science policy. In point of fact, the institution of sectoral government policies is truly possible only after the overall scientific stock-taking of the milieu has been completed.

5. Developmental research warrants particular consideration. It consists of the small-scale reproduction of laboratory results, through a process of technical adaptation in which the know-how necessary for practical application proper is progressively accumulated, in one of the productive sectors of national life (industry, agriculture, transport, telecommunications, etc..).

6. Descriptive research (the preparation of large-scale national inventories) and developmental research have this in common, that they call for very considerable financial efforts, the coverage for which often has to be provided well ahead of the decision by the national planning authorities (or private industry) to proceed to the stage of directly productive investments - i.e., to the practical application of the knowledge acquired.

7. The main aims of a national science policy may be briefly defined as follows (the list, of course, is not exhaustive):

(a) Assessment of trends in science and technology through the collection of factual, objective and (as far as possible) numerical data essential for planning the development of the country's operational research network (personnel, funds, buildings) and for evaluating the possibilities of practical application of new knowledge for economic and social progress afforded by scientific research. It should be stressed here that only the specialists in research can supply the basic material concerning actual needs in science and technology, on the one hand, and the possibilities held out by the application of science and technology, on the other;

(b) Serving as a driving force for economic and social progress, in addition to the contribution made by research in the form of applicable results;

(c) Preparing the way for the development and exploitation of a country's natural resources by conducting the necessary investigations preliminary to investment decisions;

(d) Achieving proper co-ordination between academic research performed in universities and the objectives of the National Development Plan. Only by reconsidering the finality of its responsibilities in the field of fundamental research will the university be able once again to discharge its task effectively, especially in developing countries.

8. Any genuine national science policy requires the setting up of:

(a) a governmental structure permitting the effective exercise of the functions of scientific planning and decision-making;

(b) an infrastructure of scientific organizations and institutions of higher education forming the material and intellectual basis of research, and whose activities should be co-ordinated and harmonized so as to constitute an efficient operational network serving the aims of national science policy.

9. The organization of national science policy should take account of the two following basic principles:

(a) Evolutional flexibility - one might say "plasticity" - of the governmental structure, so as to ensure the rapid adaptation of science policy decisions to the concrete situations and objectives of national development;

(b) stability and continuity of operation of the organization and institutions constituting the country's operational research network, as well as of the auxiliary services of research.(1)

10. The aggregation of governmental institutions for science policy should be capable of performing several functions which may be summarily listed as follows:

(a) decision-making, the exercise of which rests with the members of the Cabinet acting, depending on the case in point, either in isolation, or as a small ministerial committee or as a plenary cabinet meeting;

(b) policy-formulation and planning, the work of which requires complete independence from any preponderant influence wielded by any of the government departments, and the right of unrestricted information concerning the research activities conducted under the auspices of all the ministerial departments. This function, in consequence, should be entrusted to a body attached, according to the particular case, to the Prime Minister or to the Office of the Chief of State. This body should enjoy a large measure of autonomy in respect of conception and methodology; in addition, it should be equipped with adequate means of investigation, study and synthesis; it should be connected with the Central Planning Organization, if any. Within the framework of the scientific policy formulated by this body and decided upon by the government, the detailed programming should be conducted by the various government departments and by their scientific institutions in charge of performing and directing the execution of research activities;

(c) the executive function mainly relates to scientific and technical research proper. It may be exercised in very different ways in the universities, in the research centres and laboratories of the various government departments and in the public or private sector of the economy.

11. Over-centralization of the executive function is to be avoided. In particular, the universities and the research centres of the various government departments should be granted sufficient autonomy in carrying out the functions and missions assigned to them.

Experience shows, however, that this executive function needs to be co-ordinated at the national level by one or more bodies (such as national research councils or academies of sciences), which would also be responsible for the decisively important task of initiation and stimulation, at the national level, in specific branches or fields of scientific research.

Recommendation no. 1

Scientific co-ordination should be extended not only to research activities conducted at the universities and specialized institutes but also to those undertaken at ministerial departments. Each country should carefully choose the organization for research co-ordination and science policy which is best suited to it. However, the countries of the region should have the opportunity of consulting Unesco's Science Policy Division on this score, and of taking account of the conclusions reached by the ECOSOC Advisory Committee on the Application of Science and Technology to Development (Third Report, May 1966 - E/4178).

B. Organization scheme for a governmental science policy structure

12. The simplest imaginable structure would take the form of a single body for national research covering all disciplines and types of research and combining the policy-formulation, planning and executive functions alike. Bodies of this kind do in fact exist in several countries, where they are known as "National Councils for Scientific Research".

While this organizational scheme is applicable in certain countries, given their population and level of academic, agricultural and industrial development, it would seem that in other circumstances a single body might well, under such a heavy responsibility, be paralysed by the wide variety of tasks to be accomplished.

13. Diversification of the governmental structure for science policy may be effected in two different ways, these being sometimes combined, judging from the experience of the most advanced countries:

(1) Such as documentation centres, workshops for the manufacture of scientific equipment and instruments, standardization and scientific metrology services, etc.

(a) Diversification based on the separation of decision-making, planning and executive functions;
(b) Subsequent diversification of the planning and executive functions either according to types of research (fundamental, oriented fundamental, applied, developmental) or according to sectors of the national economy or - which amounts to much the same - according to the main disciplines of applied sciences (agriculture, industry, medicine, etc..).

C. Governmental organs for science policy

14. The supreme decision-making organ in respect of national science policy may be:
(a) the Council of Ministers; or
(b) a Ministerial Committee consisting of the Ministers whose departments administer a substantial research budget, including, of course, the Minister of Education (this being the solution usually adopted); or
(c) a Minister (or a Secretary of State with ministerial rank) having responsibility for scientific questions by delegation of powers by the supreme political authority.

Whatever the system adopted, it is essential that specific responsibilities should be defined in respect of national science policy. Furthermore, it is essential for a governmental will to be continuously expressed within the constitutional power of the State itself, which thus becomes the master mover of a genuine science policy.

15. The National Council for Science Policy (or any similar body responsible for planning national science policy) is the deliberating body attached to this supreme decision-making organ, which will make its decisions on the basis of studies and briefs prepared by the Council.

The task of the Council is to deal with the budgetary,[1] structural and organizational problems relating to the country's operational network of research institutions (including the questions relating to the training and employment of scientific and technical personnel), as well as the programming and co-ordination of scientific and technological research, with particular reference to the setting of objectives to be met.

It is this body which will be responsible for formulating the country's science policy, in conformity with the financial conditions and economic directives laid down by the National Development Plan, and with due attention paid to the rôle which the country proposes to play in international co-operative research programmes.

16. In carrying out this important task, the Council will be assisted by its members, by a scientific secretariat and by such ad hoc working parties as it may set up for limited periods. Provision should be made for consulting leading scientists and administrators, and for the establishment of working parties set up on a temporary basis. Preference should be given in all cases to a hierarchical group structure rather than to large assemblies; and care should be taken to provide for the possibility of renewal of members.

17. The membership of the Council should be limited. Experience has shown large gatherings to be inefficient in such matters. The Council should include representatives of academic and applied research, in the field of natural as well as social and human sciences, and the directors of major scientific research institutions, an expert appointed by the department responsible for the National Development Plan, and a financial adviser.

The representatives of Research serving on the Council should be appointed by the executive organs of the national science policy[2], the appointment being made:
(a) by the autonomous institutions responsible for co-ordinating and stimulating the country's scientific research (e.g. national councils for scientific research or academies of sciences); or
(b) directly by institutions belonging to the operational research network proper; or
(c) even more directly, by elections by a small electoral body consisting of qualified research workers working at least part time in a research institution belonging to or officially recognized by the State.

18. The Council's scientific secretariat should be a State administration whose members form an integral part of the administrative staff of the Office of the President of the Council of Ministers (or the services of the Prime Minister or even the Office of the Chief of State, as the case may be). The members of this administration could be limited in number but should have high qualifications. The Secretariat should ensure co-ordination between the various government departments (including the Ministry of Education) in budgetary and administrative matters in respect of all questions relating to science policy. It would undertake or arrange for the preliminary studies necessary for the Council's work.

The Council should be provided with contingency funds amounting to some 2 to 4% of the total science budget so as to be able to take direct financial action itself in the interest of the science activities of the nation.

It should keep permanently up-to-date an inventory, of which the national science statistics would be an important component, of the national scientific and technical potential.

19. The executive organs of national science policy are normally of two types which are very distinct[3] but whose functions may nevertheless overlap, as witness the experience of certain

(1) The question of the national budget for science policy is dealt with in Chapter IV, Section I.
(2) See paragraphs 20 et seq. below
(3) See paragraph 11 above

countries (the academies of sciences of the socialist countries are an example).

(a) The first type includes the national bodies for co-ordinating scientific research, which exercise a decisively important rôle of promotion and stimulation. It is also their task to make scientific trend studies and forecasts which will enable the body responsible for planning science policy to define the main priorities of national research, and to provide the body responsible for the National Development Plan with blue-prints of the probable evolution of scientific and technological societies. The universities, in the developing countries, might possibly be required to play this rôle temporarily.

(b) The second type of executive organ includes the institutions which specifically make up the operational[1] research network of the country, i.e. the university laboratories, the laboratories and scientific and technical services of the government departments (including the Ministry of Education) and the laboratories of (public or private) enterprises engaging in research.

20. The questions concerning institutions actually conducting research are outside the framework of the present study. The ensuing section will therefore deal exclusively with executive organs of the first type, i.e. the institutions whose function is that of promotion, co-ordination or financing of research, and of making forecasts as well as evaluations of scientific trends. To make it quite clear, the reference here is to bodies existing in the most advanced countries such as national centres for scientific research, national academies of sciences[2], sectoral councils for research or national science foundations.

D. Structural pattern of national institutions for research co-ordination and financing

21. These institutions should be primarily characterized by:

(a) the exceptional human and scientific qualities of the members of their governing bodies, in which experience and maturity should be harmoniously combined with the dynamism and creative spirit of gifted young research workers;

(b) a very considerable measure of administrative and financial autonomy within the State scientific system.

22. The political and administrative traditions of countries differ, of course, very widely; in addition, they present a very wide range of scientific development.

It is therefore impossible, in the present situation, to devise a specific organizational pattern which could be applicable to all national institutions for co-ordinating and financing research.

23. However, a distinction can be made between three types of research, the end object of which, in relation to national development, could be clearly differentiated:

research aimed at cultural and educational goals, which should be rooted not only in the world "pool" of science but also in the traditional scientific culture of the nation;

research aimed at social objectives, i.e. medical, psychological, anthropological, sociological or similar research;

research aimed at economic targets, the results of which are of direct interest to industrial and agricultural enterprises or public utilities.

Each of these three types of research is found to include elements of fundamental research (pure and oriented) and of applied research including development work although, of course, in very different proportions. It should indeed be recognized that research having cultural and educational objectives may include a considerable element of "technical development"; examples that immediately spring to mind are astronomic telescopes, space-ships, oceanographic vessels and underwater stations. The innovatory "fall out" effect produced by this type of technical development on the whole field of national technology is in any case considerable.

24. It can be stated that the characteristics of research aimed at cultural or educational goals and research geared towards social objectives have much in common, namely:

(a) a predominant proportion of the budget devoted to oriented fundamental research;

(b) a privileged geographical location either at or near universities.

Research designed to serve economic ends involves on the other hand a predominant proportion of the budget devoted to developmental research as well as working methods which are more closely related to industrial practices than to the academic approach.

To sum up, the two categories of research thus differentiated are based on intellectual attitudes of mind and methods of work which are often alien and generally prejudicial to each other. To simplify the problem, we shall call the first category that of "fundamental research" and the second that of "applied and developmental research".

It is therefore useful to separate the institutions responsible for promoting, co-ordinating and financing these two categories of research.

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(1) The term "operational" is here used to designate the function of effective investigation, as well as the permanent existence of direct horizontal links between research workers and laboratories in a given country, this conferring on the network as a whole the necessary cohesion and corporate spirit.

(2) i.e. academies of the type existing in the socialist countries

25. The setting up of institutions should however be spread over a period and it would be possible only very gradually to establish them successively. Experience shows that if it was necessary to spread the establishment of institutions over a period of time through lack of human and/or financial resources, it would be advisable to begin by setting up the "fundamental research" institution, its existence being one of the essential conditions for an endogenous scientific and technical growth of the nation. It is impossible, in fact, to "transfer" brains[1], but what can be done, if necessary - in the first phases of development - is to transfer industrial or agricultural techniques and root them firmly.

> Recommendation no. 2
>
> The countries of the region should make a special effort in the field of research. More money must be devoted to it, and the operational network of scientific institutions should be given the necessary financial means as well as the administrative autonomy enabling it to respond rapidly to the needs of priority research projects. Such means ought to be additional to what the government departments (ministries) at present spend on their own research budget.

E. Research aimed at cultural, educational and social goals (Free fundamental research and oriented fundamental research)

26. The aims, functions and means of action of the institutions[2] responsible for this research may be summarized as follows, without the list being in any way exhaustive:

(a) Selective assistance in training research workers, in harmony with the national science policy. The question will be mainly one of temporary posts or fellowships enabling young graduates to obtain degrees equivalent to the science doctorate;

(b) Assistance for the research programmes covered by the national plan of science priorities or proposed by one of the establishments belonging to the operational network of research institutions;

(c) Maintenance of a staff of research workers and technicians (including scientific secretariat staff) whose status could be:

that of a "scientific civil service" quite distinct from that of the regular civil service; or

that of staff working under contract whose status is laid down by the institution itself, within the framework of the national legislation governing employment contracts.

All grades of qualifications should be represented among the institution staff, from the manual worker to the doctor of science and including the secretaries, technicians and engineers.

One observes frequently a lack of technical and secretarial staff in the various research units, especially in the developing countries. It was suggested that Unesco make a detailed study of that problem.

The technical and secretarial staff of the institution could be drawn upon to form a small number of research units. The latter, thus constituted in order to solve specific problems selected on a priority basis, should be disbanded once the desired results have been obtained. These research units should not be allowed to transform themselves into permanent laboratories of the institution.

(d) Financial support of research
The institution should be able to grant subventions in order to assist in the implementation of research programmes. It should also be able, in the case of one of its own research subjects to conclude contracts with laboratories belonging to a university or to a public or private research centre.

The practice of entering into financial arrangements with the laboratories and research services of government departments is undesirable, for in most cases the sole effect is to undermine the authority of the responsible minister in his own laboratories and services which often find themselves thereby enabled to undertake research work not chosen by the responsible authority i.e. their own minister.

(e) Inventory of scientific and technical equipment
The institution should draw up an inventory of scientific and technical equipment which should be brought up to date annually. This inventory, which should be widely circulated, would enable costly apparatus to be used to the best advantage and would serve as a basis for equipment requests.

(f) Scientific and technological trends reports
The institution should draw up annually a report describing the scientific and technological trends and presenting a prospective picture of developments in science and technology, and their applications. This report would constitute an essential background document for the forecasting work to be undertaken by the institution for the organ responsible for formulating the national science policy.

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(1) In this argument, we of course exclude the foreign experts who will eventually go back to their respective countries

(2) They may be styled National Centre for Scientific Research, National Fund for Pure Research, National Science Foundation or National Academy of Sciences.

27. The integration of the institution in the national science system is an essential element of science policy, the aim being to co-ordinate its activities with those of the establishments belonging to the operational research network, on the one hand, and the decision-making and governmental science policy planning bodies, on the other.

Research in general - and in the present context free fundamental and oriented fundamental research in particular - should make a positive contribution towards solving the major medium and long-term economic, technical and social problems confronting the country. University research, in particular, should assist in this task to an ever greater extent.

While the true sphere of universities is fundamental research, work can be done just as effectively as regards the training of research workers, on research themes directly related to the economy of the various countries; hence the key rôle played by oriented fundamental research (in all fields) as well as by biomedical research and basic technological research.

Recommendation no. 3

All universities in the region should ensure an adequate balance between their teaching and research. The university research, though being mainly fundamental and especially fundamental oriented research, should not exclude applied research.

28. The administration and direction of the Centre should be entrusted to scientists acting collectively as a Board of Management. The Board should be assisted by an advisory committee (or committees) of specialists and by a staff of science administrators.

Recommendation no. 4

A corps of science administrators should be formed to assist the Board of Management of scientific research institutions. Scientists who show aptitude towards administration should be given the opportunity of being thoroughly trained in administrative techniques and assigned administrative jobs.

The Board of Management should be authorized to make decisions regarding the budget and the general programmes of work. The functions of the advisory committees would consist essentially of the technical preparation of these programmes.

The advisory committee(s) would be composed of representatives of the different areas of research in the natural, social, human and medical sciences. The members of the Board of Management would include, in addition, representatives of the ministries concerned with lines of research, the establishment of objectives and the exploitation of research results, together with representatives of the economy.

F. Research aimed at economic objectives (Applied research and developmental research)

29. The institution responsible for stimulating, co-ordinating, and financing this type of research is more particularly directed towards industry, the public services and agriculture.

Whether it is a single institution, with various sections corresponding to the different economic sectors, will depend on the case in point. In small countries, or in those which have not yet achieved full scientific development, this will be generally so. Elsewhere, there would be a gradual process of diversification of institutions, as stated earlier.

30. The research work conducted under the auspices of this institution should lead to results capable of industrial and agricultural exploitation. In countries which have achieved a high level of economic development, this category of research occupies an important place, and is more costly than fundamental research. Its primary concern is to stimulate the national economy.

However, research work is without significance for the economy of a country unless its results are exploited in practice. The arduous transition from the laboratory stage to the practical application stage involves a number of difficult problems, especially in countries which lack a well developed industrial structure and well organized agricultural field services. Particularly in this field, therefore, planning is imperative, for research, development work and industrial or agricultural operations are intimately linked, and it is essential to harmonize them by concerted action.

31. Questions concerning the organization and administration of the institution responsible for promoting research aimed at economic objectives, and its integration in the science structure, call for much the same solutions as those proposed above in the case of the institution responsible for research aimed at cultural, educational and social goals..

32. However, certain specific and essential features of the institution geared towards economic objectives are worth special mention.

(a) The institution should play a dual rôle in respect of liaison and stimulation

on the one hand, between oriented fundamental research and the production of goods and services (economic sector) with a view to the optimum utilization of discoveries and innovations;

on the other, between the governmental organs responsible for science planning and the industrial or agricultural sector and the public utilities sector.

(b) In its programme of assistance to developmental research, feasibility studies should be conducted with very special care in order to determine clearly, in advance, the advantages and drawbacks of various tasks of research as well as their cost/benefit ratios, thereby limiting the risks involved, since developmental research calls for heavy capital investments.

In the case of industry, in particular, a pilot plan is nearly always required in order to ensure a smooth transition from the "research" stage to production operations. Developmental research may also take other forms, such as the construction of prototypes or even the production of small series, especially where the work relates not to products but to production systems and equipment.

(c) The impact of the institution on the functioning of the State research laboratories and services may be considerable. It will in no sense be a substitute for the ministerial research establishments; its action, rather, should be complementary, in cases where the government departments are unable to complete or carry out fast enough a priority research effort in a given area. Furthermore, being in direct contact and on familiar terms with the world of research, it will be in a position to put forward proposals for adapting the government's science policy more closely to the needs of national economic development.

(d) The scientists belonging to the Board of Management of the institution will include officials selected for their special competence, serving in government departments with a particular interest in the fields of mining, the extractive industries, hydraulic engineering, rural development and agricultural production, as well as individuals concerned with scientific and technical questions in enterprises and at universities (including Faculties of technology).

G. The human factor

33. Whatever the governmental structures for science may be, the success of scientific planning work and the productivity of research will depend in the last analysis on the quality of the men engaged in it.

34. In this connexion, the following points are of considerable importance in the developing countries:

(a) The status of research workers

They should be offered higher salaries than those of civil servants, and if necessary a scientific civil service should be set up with a legally recognized charter - in this connexion, the examples of the United Kingdom and Belgium are particularly worth noting. It is possible, in this way, to recruit the most competent elements among those seeking a scientific career, and subsequently ensure the stability and continuity of their work. These measures will also help to counteract the well-known phenomenon of the "brain drain" from which many of the developing countries are suffering.

> Recommendation no. 5
>
> The status of research workers should be upgraded by the adoption, in particular, of appropriate legislative texts governing their working conditions. In the event of the benefits attached to the university function being also insufficient to permit the availability of an adequate number of higher educational personnel and hence meet the needs of research, it is absolutely essential to upgrade at the same time the status of the university staff.

(b) Higher education and national science policy

There is no need to labour the obvious fact that higher education and research should be inseparably linked together at the university and at the university institutes or faculties of technology, medicine and agronomy.

Accordingly, in order to take account also of the university's rôle in educating and training, national science policy should promote the full accomplishment of its twofold mission, namely, teaching and research. This explains, incidentally, why certain countries have entrusted to the government organ responsible for science policy planning all the questions involved in planning higher education (the latter remaining administratively attached, of course, to the Ministry of Education).

> Recommendation no. 6
>
> It is advisable, whenever possible, to integrate higher institutes of technology, medicine and agronomy into the universities by giving them the rank of university institutes or faculties. They should be given a rôle in the national programmes of applied research and developmental research.

(c) Just as important is the question of scientific and technical staff. In the developing countries, it should be possible, by a solid effort of planning, for the bodies responsible for science policy to "project" a balanced distribution of specialists so as to ensure that there

are not too many of them in some sectors and too few in others.

Recommendation no. 7

The need for team work in the field of research is widely recognized. The training of intermediate technical staff capable of working with and integrating themselves in the teams in question must therefore be ensured. In this respect, it is necessary to have two grades of technicians; one, of secondary level, serving the everyday work in the laboratories and the others of higher level, participating in the actual research work. There is great need to increase the number of both types of technical staff and to improve their status. Particularly, in order to attract a sufficient number of students to the secondary technical school, openings should be provided to the best elements to complete their training in the university faculties of technology and in the higher polytechnic institutes.

(d) In the developing countries which have to build up or complete their operational network of research institutions, the human potential of research workers and technicians can be very effectively developed by a national research centre specializing in oriented fundamental research, applied research and developmental research and covering a large number of scientific disciplines. This is the "multipurpose research institute" formula which has successfully been tried out in the United Arab Republic and in India.

This formula provides a satisfactory approach to problems requiring the combined efforts of specialists in different disciplines. The partnership between different research units compensates the high cost of scientific equipment needed by the research workers. Furthermore, such equipment may not be fully utilized if assigned exclusively to a single laboratory. An expensive apparatus in a small institute, through the impact of its price, would tend to single-track the research thus impairing flexibility. Last but not least, the necessity of putting the right equipment in the right place for proper maintenance and long-lasting performance cannot be overemphasized. For instance, an instrument such as an electron microscope, occasionally needed by the biologist, is better maintained by a physicist.

Specialized research institutes may branch off from a national research centre of the above type, when one or another unit attains a high degree of development and can directly serve an important sector of the economy.

(e) With respect to the training of research workers up to the highest level of qualification, it was recognized that young graduates are often sent abroad to obtain their degrees. However, in the long run developing countries should rely on self-development. True, it sometimes appears necessary to send a graduate abroad for special studies, particularly in special fields of application of science to technology. However, it has been found that once the universities in a country are capable of pursuing post-graduate research of a high calibre it is preferable for a graduate to obtain his doctorate degree at home first in a basic science related to the applied field relevant to his future work. Thereupon, he would be afforded the means of pursuing his studies abroad in that particular field, for one or two years. This ensures a better comprehension by young graduates of national needs, and because they have achieved the necessary maturity they will not hesitate to return to their home countries to participate in the national development.

CHAPTER III

FORMULATION OF NATIONAL SCIENCE POLICIES ON A QUANTITATIVE BASIS

A. Introduction

1. The introduction of quantitative methods for planning scientific and technological development may be directed to answer several kinds of questions, corresponding each to a different stage of the planification activity. The scope and limits of the methods employed must be carefully studied, bearing in mind that the specific methodology to be applied in each case is determined, on one side, by the goals to be attained and, on the other, by the data available for the analysis of that particular aspect of the problem which is under consideration in each stage of the planification process.

B. An ideal methodological scheme of planification

2. The introduction of the idea of planning, and the effective implementation of a plan in a country or a region, or in a particular aspect of a country's activities, always amounts to a change in the direction of a "system" which is describing a determined "path".

The "system" may be an institution or a set of institutions mutually related in connexion with an activity or activities which concur to a certain established goal.

In each system one must be able to identify a set of characteristic magnitudes, the "variables" of the system, the values of which are a function of time. At a given moment, the values of the characteristic variables of the system determine its "state". The mutual relations among the values of the variables define the "structure" of the system.

Each variable takes a certain range of values in a given time interval. This determines the "path" followed by the system.

When a system moves from a state E_1 to a state E_2, it is said that it has suffered a "change of state", which is defined only by the values taken by the variables in state E_1 and state E_2. The same change of state can be obtained through different paths.

Once the path followed in a change of state has been established as well as the method used in following such path it is said that the "process" involved in the change has been described.

3. An ideal scheme of planning would therefore involve the following stages:

(a) Definition of the system S, whose evolution must be studied and with which certain goals are to be attained.

(b) Evaluation of the initial state E_o of system S, at a given time T_o.

(c) Diagnosis of the processes involved in the history of the system, by the identification of the different factors which have determined its present state and the path it has followed.

(d) Prognosis of the future state E, to which system S will arrive at time T, by the projection of present trends.

(e) Adoption of goals for system S at time T, that is, definition of the state E' to which it is desired that it reaches at time T, instead of state E, to which the system would reach, should present trends stay unchanged.

(f) Establishment of boundary conditions, which limit the methods which can be applied so that the system follows a certain path.

(g) Selection of a development model for system S, that is, adoption of a theory which establishes the relation among the different variables and makes it possible to forecast the path which the system will follow if some variables are changed in a certain way previously agreed upon.

(h) Choice of a strategy to attain the goals adopted in (e), by means of a process compatible with the conditions established in (f), and indicated as the most satisfactory by the simulation studies made on the model selected in (g).

(i) Determination of institutional policies to be adopted in order to follow the strategy chosen in (h).

Items (a) to (d) demand census, surveys and

statistical studies. Items (e) and (f) are of a political nature and constitute an essential part of the definition of government science policies.

Finally, items (h) and (i) are the contribution of systematic methods to development theory. They have been incorporated only recently and though still in an embryonic state, they carry in themselves the prospect of much more rational bases for an adequate development planning than those used so far.

C. Definition of the system

4. In the particular case of science policy-making, the system is defined by the total scientific and technological activity falling under what is universally known as "Research and Development" (R & D), including the training and occupational programmes related to the manpower needed to carry it out. One could also consider systems which are sub-systems of the total one as, for instance, the training of scientists.

The definition of the system and the selection of the variables on the basis of which the state of the system can be clearly defined, require careful consideration.

5. The evaluation of the efforts of a country in research and development cannot be made in a vacuum. Research expenditures, manpower potentials, educational structure and other crucial factors which make up the overall picture, can only be judged with reference to what is known from other countries and to past experience in the respective fields. Comparative studies between countries of similar state of development and with reference to the most advanced countries are therefore essential. A first step to overcome these difficulties is the adoption of standard practices in all countries, to ensure the use of uniform sets of definitions and computing methods. The Unesco document "Guidelines for the elaboration of national science policy studies" (UNESCO/NS/ROU/85) is an effort in this direction. The adoption of internationally accepted operational methods may however take some time.

6. Once the practices become uniform in all countries, the task is considerably easier, but the difficulties will not entirely vanish. Definitions are not always being interpreted and applied in the same way by everybody. There will always be borderline cases which can only be decided one way or another by rather subjective evaluation.

D. Evaluation of the state of the system, at a given time

7. The assessment of the state of this system, at a given time, requires a judicious choice of the items on the basis of which a survey is conducted to collect the information needed. The Unesco document referred to above provides a comprehensive list of tables, graphs and organization charts, out of which a relatively complete evaluation of the situation of a country can be made. Notwithstanding, an evaluation made in such a way as to be useful to the science policy-maker is not automatic. In addition to the difficulties in the definition of the terms involved, there are others, arising when the comparison is made between countries having different economic, demographic or occupational structures. The absolute or even the relative amount of expenditure of a country in research activities or in training can only acquire a clear meaning in the context of what has happened and what is happening in the same field in other countries, at different levels of development. Here, it would not be enough to agree on exactly the same definitions, or make exactly the same decisions concerning the data to be included. The particular conditions pertaining to each country must be taken into account, to make the comparisons really meaningful.

E. Diagnosis of the processes involved and prognosis of the future state of the system

8. For the diagnosis of the processes that have been responsible for the state of the system at time T_o, it would be necessary to have time series of data for some - or all - of the variables of the system.

Statistics can be prepared, on the basis of these past records to indicate the probability of any occurrence or combination of occurrences. The statistical extrapolation techniques which are applied to the long-range forecasting are quite simple in principle, being based essentially on persistence and trend, linear lag-correlation (regression) and period analysis. It is quite obvious that none of these statistical extrapolation techniques can be expected to forecast exceptional occurrences due to sudden changes in policies or in the structure of the system.

In order to have a description of the state of a system, parameters must be found that will adequately represent the general features, so as to give a "static picture" of the situation at a given time. The forecasting of the future path of the system, on the other hand, requires parameters which actually identify its dynamic features.

9. Ideally, a diagnosis of the processes involved leads to the identification of the dynamic parameters; the behaviour of these parameters in the past provides the elements to make statistical projections and forecast the path of the system in a certain period of time. Should the system behave in the future as it did at time T_o, the forecast predicts that it will arrive at time T at a certain state E. The description of the state E thus arrived at, is called the prognosis of the system at the time T.

In so far as Research and Development (R & D) is concerned, the statistical material is far from satisfactory, even in advanced countries. The

systematic measurement of the variables involved in R & D is only very recent. The field of training and education, which is a sub-system of the system we are considering, is perhaps the one having in most countries better material for the analysis. This sub-system is of utmost importance: in some advanced countries the expenditure for scientific and technical manpower accounts for as much as 40% of the total expenditure in R & D. The proportion is undoubtedly much higher in less developed countries.

10. Once the statistics have been straightened out, and the meaning of the data made clear, quantitative methods may be applied to find out the interrelation of the variables, or the particular weight of each one of them in determining some special aspects of the development process.

F. Goals and boundary conditions

11. The definition of the goals is a task for the science policy-maker, based primarily on the political programme of the government and/or the National Development Plan. The definition of the goals is not, however, independent of the planning process itself. Realistic goals can only be established in terms of a feasible plan of development. This plan, in turn, will depend not only on the conditions of the system but also on the objectives envisaged in other sectors of activity of the society, which are related to it. These other objectives may restrict the path which the system is allowed to follow, in order to reach the final goals; they are therefore in a way similar to the "boundary conditions" of a physical system. The boundary conditions are a constituent part of the social, economic and political structure of the country concerned and of the overall National Development Plan of the government.

There is obviously an interrelation between goals and what we have called boundary conditions. The same change of state of a system may be attained through several paths. But restrictions in the choice of paths accepted as permissible may imply that certain changes of state cannot be produced in a given time.

12. Policy-makers often make use of rather vague ideas concerning the evolution of a system and the way certain policies may produce certain end results. When the hypotheses which are implicit in those ideas are not explicitly formulated, it is impossible to realize whether the underlying "theory" is consistent or not. Only a formalization of the problem may reveal whether all factors have been taken into account and if the reciprocal relations among them, that the policy-maker has in mind, are either contradictory or insufficient to determine a solution for the problem.

13. To formalize the problem means to specify the variables and to establish the functional relations among them. One is led therefore to formulate a "model" for the system, to analyse its internal consistency and test its capability to predict the evolution of the system.

In the case under consideration (planning for R & D policies), it is obviously difficult to devise models which formalize a reality that is not amenable to quantitative treatment. However, recent developments in the theory of models and in computing techniques have opened the way for the treatment of problems that are difficult to quantify, and for which the information available is incomplete and scattered. What these models provide is not an exact "result", but rather an exact method to test several hypotheses concerning the functional relations among the variables and to find out the effects of imposing predetermined patterns of variation to some of the variables of the system.

These models are not therefore used as means to make exact quantitative predictions. They are used as tools to take decisions when one has to choose among alternative paths which may be followed by a system to reach a certain goal.

G. Mathematical models and strategies

14. As indicated above, a number of different types of models can be formulated, according to the degree of formalization that the nature of the problem in hand allows for. But whatever the degree of formalization, the formulation of the model requires a clear specification of the types of variables and of the functional relations among them.

15. In the ideal case, exact functional relations are established among the variables. Given a set of values for the "initial" conditions of the variables, one can predict the evolution with time, under proper boundary conditions. These models allow for exact quantitative predictions. One can experiment with them by changing the "instruments" and find out the effect of each policy decision. The selection of the "best strategy" for a given goal is therefore obtained in exact terms.

The econometric models belong to this class. Here, the functions are obtained by statistical analysis of historical series. This introduces some important restrictions to the models. One is compelled to use only those variables for which there is enough information about their behaviour in the past. In addition, only linear relations can be used, in practice, because the functions are found by applying the method of least squares.

16. Simulation models are free from the above restrictions. They are particularly suitable in fields where decisions have to be made concerning systems which are difficult to describe in quantitative terms and whose evolution is not known in detail. They are, therefore, a much more powerful tool than the previous types of models and may be successfully applied in cases where, due to the lack of statistical information or to the complexity of the functional relations, the econometric models fail.

In the simulation models neither the behaviour of the variables nor the form of the functions are

exactly known. Only a set of possible types of functions is given.

For each particular function, which is compatible with the data, a numerical experiment is set up by means of which several strategies are tested and classified according to their ability to approach the given goal. The set of all numerical experiments carried out with the different functions provides a way to classify all strategies open to choice and make a decision which is based on the best information available. It should be emphasized that only with the help of electronic computers is it possible to make use of simulation models of such flexibility. This is due not only to the amount of computation which is involved in each "numerical experiment", but more particularly to the types of functions that need to be introduced. The systems of equations to be solved are very seldom amenable to analytical methods. System analysis by means of simulation models is thus a branch of applied mathematics making use of the more modern techniques of numerical methods already used in operational research and the theory of games. Science policy should therefore be developed by scientists well trained in these methods and making full use of their potentialities.

H. Science policy and strategies

17. The present state of studies concerning scientific and technological development policies does not as yet offer the promise of a ready-made method, out of which clearly defined strategies might be presented as alternatives for the policy-maker. This is undoubtedly due, not only to the complexity of the problems, but also to the very fact of being a rather new field of research. Notwithstanding, the experience gathered so far points to the convenience of the universal adoption of quantitative methods in this field.

Perhaps more important than any other argument in favour of these methods, at the present moment, is the fact that they offer the possibility of self-correction and self-adjustment, making all experience which is gained a cumulative process. The planning of policies in any field, when visualized as a continuous process, brings the hope of attaining new levels of efficiency by successive approximations in the all-important function of decision-making.

Recommendation no. 8

Planning of the scientific development should be organized in close horizontal liaison with national development planning (economic and social planning). The countries of the region are invited to concert their efforts to establish the most modern procedures and techniques for scientific planning based on simulation methods which would permit the quantified forecasting of the development of scientific research and the country's scientific and technical potential.

CHAPTER IV

OBJECTIVES AND METHODS FOR INTEGRATING SCIENCE POLICY AND OVERALL POLICY FOR SOCIO-ECONOMIC DEVELOPMENT

A. Introduction

1. The object of a national economic and social development plan is to ensure the optimum distribution of what slender resources may be available to the nation and government. The normal criterion for optimization is the increased rate of growth of per capita income and the improvement or transformation of the social and cultural conditions for the advancement of the individuals and communities making the nation.

2. Among the resources in short supply are scientific and technical personnel, on the one hand, and the material means used for the equipment and operation of research units, universities and higher educational establishments, on the other.

3. To integrate science policy and economic and social development policy, therefore, it is necessary to determine:

(a) the proportion of its human and material resources which the nation should devote to research, to the related scientific activities, and to higher education;

(b) how this part of the national resources should be distributed between the various lines or disciplines of research or higher education, and between the institutions responsible therefor.

But before taking up these two problems, it has to be determined how far a national research effort can effectively contribute to development.

B. Science as the instrument of economic and social development

4. Science has a very direct impact on economic and social development by its contribution to the improvement of techniques, in the broad sense of the word.

In this broad sense, a technique is the aggregate constituted by an optimized method and the corresponding instrument. The concept applies to all fields of human activities without exception.

5. Mankind devised techniques long before the scientific era in which we are now living. Its first attempts were empirical, and many centuries passed before the techniques developed in this way attained their definitive form.

There is no need to stress the fact that the scientific approach is more efficient than the empirical approach, nor elaborate on the extraordinary rate of progress made possible through it. In the developing countries, this potential rate is even faster because, there, it is possible to avoid the successive stages in which modern techniques were perfected.

One obstacle, however, is that the masses are less well prepared to assimilate these new methods of procedure and realize at once the need for them.

More often than not, the validity of the techniques which developed empirically during the course of many generations was confirmed by the rules of social life and they became accepted procedures sometimes just as binding as moral or religious laws or legal principles.

6. Ordinary people often fail to grasp their utilitarian character and are therefore opposed to technical changes which seem to them to call into question the very foundation of community life as they know it.

The resistance to change becomes relatively less frequent in cases where the scientific approach to technical problems is understood and recognized by the majority, thanks particularly to the spread of education, as being beneficial. People are less afraid of what they are able to grasp, and changes are more readily accepted when the reasons for them are known and the need for them is understood.

7. This is why a scientific policy applied to the accelerated development of peoples who are still to some extent traditionalist cannot succeed if it is confined to an élite of scholars and research workers and fails to penetrate deeply into the working-class and peasant sectors of the population.

8. The natural leaders of these sectors - foremen, local trade union officials, village chiefs - must themselves have undergone some psychological transformation and not only be able to explain in outline the why and wherefore of what should be done and allay the fears and misgivings of those around them, but be also able to communicate with the responsible technicians and laboratory research workers when difficulties arise in applying the directives received from them for carrying changes into effect.

C. Need for research in the developing countries

9. In the case of the developing countries, the possibility may be considered of confining themselves, in the early stages, to the application of techniques that already have been tried out in the industrialized countries and to the dissemination of the scientific knowledge they have acquired.

10. This would be a misguided policy, for the following reasons:

(a) Not all European, American or Russian techniques can be transposed without adaptation to Africa, Asia or Latin America;

(b) The technicians responsible for disseminating modern techniques are unable to acquire and maintain the necessary level of competence without direct contact with the research workers in applied science who devise the new techniques;

(c) It is also obvious that an applied science cannot be effective unless the research workers are in personal daily contact with the most advanced ideas in the basic science on which it rests; nor can research workers who have a vocation for pure science be forced to choose between expatriation and undertaking work in applied science which does not satisfy them. For these two reasons, adequate allowance for pure science should be made in plans and projects. The opposite danger, however, seems to arise more often: the absence of a well developed local industry, provided with active research laboratories, means that there are only a limited number of jobs available in applied science. In these circumstances, the proportion of the national resources allocated to fundamental science is liable to be abnormally high if up-to-date industrial and agricultural techniques fail to develop at a rate sufficient for the country;

(d) Again, in sociology, ethnography and archaeology, indigenous research workers who have been brought up in a different cultural tradition - often a very old and rich one - will undoubtedly open up new and untrodden paths when enough of them take up the study of their own societies and their own past.

D. The overall volume of scientific activity - the national research coefficient

11. The object of this section is to determine the proportion of national expenditure to be allotted for scientific research[1].

We shall employ the term "national research coefficient" to express the ratio between:
national expenditure (public and private sectors) on research and ancillary activities (excluding education);
and the gross national product.

12. The calculation of the national research coefficient to be adopted in formulating the National Development Plan (economic plan) has to be approached from two angles:

(a) First, we must inquire what level of the national expenditure on science corresponds to the maximum rate of growth of the national economy. For there is an optimum level[2]. Below this optimum, the economy is not sufficiently stimulated by scientific and technological thinking in preparing decisions, and innovation is too slow. Above it, the budgetary and human resources allocated to science might perhaps have been better used for investment in production or in general education, or in some other activity with economic or social implications.

(b) Secondly, the possibilities must be considered. The scientific potential of the country can be built up only gradually, starting from what already exists, by the addition of part of the yearly output of graduates, engineers, doctors and technologists from the higher educational establishments.

13. It is possible to step up the rate of growth of the national scientific potential through the grant of priorities under the Plan. It is also possible to recruit research workers abroad. But it appears to be impossible to exceed an annual growth rate of the scientific potential of 15-25% without subjecting scientific organizations as a whole to serious stresses. Such rates result, in fact, in doubling the volume of activity at the end of 3-5 years. In applying the maximum annual growth rate accepted as possible in practice to the research coefficient worked out for the country, the limit value will be found which the coefficient can reach during the concluding year of the Plan.

It is this latter value which should be adopted as the objective in the Plan if the figure thus calculated is lower than the optimum one.

(1) Fundamental, applied and developmental research, and scientific inventorization activities (excluding routine tasks of research offices, quality-control laboratories and mine prospecting services).

(2) Other things being equal, i.e. under constant conditions of quality and sectoral distribution of the national science effort.

14. There is still no reliable evaluation of the optimum figure. As regards the industrialized countries, it would appear, judging from converging indices, to be not less than 3% of GNP.

In the case of countries not yet industrialized, we find two factors which offset each other. It must be borne in mind that very considerable economic advances can be made in these countries by means of imported science and technology; but it must also be remembered that per capita GNP is much lower than in industrialized countries while the cost of science per research worker per annum is not reduced in the same ratio as per capita GNP.

15. While it is therefore impossible to speak with scientific certitude, the available data suggest that the optimum national research coefficient for the developing countries is definitely not less than 1%, and probably not less than 2%, of GNP.

16. It would seem that the present level is almost always considerably below the optimum, and that the figure to be included in the current plans should normally be calculated on the basis of the given level to which the maximum growth rate deemed possible will be applied.

Recommendation no. 9

The governments of the developing countries should accord an annual increase of at least 10-15% in their allocations for scientific research in general (and for oriented fundamental research in particular), thereby permitting the more rapid development of the countries of the region.

17. It is essential, however, that research be undertaken at the international level(1) on a scientific basis, exploiting the possibilities afforded by the new methods(2) of economic forecasting and system analysis, to elucidate the quantitative problems of the impact of science on economic growth.

It is to be hoped that by the end of the present decade, more rigorous approaches to the problem of optimization of national science expenditure will be available to planners as a result of such research on the economics of science.

E. A material constraint: the availability of a sufficient number of research workers

18. The expansion of budgets allocated to research and to the inventorization of natural resources is of little effect if the number of research workers and of auxiliary technical personnel cannot be increased at the desired rate.

19. It is of course possible to rely, to some degree, on recruitment from abroad, but the extent to which this can be done is limited.

An insufficient yearly output of science and technology graduates can immediately slow down the development of the country's research potential. Again, it must not be forgotten that there is always a large proportion of university graduates who immediately take up positions of responsibility in government service or in the private sector (civil servants, doctors, lawyers, engineers or executives in industry, secondary school teachers, etc.) without doing even a few years of research.

20. Hence the yearly output of graduates should be high enough to provide both for the filling of positions of responsibility and for the needs of research. If it is not high enough, provision should be made in the National Development Plan for a more rapid expansion of higher education.

21. The plan of expansion of higher education may be slowed down, in its turn, if the number of pupils who have completed their secondary education is insufficient.

It is for this reason that, in most of the developing countries, the expansion of education at all levels rightly constitutes one of the principal priorities in the Plan.

22. This expansion, however, should be synchronized with the growing needs, in respect of qualified staff, of the economic sector, of the State, and of education itself. It is therefore essential to consider the National Development Plan (plan for economic development) and the plan for educational expansion as parts of one and the same long-term project, with a view to ensuring that no serious bottleneck will occur and that the economy will effectively absorb all young people with educational qualifications.

23. In this connexion, an analysis of the actual employment position in countries at various stages of development makes it possible to evaluate with a fair degree of accuracy the probable staff needs at the various levels of qualification for the economy as a whole and for the State for several decades ahead. Considerable importance and some degree of urgency must be attached to these studies, the purpose of which is to provide the planners with reference data.

24. The planned expansion of higher education should also ensure progress in the proper distribution of students between disciplines.

This requires the very careful establishment of statistics giving the number of students in each branch of learning, together with the professions taken up by graduates. On the basis of statistical projections, on the one hand, and of openings predictable from the economic plan, on the other, forecasts should be prepared in regard to the future supply of and demand for scientific personnel. Forecasts for five or ten years ahead are essential, since measures to rectify a foreshadowed imbalance must be taken at least four or five years in advance (for instance, change in the number and amount of fellowships available to students in the different branches of learning, opening of new

(1) See Chapter V, Section A (paragraph 14)
(2) See Chapter III

sections of educational institutions, information campaign directed to young people and parents, etc.).

25. As an economy develops, the centre of gravity of the body of graduates should shift from the pole of humanistic and legal studies to that of mathematics and technology.

In this context it has been found useful:

(a) to locate the faculties of agronomy and technology at the universities themselves, so that they acquire the same status and standing as the traditional academic faculties;(1)

(b) to permit arts pupils to enter science faculties, helping them to do so by adaptation courses, if necessary;

(c) to promote the rapid development of technical secondary education and facilitate the entry of those holding technical secondary school certificates to enter science faculties, by means of adaptation courses.(2)

26. The availability of a sufficient number of secondary level technicians is often an essential condition for the proper functioning of research centres, as also of industrial and agricultural enterprises. The presence of these technicians enables the engineers and qualified research workers to devote themselves exclusively to the activities for which an advanced training is necessary; while their absence often results in the underemployment and hence in the discouragement, of those research workers.

F. The economic bases of selection of general lines of science policy for the countries of the region

27. During the economic development stage preceding industrialization, the national product consists mainly of agricultural commodities and of materials extracted from the soil and sub-soil. These two categories of goods supply practically the whole of the foreign currency resources. But agricultural output is often well below what it is biologically possible to achieve and mineral resources are to a large extent unexplored.

28. Therefore, if the country concentrates its scientific activities on the improvement of agriculture and on geological prospection, it can, during the initial phase, anticipate a substantial increase in its supplies of foodstuffs and foreign currency. Technical progress in agriculture will release manpower that can be assigned in part to mining and in part to the establishment of a manufacturing industry.

> Recommendation no. 10
>
> Keeping in mind the potentialities of the region in solving the food problem, the agencies of the United Nations should provide more effective assistance in research oriented towards the exploitation of its agricultural resources.

Foreign currency resources could thus be allocated for the first stage of industrialization. The first industrial efforts will in most cases be directed towards meeting the national demand of consumer goods, basic chemical products and semi-processed industrial products (metals, cement, glass etc.).

In getting these new industries under way, every advantage will be taken of imported technology, subject to undertaking a minimum number of development activities for the adjustment of the techniques to local raw materials and to national or regional consumer demand.

During this first stage of industrialization, the country will continue to import a considerable amount of equipment (as well as the industrial materials which it does not yet produce). It will pay for them out of the revenue from its agricultural and mineral exports, reducing the proportion of that revenue to be allocated to the importation of consumer goods.

29. During the second stage of industrialization, the country will begin to produce its own items of equipment (machines, vehicles and instruments) and will of course export some of these articles on an exchange basis. The reason for this is that, in practically all specialized fields, the demand for machinery and instruments far outstrips the requirements of a national market. At this stage in the development of the national economy, scientific research should be concentrated mainly on industrial developmental research and on the basic disciplines (physics, chemistry) which are its direct source of supply. For indeed, the industrial production of a wide range of different commodities to be placed on a competitive world market can be developed only through a constant effort to keep up with technological innovations and to apply the most advanced knowledge with all possible speed.

By way of illustration, it may be pointed out that the countries of Western Europe (excluding the Iberian Peninsula and Southern Italy) are now going through this second stage of industrialization, while Japan reached it a few years ago.

> Recommendation no. 11
>
> In choosing the lines of research for the nation, a prominent place must be given to research having an impact on the social and economic development of the country.

(1) See Recommendation No. 6, Chapter II, Section G

(2) See Recommendation No. 7, Chapter II, Section G

G. Suggestions for selecting the main lines of research in respect of the countries of the region

30. The countries of North Africa and the Middle East have but fairly recently embarked on the first stage of industrialization. One of their distinctive features is their Mediterranean or sub-desert type of agriculture, in which the problem of water supplies generally plays a vital part. Several of them have abundant oil and natural gas resources, which means that they can count on a considerable revenue of foreign currency and cheap local power.

31. Subject to detailed case-studies of participating countries, a few suggestions[1] on the following lines might be made in regard to the content of a science policy which can be fitted into the National Development Plan:

32. (a) Research and scientific inventories aimed primarily at the development of agriculture, stock-breeding and fishing

accurate hydrogeological maps - inventory of surface and underground water resources;
climatological and meteorological stations for determining the atmospheric factors of the water balance;
pedological and geological study of surface soils (cultivated, arable or suitable for afforestation), priority being given to zones where irrigation works are under way or planned, and to areas where the soil is deteriorating;
study of the existing ecological balances and their evolution under the impact of modernized land use methods; inventory of the flora and fauna to be conserved;
experimental research in rural engineering (research with a view to adaptation), with particular reference to irrigation processes and the mechanization of labour;
research directed towards increasing the yield of existing crops and stock-raising arrangements through the acclimatization (either direct or by hybridization) of exotic varieties, sought either for their yield or for their resistance to certain parasites or climatic conditions, and through combating parasites, etc.;
experimental research on the introduction of new crops and reafforestation;
studies concerning rural economy and the commercialization of products;
oceanographic research aimed at increasing the yield of fisheries.

33. (b) Research and scientific inventories directed towards exploiting the minerals in the soil and sub-soil and collecting the information required for land development, during the town planning and industrialization phase

complete and accurate oro-hydrographic and topographic surveys;
geological maps and geological research on the structure and genesis of deep-lying formations;
regular, organized prospecting for oil, natural gas, coal and exploitable minerals;
inventory of commonplace minerals which can be used for manufacturing cement, building materials, glass, etc.;
seismology[2];
research on safety precautions for workers, productivity and the safeguarding of sources of supply in the extracting industries.

This last type of research is indispensable in order that government services, if they do not themselves exploit the oil wells and mines, may be able to keep up a real interchange of views with the technicians of the concessionary companies, thus making it possible to guarantee a form of exploitation which safeguards the interests both of the workers and of the country.

34. (c) Research with a view to the expansion of the basic chemical industry and of industries which produce semi-processed goods

This is mainly a question of developmental research directed towards the adjustment of techniques. Oil producing countries will attach special importance to petrochemistry, involving the use of the gases derived from distillation. Countries which resort to big private companies for the extraction of crude oil may find that it pays them to retain the refining of supplies for national or regional consumption within the framework of national arrangements.

The development of chemical research within the country's refineries, or directly as an adjunct of their activities, may produce a national industry or petro-chemical synthesis, directed in particular towards the production of plastics, synthetic fibres, synthetic rubber, nitrate fertilizers, etc...

The creation of such industries will of course entail resorting in a large measure to the purchase of manufacturing licences. But experience shows that a research service, by virtue of its practical knowledge of the problems involved, is the best adviser in matters of licence purchases. Moreover, it is in a position to adapt the purchased processes to particular conditions of the exploitation concerned.

(1) See also Chapter V, Sections A (paragraph 11) and B

(2) Since all the North African and Middle Eastern countries are subject to earthquakes, a complete world network of geophysical centres would not only be particularly helpful in guarding against town planning in areas subject to serious landslides, but would also be very useful for geological surveys of the territory. In these countries, seismology must be considered as an auxiliary science essential to the planning of development.

Again, the availability of appropriate minerals and cheap power makes it possible to undertake the production of basic metals, glass, cement, etc. for the national or regional needs. The adaptation of technological processes to the characteristics of local minerals may justify research programmes[1].

However, as in the sphere of chemistry, national research will, in the initial stage, be no more than complementary to the implantation of imported technologies.

Apart from the programmes directly connected with specifically local technical problems, appropriate research will be primarily useful in allowing of real exchanges, on an equal footing with the technicians of international concerns whose technology is purchased.

35. (d) Developmental research designed to promote the expansion of consumer industries

Countries in process of industrialization often accord customs protection to newly-established consumer industries, so as to help them to overcome their initial difficulties. This device is only effective in cases where there really are local industries that have proved their dynamic qualities or foreign concerns that can be attracted to the country. Where such conditions do not exist, the public authorities can undertake or promote the necessary action. In some cases, a phase of developmental research, followed by a phase of pilot production, may be the best course to follow.

36. (e) Research in the sector of construction

The construction of dwellings and offices is a sector in which advances in productivity have been particularly slow and belated in the majority of industrialized countries.

In this sector, purchase of foreign licences will therefore hardly allow of the rapid leap ahead, which is necessitated by the magnitude of construction needs in the initial phase of industrialization. This phase is characterized by a massive drift of country-dwellers to the towns. A national developmental research effort bearing on mass construction can bring about a drop in the cost price of dwellings and help national construction programmes to make rapid strides. Its impact on the implementation of the economic development plans would thus be direct.

37. (f) Preparation of the subsequent phases of industrialization

Research, including developmental research, in certain areas that form the spearhead of progress within the fields of mechanical engineering, electrical engineering, electronics, synthetic chemistry, nuclear and space metallurgy, etc., will only occupy a central place in science policy when the nation has completed the first phase of its industrialization. The foundations of the future edifice must, however, be established during this phase.

To this end, the introduction of specialization might be recommended in certain areas of advanced technology for which the nation under consideration is basically in a favourable situation. Reasonable customs protection, supplemented by national developmental research, should allow the strengthening of this situation.

In addition, certain sections of the workshops of national enterprises in the mining industry or the transport and communications sector could be directed towards the manufacture of their own capital goods, with a view to later separation from the mother enterprise and the constitution of local enterprises in the field of mechanical and electrical engineering.

38. (g) Sociology, applied economics, ethnography, linguistics, history

Lastly, the magnitude and speed of the social and political changes entailed by development afford a choice field for applied sociology. It is to be hoped that the advances of this discipline will help to mitigate the difficulties and conflicts experienced by peoples in our time as a result of the upheavals incidental to change. This can only be achieved through a systematic observation of contemporary sociological facts, and implies a considerable improvement in statistical machinery, both in respect of the volume of data and of need for a more exact conceptualization in closer conformity with the local sociological situations.

In the developing countries, the scientific study of man and his society is of the utmost importance and urgency. This urgency arises from the fact inter alia that these countries are destined to undergo, in the next few decades, a rapid development which will profoundly affect, sometimes even completely obliterate, certain characteristics of the former societies. A complete inventory of the institutions, customs, dialects and oral literature of the populations should be made before they are drawn into the process of modernization. This task of conservation is essential to the common heritage of mankind.

Today, moreover, a knowledge of its past and an appreciation of its scientific, artistic and literary traditions constitute a moral necessity for every people, in that they help the latter to become alive to the individuality of its contribution to culture and, consequently, to maintain its dignity and autonomy in a world community now open to reciprocal influences. The assistance of international bodies is often essential, in view of the high cost of this research.

(1) An old and classical example is the perfecting of the Thomas process in steel-works, which enabled phosphorous iron ore deposits to be turned to account though these had previously been unusable for purposes of the production of steel.

Recommendation no. 12

It is advisable to give a worthy place to the social sciences in the general context of research activities integrated with scientific research programmes based on the National Science Plan.

39. (h) Fundamental research

Fundamental research is an indispensable support for applied research, to which it is continually affording new ideas and new lines of approach. General biology, zoology, botany, physics, chemistry, etc. are basic disciplines relating to agricultural research. Geophysics and solid state physics relate to applied geology. Pure and applied mathematics, physics, chemistry, etc. form a support for industrial technology in all its forms.

To ensure that in each of these basic disciplines there is a sufficient number of scientists with whom research workers in applied science and technical development can maintain the necessary contacts, it is essential that provision, including financial provision, be made in such disciplines for an adequate level of activity.

40. (i) Medical research

Fundamental research in this branch contributes indirectly and vitally to national development by ensuring a quality level for applied research.

A similar reasoning applies to medical research, which has not been dealt with in the foregoing paragraphs. It is clear that the country's progress in health matters, which forms an essential section of the National Development Plan, will not attain to the desired quality unless the network of establishments providing medical care is supplemented by medical research services.

Recommendation no. 13

Member States of Unesco are invited to make full use of the services of scientific international non-governmental organizations in planning their national research programmes and in the training of scientists and technicians, as well as for the study of the scientific and technological aspects involved in the application of science and technology to development.

The financing of such assistance could be requested of Unesco and other competent organizations belonging to the United Nations system under the technical assistance scheme of the United Nations Development Programme or through the regular budgets of the competent organizations such as the so-called "Participation programme to the activities of the Member States" in the specific case of Unesco.

H. Weighing of efforts, and establishment of priorities

41. The decisions on principle regarding the main changes in the economy, whether they relate to major activities for developing agriculture or mining or the creation of manufacturing industries, should be taken well in advance. The studies, research work and experiments preliminary to the pilot stage take several years, and should therefore be included in the National Development Plan preceding that scheduled for large-scale implementation. It is logical, in fact, to give priority to the research work preparatory to the major activities covered by the following plan and the concluding years of the current plan.

42. The present report gives no indication of priorities in the strict sense. However the order in which the various suggestions listed above are classified reflects to some extent the importance which might be attached to them. It is advisable, in view of the lack of resources, to assign an appropriate place to each of the nine heads suggested above (Section G). It is obviously impossible to suggest what those places should be without an analysis of each of the National Development Plans and without an inventory of each country's scientific and technical potential.

I. The budgetary cover for science in the State budget

43. It emerges very clearly, from the above, that the major options in respect of science policy cannot be dissociated from the work of general planning, and that the science development plan is a section of the overall plan. Its formulation, and the co-ordination of its execution, should therefore come under the responsibility of the highest government authority, or under that of an authority at a level very close to it.

44. It can be referred, in that connexion, to a report approved by the United Nations Economic and Social Council (document E/4026), which is summarized in the Third Report of the Advisory Committee for the Application of Science and Technology to Development (document E/4178, paragraphs 28 (b) and (d)).

45. In the structure recommended, the budgetary allocation for the research centres of the technical ministries continue to appear in the budget of those ministries. Similarly, the budgetary allocations for the universities and higher educational establishments continue to appear in the budget of the Ministry of Education. Only the sums allocated for financing the national institutions for

co-ordinating and financing scientific and technical research covering all fields are included in the budget of the Prime Minister.(1)

It is therefore desirable to include separately, in a special section of each of the ministry budgets, the items relating to science policy expenditure. The total for all those articles constitutes the "budgetary cover for science".

46. Prior to the establishment of the overall State budget, the government fixes within the context of the National Development Plan, the amount of the budgetary cover for science.

It then commissions the body responsible for science policy planning(2) to frame, with the help of its scientist members, a balanced proposal for apportioning that "cover" between the various ministerial budgets. The proposal thus framed is then decided on by the Ministerial Committee for Science Policy of the Council of Ministers. By that decision, the items constituting the "cover" are collectively fixed by the ministers concerned, for presentation to the legislative authority, in each of their respective budgets.

47. This procedure makes it possible to safeguard the authority of each minister in respect of the management of the establishments coming under his administration, while making the distribution of the resources for science an act of general governmental policy based on a study of optimization and on consultation with all concerned.

J. The science plan and the overall National Development Plan

48. The Science Plan, although it is designed to be integrated with the National Development Plan, does not derive its options from the latter. It therefore is not subordinated to the National Development Plan except as regards the total sum involved.

This is because the Science Plan involves research activities, the expenditure for which is included in the current National Development Plan but whose culmination and economic impact concern a later period.(3)

49. Thus the science options prefigure and pave the way for the economic options of the later plans. They constitute their element of mutation, whereas the current plan is primarily one of growth.

It will be seen that because of the knowledge its members have of future trends, the government organ responsible for science policy planning(4) is the most appropriate place for developing constructive thinking concerning the country's long-term perspectives and the basic options of the subsequent economic plan. Participation in this work by the authors of the current National Development Plan is obviously essential.

(1) See Chapter II, Section D
(2) See Chapter II, Section C (paragraph 15)
(3) With the exception of a small number of applied research activities (inventories, pilot stage experiments) which concern the preparation of economic action envisaged for the concluding years of the current plan.
(4) See Chapter II, Section C (paragraph 15)

CHAPTER V

PRIORITY PROGRAMMES AND METHODS OF SCIENTIFIC CO-OPERATION

A. At the international level

1. The question of the application of science and technology for the benefit of the developing countries reached a turning point in 1963 with the convening of the UNCSAT[1] Conference in Geneva. Eminent scientists from all the developing countries were at that time facing a real crisis, consequent on the political literation of their countries.

2. To meet the urgent requirements of economic and social development and to co-ordinate this with scientific development, the Advisory Committee to the United Nations Economic and Social Council on the Application of Science and Technology to Development was created. In its Third Report (document E/4178, May 1966) this Committee outlined a World Plan of Action to deal with the problems of underdevelopment; the resolution setting out the principal objectives of this Plan was approved by the Economic and Social Council (ECOSOC) at its 41st session (Geneva, July 1966, E/RES/1155).

> Recommendation no. 14
>
> The Third Report of the ECOSOC Advisory Committee on the Application of Science and Technology to Development (document E/4178, May 1966) should be widely circulated by the National Councils for Science Policy or by all similar organizations having responsibility for research at the national level in the countries of the region. It is advisable, in particular, to support the recommendation (paragraph 52(g) of the Report) urging the United Nations Development Programme to extend the criteria of the Special Fund, so that projects for the establishment or reinforcement, in the developing countries, of faculties of sciences and research institutions, including those conducting research in the basic sciences and technologies, may be included among those which it supports.

3. This "World Plan of Action" is based on an analysis of the results of the activities, in the field of science and technology, of organizations belonging to the United Nations system. From this analysis it became clear that the funds available were nowhere near sufficient, hence the amounts distributed were inadequate to meet the actual needs of the countries concerned.

> Recommendation no. 15
>
> The United Nations Development Programme should concentrate its projects and programmes for assistance to the developing countries in order to make them more effective and thus expedite the development of the countries of the region.

4. It is possible, for example, to calculate the amount, per capita per annum, devoted to science and technology[2] in the developing countries during the first half of the Development Decade. The total amount allocated by the organizations of the United Nations system to science and technology over the period 1960-1965 is of the order of 385 to 400 million United States dollars.[3]

(1) United Nations Conference on the application of science and technology for the benefit of the less developed areas.

(2) Total expenditure on the application of science and technology to development (including expenditure on research and development)

(3) See Third Report of the ECOSOC Advisory Committee on the Application of Science and Technology to Development (document E/4178, paragraph 76)

Taking the total population of the developing countries (excluding Mainland China) as 1.6 milliard, this gives 5 cents (US $0.05) per capita per annum, against a corresponding figure of the order of US $50, for research and development only, in the highly developed countries for their own account.

5. It is thus necessary to find other sources of finance for the developing countries, in particular national sources. Since the sum of the GNP's of the developing countries (excluding Mainland China) is of the order of US $360 milliards, if the target for the total funds to be devoted to scientific and technological activities applied to development is set at 1% of the GNP, an amount of the order of US $3.6 milliards should become available. The governments of the developing countries are urged to bear in mind this fundamental fact when drawing up their science budgets. Funds received through bilateral assistance may also make a substantial contribution to this target amount. It is estimated, for example, that during the year 1961 the total for all types of bilateral assistance amounted to about US $9 milliards; an increasing fraction of these funds could be devoted to the scientific and technological activities of the developing countries.

Recommendation no. 16

The competent national authorities of the countries concerned are invited to take steps to have bilateral assistance more intensively focused on the promotion of scientific research in the developing countries. These national efforts of bilateral assistance should also be concentrated and increased significantly.

6. Since the financial resources are bound to be limited, it appears desirable, in order to co-ordinate efforts, to consider technical assistance in a more systematic manner. The ECOSOC Advisory Committee has therefore proposed certain guiding principles concerning the allocation of financial resources for the application of science and technology in the developing countries.

7. The first of these principles is that a long-term objective should be defined, such that within the coming generation, all countries will have emerged from the state of underdevelopment. This objective would be attained by stages, making use of short-term (five-year) plans which should be closely co-ordinated with the long-term plan.

8. The second principle, on which the implementation of the objective defined above depends, is that the application of science and technology at the international level should be designed so as to accelerate development, thus eliminating the need for the developing countries to follow the same long path as the now-developed countries had to tread in their time.

9. The third principle is that progress in the scientific development cannot be evaluated only in terms of quantitative goals, but rests above all upon an entire cultural transformation of the society. Science education is of paramount importance, and science planning is void of any significance without educational planning. Eradication of illiteracy, establishment of a network of primary schools, then of secondary schools, then of universities, these are the successive levels of the pyramid to be built.

10. The fourth principle concerns regional co-operation. The fact is recognized that international organizations can only offer advice and suggestions; for the countries are sovereign, and their governments, the decision-makers. If advice is to be given however, it is highly recommended that regional co-operation be strongly encouraged. In relation to this, the United Nations budgetary facilities were broken down into two groups corresponding to two kinds of needs: national needs and regional ones. It was felt that each developing country cannot afford to have a full-fledged scientific infrastructure as some richer countries do. A sharing of different types of facilities becomes compulsory. Documentation centres, central statistical offices, scientific instruments maintenance centres, medical institutes, even universities are examples of such type of facilities.

11. The following concrete forms of regional co-operation could be envisaged(1):

(a) Establishment of field or laboratory working teams in the area of natural resources exploitation or other experimental studies;
(b) regionalization of certain national institutes in a given branch of technology (e.g. seismology) for research and for training of scientists and technicians from the different countries of the region;
(c) in certain fields like agriculture, preparation of programmes based on ecological regions and sharing out of research projects among the main research institutes of the countries constituting the regions;
(d) establishment of a standing regional conference(2) for the co-ordination of the science policies of the different countries;
(e) establishment of regional institutes through international conventions, with an international governing board and staff. This method seems however less appropriate than others in developing regions.

12. The fifth principle is that scientific development cannot be attained only through national or regional efforts, but must be related to the international scientific life, and that it can sometimes be better served through international co-operation. For science knows no frontiers, and

(1) See also Chapter IV, Section G and Chapter V, Section B
(2) See Recommendation no. 20, Chapter V, Section B

certain projects, such as oceanographic studies or meteorological research programmes, have, by their very nature, to be carried at the international level.

In this respect, two topics deserve special attention owing to their common importance to a number of countries in the area: fisheries development and exploitation of mineral resources. In the first case, co-operation can be undertaken between advanced and developing countries sharing a coastline which has common characteristics over thousands of miles. In the second case, field specialists are required for the large geological surveys and they will, for some years to come, have to be provided by advanced countries.

13. Another example of international co-operation is offered by bilateral institutional links[1]. These links include typically provision and/or exchange of teaching or senior research staff, provision for training facilities at the advanced institute for selected personnel from the developing institute, guidance on the selection of research projects, provision of equipment, exchange of publications etc. They should be registered at a central index, a proposal which is fully endorsed by Unesco.

Recommendation no. 17

Universities and research institutes in advanced countries are earnestly requested to create permanent co-operative bilateral links with similar institutions in developing countries, so that graduates of the latter countries could be trained in their own country with the help of this bilateral assistance, thus minimizing the rate of brain drain from developing countries to advanced ones.

14. A final example of a problem that can best be solved at the international level is discussed in Chapter III of the present report. Research on simulation studies and on the application of the techniques of operational research to the organization of the scientific development deserves to be tackled by an international team of specialists and Unesco might well sponsor such a co-ordinated research programme while expanding forthwith its activities in that field.

15. It might be mentioned that the programme described above is only an outline. A detailed programme will be prepared by January 1968 when the implementation of the United Nations World Plan of Action will start.

Recommendation no. 18

The expenditure made by the organizations of the United Nations system for science and technology should be planned as far as possible in accordance with a global science plan for developing countries. This plan should aim at making science an active organ of development and progress. In this respect, full support is given to the elaboration and execution by the United Nations system of organizations of a special long-term plan of action and of 5-year plans for the application of science and technology for the benefit of developing countries as from 1968.

Authorities of the countries represented at the Algiers Meeting will, no doubt, wish to let the different organizations of the United Nations system know their precise and concrete suggestions about this programme.

Recommendation no. 19

The countries of the region are invited to present their suggestions and their research programmes to the United Nations by July 1967 through the medium of the Specialized Agencies concerned, so as to enable the United Nations to formulate a concrete plan of action for the remainder of the Development Decade, and work out the preparatory activities already envisaged for the following decade.

B. At the regional level

16. When tackling problems common to a wide area embracing a number of States, co-operation between neighbouring States would provide for greater efficiency, savings in capital expenditure and highly-skilled manpower and better recruitment prospects, since scientists are afforded opportunities for working over a wider scope. For a number of States, regional co-operation would be the solution to the problem of shortage of specialists, funds and institutions. It warrants for a proper diagnosis of complex problems through the exchange of ideas, and provides for the research to be complementary, thus avoiding all possible overlappings.

(1) See document UNESCO/SPRAL/4 "International co-operation for the advancement of scientific and technological research in the countries of North Africa and the Middle East through bilateral institutional links".

Recommendation no. 20

Regional scientific co-operation should be intensified by the establishment of a Standing Conference of representatives of the national science policy bodies of the countries of North Africa and the Middle East, which would make use of the services of the Unesco Science Co-operation Office in Cairo to provide its secretariat and examine the questions included in its agenda. The main tasks of the Conference would be as follows:

(a) to apprise its members of the progress of science policy and of new research activities in the countries of the region;

(b) to draw up, with the assistance of the National Councils for Science Policy of the countries of the region (or equivalent bodies), a list of priority research programmes in the region, with an indication of those for which regional co-operation is desirable. The list would be examined within a reasonable time by a small ad hoc committee (appointed by the Standing Conference from among its members) and submitted to the Scientific Councils of the countries of the region with a view to co-operative action. The councils would then be invited to take the necessary measures, making use of national resources as well as of bilateral or multilateral aid for the co-ordinated implementation of these regional research programmes. With the least possible delay, consideration should be given by the science policy organs of the countries of the region, with a view to the establishment of their national programmes for priority research, to the list of research programmes of regional importance included in the present Report and in paragraphs 229-230 of the Third Report of the ECOSOC Advisory Committee (document E/4178, May 1966);

(c) to ensure co-ordination of the national science policy decisions designed to meet the needs and the interests of the countries of the region;

(d) to study systematically the possibilities for establishing multilateral specialized research institutes dedicated to the investigation of major fields of common interest. Specialized research institutes of this kind should represent a co-operative effort from the points of view of both budget and personnel. In addition to this, work in national research institutes dealing with problems of common interest should be co-ordinated, whenever possible, with the help of Unesco;

(e) to identify research efforts beyond the means of each country taken separately, with a view to studying systematically their possible organization on a regional or sub-regional basis;

(f) to keep up to date, with the help of Unesco's Middle East Science Co-operation Office, an inventory of current trends in scientific research programmes selected by their governments within the framework of their national science policy, with a view in particular to familiarize scientists and research workers in the region with the scientific activities of other countries and thus bring more effective co-ordination among them;

(g) to supervise the preparation of the Arabic version of a glossary of the terms used in science policy-making based on the international glossary that Unesco is compiling. This glossary should include, among others, a standardized title classification pertaining to the various functions of the research workers.

17. Such co-operation among North Africa and Middle East countries would facilitate the constant reviewing of programmes of activities to keep up with world pace. This is a long path, along which we may pose the following landmarks, which are far from being exhaustive[1]. They only represent guidelines which need further discussion and elaboration.

18. (a) Education and training of research scientists

Educational systems are made for a time and not for all times. A curriculum which had effectiveness fifty years ago, cannot continue unaltered till our days. Countries in North Africa and the Middle East should not merely adopt but adapt wisely and well to changing conditions. Once this is recognized, the need for reviewing constantly the training programmes of scientific and technological personnel becomes real and urgent and this should profitably be made on a regional basis.

Scientific and technical personnel designated to carry out research should be looked upon as the architects who will shape the countries' future in 15-20 years from now. Hence the educational system should aim in the first place at developing

(1) See Chapter IV, Section G and Chapter V, Section A (paragraph 11)

competence, independent thinking and sense of values. Science and technology are moving more and more towards quantitativeness, hence in their formal training individuals destined to become research workers should acquire the appropriate amount of mathematics and physics and should master other basic sciences relating to their fields of specialization. These among other matters such as the integration of physical and biological sciences, representation of humanities and social sciences, need to be reviewed periodically.

Recommendation no. 21

Due to the primary importance of basic science teaching at all levels in the training of scientific and technical personnel the countries of the region are requested to ask their national science policy organs to keep well acquainted with the world-wide activity of Unesco in this field (revision of curricula of biology in Africa, of chemistry in Asia, of physics in Latin America and of mathematics in Arab States).

The national science policy organs are furthermore invited to support and to promote the action undertaken in their respective countries along the lines suggested by Unesco so that the revision of curricula in these basic sciences be effected as soon as possible.

19. (b) Arid zone research

Arid zones stretch over large parts of North Africa and the Middle East. The challenge of nature in these areas represents the major problem facing inhabitants of the concerned countries. The question of co-operation on arid zone research has been repeatedly discussed at various national and international levels. The field of action of any regional co-operation scheme on arid zone research would be as follows:

(i) Collecting basic data on climatology, water resources, soils, flora and fauna.

The studies on water resources should comprise: inventory of water resources, humidity, precipitation, surface and underground water, with the ultimate aim of a rational utilization of these resources.

Soil investigation should include: soil surveying and mapping, soil erosion by wind and water, conservation problems, geological and geomorphological aspects, salinity etc.

Studies of the flora and fauna should aim at developing the natural resources of the desert areas with special emphasis on agricultural developments, acclimatization of plants and animals, range management and development and counteraction against deterioration of the green cover. Phytochemical screening of local flora is also of importance. Examination of large numbers of individual plants, both wild and cultivated, for their chemical constituents, should be undertaken with the object of assessing their pharmaceutical values.

(ii) Studying the physiological and psychological factors affecting human life and work under arid conditions, with special reference to the psychological effects of high environmental temperatures and aridity on human performance.

(iii) Training of young research workers in the various aspects of desert research.

20. (c) Pest control

As is well known, climatic conditions in a number of North Africa and Middle East countries are optimal for enhancing prevalence and rapid multiplication of a wide variety of insect pests. Several insect pests are practically the same, both in nature and magnitude in these countries. Fruitful co-operation may be launched on these problems of mutual economical importance such as cotton pests. Organized efforts of scientists and applied entomologists of the region to solve pest control problems are urgently needed due to the great loss inflicted upon the region by insect ravages. This could be attempted through programmes based on ecological zones.

21. (d) Integration of natural sciences and humanities

While it is a main concern of the States of North Africa and the Middle East to accelerate their progress in the natural sciences and their applications and to attain thereby a higher material level, it is of paramount importance to link this scientific renaissance with their cultural heritage.

(i) To a scientist in a developing country, who is directed exclusively towards science from abroad, science appears to be a foreign commodity. He subconsciously develops a sense of inferiority. As was rightly pointed out, "scientific tradition which is a source of inspiration to the science student in advanced countries, urging him to excel his predecessors, produces the opposite effect in the minds of the science students in developing countries". In order to surmount this barrier it is imperative to implant in the minds of students in this area, through a study of humanities, the awareness that they are the inheritants of an intellectual and spiritual patrimony of exceptional value, from which they can derive pride and encouragement. Inasmuch as this patrimony testifies to their intrinsic ability to attain the highest achievements of the human mind, it should pave for them the way to new vistas once they are immunized against psychological inhibition. In their scientific venture, they can thus take their élan on a historical basis with a feeling of serenity and confidence.

(ii) The tendency to link natural sciences with humanities is a dominant trait in mid-eastern

philosophy. Planners of science policy in our countries should remain faithful to this time-honoured attitude of mind. Works of great scholars such as Al Khorasmi, Al Razi (Razès), Al Farabi, Ibn El Haitham (Al Hazen), Avicenna, Ibn Khaldoun, Averroes, Geber and many others should be valued side by side with those of classic and modern philosophers. This requires an exchange of views on a regional basis.

(iii) It will further be found impracticable to divorce scientific research from social problems. An endemic disease prevailing in large areas of the region as schistosomiasis cannot successfully be combated if handicapped by social habits. Similarly the problem of demographic explosion cannot be handled only in laboratories.

22. (e) Regional scientific documentation centres

It has long been recognized and repeatedly stressed that a research worker can only be effective if he has easy access to scientific publications in his field of specialization. Serious consequences may result from inefficient information services. An incomplete review of existing knowledge may entail grave losses of time, opportunities and money, either through superfluous repetition of a research work already carried out elsewhere or through failing to avail oneself of what others have already rendered available. It thus seems that whatever efforts and funds may be needed to set up an efficient documentation centre, the latter is always repaying.

However, it must be borne in mind that an efficient documentation centre is a complex enterprise requiring a huge investment in funds and manpower, which may be beyond the possibilities of a number of countries in North Africa and the Middle East. This calls for the establishment of regional and/or subregional centres of documentation as well as a network of information services throughout the area. Such a network would provide for a multi-way transmission of scientific information. In this matter of far-reaching importance, Unesco together with appropriate international non-governmental scientific organizations such as the International Council of Scientific Unions (ICSU), can play an eminent rôle.

CONCLUSION

During the closing session, the Meeting voted unanimously the adoption of its report and of the recommendations therein contained.

Participants from Iran (Dr. Rassekh), Iraq (Dr. Al-Tai) and Kuwait (Mr. Karmi), in the name of their governments, then extended invitations to Unesco and to Member States of the region to hold the next meeting, scheduled for 1969, in their respective countries.

On a proposal of Dr. Hafez (United Arab Republic), the following motion of thanks was adopted unanimously:

> "As our Meeting is coming to an end, I wish to move a motion of thanks to the Algerian Government for its hospitality and kind permission to hold this Meeting in the "Club des Pins". We shall all of us carry memories of the very beautiful and brave city of Algiers and hope that many will be the occasions on which we meet here again.
>
> I wish also to express our thanks to the Head of the Algerian delegation who, in acting as Chairman of this Meeting, has played a prominent part in bringing it to a success".

The Meeting concluded with the closing address of the Chairman, Mr. Ouabdesselam (See Annex II). Mr. de Hemptinne, in the name of the Director-General of Unesco, then expressed the warm thanks of the Organization to the Algerian authorities, especially the National Commission for Unesco, for their hospitality and their generosity, and to the Bureau of the Meeting, the participants, the consultants, the organizers and the supporting staff of the Meeting, as well as to the Unesco Middle East Science Co-operation Office.

ANNEX I

SPEECHES MADE AT THE OPENING OF THE MEETING

Opening address by
Dr. Ahmed Taleb
Minister of Education of the
Democratic and Popular Republic of Algeria

I have the utmost pleasure, on behalf of the Algerian Government and the recently established University of Algeria, in extending a warm welcome to our country to the distinguished visitors who have come here to participate in this Third Meeting on Science Policy and Research Organization in the Countries of North Africa and the Middle East.

Algeria fully appreciates the great honour you have paid her in holding your meeting in our capital city. And to this honour is added our feeling of profound happiness in welcoming here the scientists who will be working under the auspices of that dynamic and effective Organization, Unesco, whose spokesman I salute in the person of the representative of the Director-General and the experts who have come here to give us the benefit of their valuable assistance.

The objectives of your Meeting are of the greatest interest to our country, which followed its struggle for national liberation by embarking on a mighty effort to emerge from underdevelopment. We are convinced, in fact, that a direct relationship exists between investments in the field of scientific research, on the one hand, and the technical progress and economic expansion of a country, on the other.

It is essential, in establishing the aims of fundamental research, to consider the economic activities to be developed in our countries. In this way, scientific research will effectively contribute, as part of the training of those who will be responsible for conducting economic activities, a forward-looking outlook as well as a scientific and technological briefing. The research personnel themselves will also play a part in those activities from time to time, in an advisory capacity.

To take an example, in the case of agriculture, which is destined for some years to come to remain an important component of Algeria's gross national product, and quite apart from applied agricultural research, the development of biological research centres could usefully be encouraged. In the same way, the industries producing fertilizers and insecticides would obtain applied research staff and advice from chemical research centres. Again, solid state physics research will provide support for a metallurgical industry (as at Annaba).

Research priorities could thus flow from the economic development plan itself, it remaining clearly understood, of course, that the independence of fundamental research is a sine qua non for its existence.

Our University already has a large number of research institutes, while several bodies of a scientific nature operate under the auspices of other ministries although in close liaison with our University institutes - e.g., the Scientific Research Department of the Ministry of Public Works and the National Institute for Agronomic Research of the Ministry of Agriculture and Agrarian Reform.

In Algeria, furthermore, the link between scientific research and economic development is one of the basic elements of the science policy of the government, which actively promotes the expansion of our University in line with the economic progress of the country. The higher education curricula are based precisely on our efforts to provide a link between fundamental research in the purely theoretical fields and those in which science is applied to economic realities.

The recommendations which will undoubtedly mark the culmination of your deliberations will, I am sure, be of great assistance to us in directing our activities along the path opened by the numerous meetings - especially the Lagos Conference - which have preceded today's gathering.

As you know, the Lagos Plan provided for the planning of scientific research on the basis of a national budget for the creation of multidisciplinary institutes at the national or sub-regional level. Algeria, as a champion of co-operation at the regional as at the international level, is in a position to make available, to the executants of a project of this kind, research workers and invaluable material which will be at the service not only of the countries here represented but also of that wider community symbolized by Unesco.

It is with an affirmation of our will to co-operate in order to serve better the causes of the advancement of our peoples and the strengthening of international solidarity, and of the hope that your work will result in concrete solutions to the many problems confronting our region, that I wish you every success in your efforts and declare open this Third Regional Meeting on Science Policy and Research Organization in our countries of the Maghreb and the Mashreq.

Inaugural address by
Mr. Y. de Hemptinne,
Head of the Science Policy Division,
Representative of the Director-General of Unesco

Your Excellency, Ladies and Gentlemen,

It is a very great pleasure for me to address you here on behalf of the Director-General of Unesco. I should like to begin by thanking you, Your Excellency, for your presence among us, and to express publicly our gratitude to the Algerian Government for its kindness in acting as host to this Meeting.

I have much pleasure in welcoming the experts from the organizations responsible for science policy and research in the countries of the Maghreb and the Middle East, who have so graciously responded to the Director-General's invitation. I should like also to thank the specialists who agreed to undertake the task of preparing the introductory documents for the Meeting, and to extend a cordial welcome to the representatives of the organizations belonging to the United Nations family, of the regional intergovernmental institutions and of the non-governmental scientific institutions here present.

Your Excellency, Ladies and Gentlemen,

The present Meeting is the third in a series: the first was held in Cairo in 1960, and the second in Lebanon in 1963. I should like, first of all, to recall briefly the purpose of these meetings, as approved by the last few sessions of the General Conference of Unesco.

In the Organization's programme, meetings of experts of this kind rank among the activities concerned with assistance to Member States in the organization and planning of their scientific development.

For each of the regions of the world defined by the General Conference, the scientists and administrators who direct the major research organizations or participate in the work of the governmental councils which lay down the science policy of their countries are invited to meet from time to time to compare their experiences and present to Unesco their suggestions regarding its future action.

These meetings thus provide an opportunity for measuring the progress made and studying future prospects.

By way of introduction, therefore, I shall give a general picture of the stages covered during these past years in the field with which we are concerned, and proceed to call attention to certain new trends.

It is not Unesco's place to draw up here a balance-sheet of the progress made in organizing government research policy in your respective countries. The first item of the proposed agenda, "The present situation as regards the organization of scientific research and national science policies" will provide occasion for each of the personalities present to describe the existing situation as regards his own agency and his own country's science policy. I am sure that this mutual exchange of information will be most instructive, and that it will furnish the background material essential for your further discussions.

However, there are two facts which might usefully be noted:

Firstly, regional scientific activity has steadily developed during these past two years; and this is reflected in the Unesco-sponsored meetings and symposia held in the region and referred to in the document prepared for you by the Unesco Science Co-operation Office for the Middle East(1).

It will be seen that the most varied disciplines are represented in this list of meetings, which testifies to the keen interest of your governments in all regional activities in the field of science. The national scientific organizations to which most of you belong undoubtedly played an important rôle in the preparation and conduct of these meetings.

Secondly, Unesco itself has direct proof of the interest displayed in the countries of the Maghreb and the Middle East in the development of science policy. I refer to the requests for technical assistance which the Organization has been receiving in this fairly new field of government concern. The Science Policy Division of Unesco has been at pains to meet those requests, and reports of a significant nature have been handed in to the competent authorities of an increasing number of Member States in the region.

The resolutions and recommendations of the second meeting held in Beirut in 1963 clearly indicate the growing acceptance of ideas which has today resulted in the formulation and dynamic application of national science policies by the governments of the region.

Several decades have passed, indeed, since research ceased to be an individual matter and became a collective one, and hence requiring the existence of a body of resources, the use of which has to be co-ordinated and organized.

These human and material resources constitute, in each country, the national "scientific and technical potential" (STP). At the previous meeting you adopted a resolution stressing the necessity of systematically evaluating these national potentials.

Furthermore, at the first regional conference held in Cairo, you had already taken up the question of harnessing the whole of this national scientific and technical potential to set objectives, and had recommended that a "Central Research

(1) Document UNESCO/SPRAL/3

Organization" be set up to that end in each country at the highest governmental level.

Proceeding further, the countries of the region have shown their intentness on increasing the material means utilized by research and harmonizing research programmes with the objectives of the National Development Plan.

You will recall that at the United Nations Conference on the Application of Science and Technology for the Benefit of the Less-Developed Areas (UNCSAT, Geneva, 1963), the members of the international scientific community had gauged the importance of these three essential aspects of science policy: evaluation of scientific and technical potential; organization and co-ordination of research at the national level; integration of objectives of the science plan in the National Development Plan.

Dating from then, a general consensus has been established which has swept away the research workers' ancient prejudice against any anticipatory approach in respect of research work and the means of developing it. Meetings like today's have been a potent contributory factor in winning acceptance for these new views.

Within the United Nations system and at the highest level, these trends have been reflected, following UNCSAT, in the creation by the Economic and Social Council of the Advisory Committee on the Application of Science and Technology to Development.

I have much pleasure here in greeting one of our consultants, Professor Kovda, who has worked actively and uninterruptedly as Scientific Secretary of that Committee, after having given a powerful impetus to Unesco's science policy programme. The tasks of the Committee which meets half-yearly and will shortly be holding its sixth session, are too extensive for me to summarize here, but I shall recapitulate briefly the basic principles which it formulated in its last two reports and which, having been formally endorsed by the Economic and Social Council in 1965 and 1966, constitute as far as the work of the present Meeting is concerned, a charter, as it were, beyond any need of further comment[1].

"(a) Each government should have an explicit policy for science and technology. Such a policy should aim at self-sustained and autonomous scientific growth of the country, on the one hand, and at the organization and planning of national scientific activities in support of economic and social development through the application of science and technology, on the other;

(b) The national, central scientific organization or agency, whose task is to define the national scientific and technological policy, should be directly responsible to the government at the highest level; it may be a ministry of scientific research, a national council for science or some comparable body;

(c) Membership of the national science policy-making body should include senior scientists and engineers from universities, academies of sciences and research councils, scientific and engineering societies, industrial research laboratories, and branches of industry;

(d) The national science policy-making body should work in close collaboration with the economic and social planning authority of the country, not only to ensure adequate allocation of resources to science and technology but also to advise on the rôle of science and technology in the national development programme, including the external technical assistance which should be sought;

(e) The national science policy-making body should be the focal centre for scientific contacts with foreign governments and international scientific organizations. Liaison between these national science policy-making bodies should be developed and organized in a systematic way, with a view to ensure the co-ordination of scientific and technological activities both at the regional and international levels;

(f) The United Nations Educational, Scientific and Cultural Organization has a vital rôle to play in assisting in the development of national science policy-making bodies, as well as in assembling and disseminating information on the national organizations established by governments for the formulation of national science policies and conducting research at the national level."

The final paragraph of this text defines the general line of Unesco's concern in the matter - a concern which already found expression indeed in Unesco's programme ever since 1960. I should like, if I may, to specify the point reached by the Organization in its own doctrinal approach to its mission, as thus confirmed.

This approach was recently defined at a technical meeting of representatives of research bodies held at Karlovy Vary (Czechoslovakia). I use the term "technical meeting", for it was one which involved, for the first time, a comparison of the experiences of men who had all contributed towards the preparation of one of those national science policy studies which the Department of Natural Sciences of Unesco entrust under contract to responsible bodies in Member States with a view, precisely, to promoting mutual information. Since the science policy studies thus made were conducted in the scientifically advanced countries in both East and West, and in the developing countries alike, it was a general survey of the techniques of "evaluating" and "developing" a national scientific and technical potential which was thus effected at Karlovy Vary.

The following three techniques were recommended as guiding principles for Unesco's work:

(1) Second Report of the Economic and Social Council's Advisory Committee on the Application of Science and Technology to Development (document E/4026, paragraph 156) and Third Report of the Committee (document E/4178, paragraph 28), United Nations, 1965 and 1966.

"(a) The scientific autonomy of countries, which means that the aim of these policies is to promote endogenous, social and economic development;

(b) the duality of national science policy, i.e. (i) the advancement of science and (ii) the application of science and technology to national development;

(c) the unity of science planning, i.e. co-ordination, centralized, at least as regards their conceptual aspect, of activities ranging from information on national scientific and tecnnical potential and processing of the relevant data, to determination of the objectives of science policies and pursuance of research programmes. The information function should consist mainly in assembling the essential data of scientific and technical resources and in setting up a system of national statistics in the area of science and technology."

Such is the framework which, at the level of principles, is now being proposed, and which the experts here present will, I hope, be prepared to accept as a starting point for their work in respect of their own region.

The important point for your Meeting, therefore, is not so much to reconsider the principles of science policy as to identify the rules of action which will govern the construction, in practice, of the institutions and programmes which each country finds necessary in the light of its own situation.

The fields in which Member States are at present requesting Unesco's technical assistance are a concrete illustration of the problems they are meeting with. It is in the light of the experience thus required that the Secretariat has proposed, in the agenda, four topics for discussion corresponding to the types of programme for which Unesco provides assistance.

Topic I

Creation and operation of central research organizations. Examples of various possible structures are beginning to multiply. In this connexion, I should like you to note that Volume I of the World Directory of National Science Policy and Scientific Research Bodies, compiled by Unesco, which gives a detailed account of some 150 major research councils and institutions in the countries of Europe and North America, is due off the press very shortly.

The statements to be made by some of the participants during the initial stage of this meeting's proceedings will undoubtedly provide material to complete our information concerning this region, a similar directory for which will be published next year.

To sum up, the problems facing governments in this connexion relate to the organization and to the juridical and administrative forms of the organs concerned with formulating and deciding on science policy.

These organs are specifically governmental in nature: "Ministries of Science" and "Interministerial Committees for Scientific and Technical Research", assisted by their "Councils" or "Advisory Committees".

Then come the autonomous establishments, responsible, depending on the case in point, for promoting and co-ordinating research in respect of major social and economic sectors and of disciplines: e.g. the National Research Councils and Academies of Sciences.

Lastly, there are all the institutions in which scientific research is conducted and which are known as the country's "institutional infrastructure of science" or "operational network for research".

This first topic marks the point of convergence at which administrative and legal competence, on the one hand, and experience of scientific research on the other, are essential.

In this initial field, as covered by item 5 of your agenda ("Structures, organs and means of national science policy"), the present trend seems to be towards the diversification of juridical and administrative solutions, depending on the particular situations in each country and proceeding from a number of basic structural types. It will be your task to specify those which you consider best suited to the conditions peculiar to the countries of the Maghreb and the Middle East, and if possible to define criteria for selection.

Topic II

The second group of practical problems arising relate no longer to devising the juridical, administrative or institutional instruments but to working out the methodology necessary for developing the country's scientific community and scientific and technical infrastructure on the basis of a national research strategy.

It is not a question here, of course, of considering the actual content of research in detail, but simply of determining how to assess existing means, how and to what end to use them, and how to prepare the future framework for research.

An attempt will be made, in this connexion, to determine the factors which the scientific institutions set up in the first stage of operations should take into account as a basis for their decisions.

We might mention, by way of example, such activities as the evaluation of national scientific and technical potential and, as a corollary, the compilation of science statistics: in other words, action to ascertain availabilities.

A study will then be made of the major obstacles to be overcome by a developing country which is simultaneously obliged to construct its own science and meet development requirements by utilizing the result already achieved by world science.

As regards this second topic which consists, in fine, of an examination of the formal problems involved in formulating a science policy, the present

trend is to work out, on the one hand, a methodology for diagnosing national situations which would be valid for all countries (the Karlovy Vary meeting represents a significant contribution, in this respect), and to establish, on the other, mathematical "models" of development and strategy based on economic and statistical analysis and on operational research. The relevant agenda item here is Item 6, "formulation of national science policies on a quantitative basis".

Topic III

The third group of concrete actions with which we are concerned relates, not to the operation and expansion of the apparatus for scientific and technological production proper, but to the use of that apparatus by the supreme government authority within the framework of the general development policy.

The point here is to give science policy its place as an instrument and motive force for progress, and to integrate it in national development planning.

As regards this third topic, both trends and methods are for the moment less clearly defined than for the first two. Science policy is seen as one among the major national policies, with its part to play in the general orchestra of specialized policies such as economic and social policy, education policy, health policy, cultural policy, and so on, which together make up national development policy.

You will find a number of considerations on this subject in one of the Secretariat documents prepared for your use[1] and entitled "Considerations on the concept of science policy".

Immediately a scientific research organization takes individual shape within the national structures, a way must be found of gearing it in practical form to the other organs with decision-making functions in the sphere of public finance, scientific and technological manpower, national development, etc., and of establishing, for example, the practical procedures whereby the governing bodies of the science policy organization will co-operate with organizations having responsibilities in the field of production or investments.

The magnitude of these problems of integrating science policy and national development policy can hardly escape you.

It will also be just as much a question of fixing the budgets available for science as of establishing the procedures which will make it possible, in national development planning, to take account of the technological progress which present research will bring about in the future.

A few moments ago I referred in speaking of the general principles emerging from the Karlovy Vary meeting, to the basic duality of all science planning: on the one hand, science planning for the advancement of knowledge, and on the other, science planning on behalf of national developments. In practice, the decisions will have to relate to a single operational research network and will have to subserve both these causes, this inevitably leading to choices the criteria for which are at present the subject of major studies throughout the world.

The Economic and Social Council's Advisory Committee has tackled this last point in concrete fashion by seeking to identify the priority research themes common to the developing countries. According to the Committee, the linking of scientific research and national development could be effected in making a concerted attack on certain specific problems, such as the prospecting and utilization of natural resources, industrialization, and questions relating to human reproduction.

By adopting this line and attempting, simultaneously with the overall integration of scientific planning and national development policy, the creation of centres of concentration on circumscribed subjects, a simplification of the problem will surely result. In that connexion, you will note that some of our consultants have proposed in the same spirit and for the countries of the region covered by this meeting, major research themes to which you could accordingly pay special attention when you come to discuss questions relating to regional co-operation.

The present Meeting, in the mind of its promoters, centres particularly on the integration of science policy and development policy, which explains why two of the agenda items, Items 7 and 8, are devoted to it, namely, "objectives and methods for integrating science policy and overall policy for economic and social development" (concerning in brief the linking of science policy with the other specialized policies); and "development of scientific potential and selection of priority research programmes in relation to the National Development Plan", i.e. the decisions made within science policy proper, particularly as regards priorities in science and technology.

In view of the fact that the prime necessity, when thinking in terms of national development is to take account of the subsequent application of research results in the social context, coverage has been provided under this second item for the social and human sciences, to which a specific introductory report is devoted.

Topic IV

Topic IV of your Meeting relates to the regional level and to international co-operation. Regarding the trends in science policy, as briefly described by me, a new light is shed on them when consideration is focused, not on the standpoint peculiar to each country, but co-operation between countries possessing obvious natural affinities by reason of their geographical location, their traditions and their culture.

(1) Document UNESCO/SPRAL/5.

You have already affirmed, at the previous meetings, that regional scientific co-operation constitutes not only a means but also an end, and that it must rank as a major objective for those who lead the work of national research organizations in their respective countries.

True, powerful flows of communication are in evidence between scientists in the various specialized disciplines in this region. In the human sciences disciplines in particular, these flows are of very long standing. And as everywhere else, there is an informal network which links scientists and technologists.

However, for co-operation to emerge, no longer confined to the level of individuals who have had the same intellectual training, but at that of institutions wishing to combine their material efforts for the sake of greater efficiency, the dialogue between national bodies and research organizations has to be initiated and become confirmed.

These organizations being the chief executives of government science policy, they are particularly well fitted to think of possible areas of co-operation and to recommend the means of achieving it.

With that objective in mind, your deliberations on these systems of national science organization will no doubt culminate in a definition of the principles calculated to facilitate collaboration between institutions in different countries. In order to be concrete, they should also aim at providing at least a preliminary indication of the national development sectors and scientific and technical disciplines in which concerted efforts could be made.

Suggestions have been made on this score in two consultants' reports submitted to your Meeting, and the national situation reports will undoubtedly provide us with further possible lines of approach.

Raising the discussion to the international level, it has to be noted that the establishment of national research structures will also facilitate co-operation between nations in general. In countries which have not yet achieved full development in the field of research, one of the key functions of a national science policy body will be to select the fields in which recourse will be had to technical assistance, whether bilateral or multilateral. In particular, it will devolve on that body to initiate and co-ordinate the links between national research institutions such as university laboratories or private and public specialized laboratories, on the one hand, and similar institutions in the scientifically more advanced countries, on the other. The Economic and Social Council's Advisory Committee stressed the importance of establishing these links, which in actual fact are of very different kinds, and gave Unesco the task of conducting an international survey on this question and studying practical ways of promoting their development.

It would be appropriate, at the present Meeting, to embark on that study, and the Secretariat has accordingly presented you with a working paper on the question(1).

Such, in brief, are the main topics of discussion which Unesco proposed to this gathering.

I should like, however, before concluding this address, to define briefly the immediate and long-term prospects.

(a) Firstly, as experts in science and technology, it will be your task to formulate conclusions concerning state science policy which will facilitate decision-making by the governments of the countries of this region.

In particular, your Meeting could mark a step forward as regards the procedures for integrating science plans and National Development Plans.

(b) In the longer term prospect, your discussions will be able to shed light on the necessary link to be established, at the political responsibility level, between science, culture, education and social and economic development. For example, it seems clearly impossible to construct an endogenous science in a country - i.e., a science capable of self-sustained growth - without first paying heed to the training of scientific and technical personnel. In consequence, recourse would be had to educators in preparing the Science Plan.

It follows that while the formulation of the actual science policy decisions belongs to the organizers of research, the quantitative and qualitative objectives of the Science Plan should be drawn up jointly by all the governmental authorities responsible for national development, and especially by the government organs responsible for education, the economy and cultural and social affairs.

I leave this point for you to ponder on, in anticipation of the questions you might wish to take up at a subsequent meeting.

And to conclude, I should like to extend to you, on behalf of the Director-General, my warmest wishes for the success of your deliberations. On all sides, burning problems are arising which only the help of science will enable us to tackle.

During these next few days, Your Excellency, Ladies and Gentlemen, let us be receptive to Valéry's call to mankind to advance boldly into the future with unaverted glance.

(1) Document UNESCO/SPRAL/4.

ANNEX II

CLOSING SPEECH OF THE CHAIRMAN OF THE MEETING, MR. A. OUABDESSELAM

Mr. Representative of the Director-General,
Ladies and Gentlemen,
My dear colleagues,

It is a very special pleasure for me, at this moment when our meeting is concluding, to express my deeply felt thanks to the Director-General of Unesco, to whom we owe the realization of this Third Meeting on Science Policy and Research Organization in the countries of North Africa and the Middle East.

In the course of the past week, our first task was to describe the situation in our respective countries; subsequently we discussed topics presented by the Consultants to this Meeting.

We have all admired and appreciated the high level of the ideas, coupled with the great clarity and precision of the papers given by these eminent scientists; and we have benefited by the interesting and fruitful discussions that followed them.

However, while we may congratulate ourselves on these positive exchanges of opinions, there is no doubt that we owe this possibility to the enlightened counsels of Mr. de Hemptinne, the Representative of the Director-General of Unesco.

I feel sure that I am expressing the thoughts of all the participants here present in offering to Mr. Smid and the members of the Unesco Secretariat our warmest gratitude for the tremendous efforts they have exerted.

Fellow participants, you did me the signal honour of making me your chairman. However, I must admit that there was no great merit in performing this task, in view of the perfect cordiality and harmony which prevailed throughout the discussions. For this, my dear colleagues, I thank you most sincerely.

Lastly, in my capacity as delegate of Algeria, I take this opportunity to tell you once again how greatly my country feels honoured to have welcomed you and contributed to the success of this meeting.

Today, a step forward has been taken in the sphere of science policy and research organization in our region.

I should like to conclude with a wish - that the work of the next conference may be crowned with the greatest possible success.

Once again, I thank you.

ANNEX III

AGENDA

1. Opening of the Meeting

2. Election of Chairman, Vice-Chairmen and Rapporteur

3. Adoption of Agenda

4. The present situation as regards the organization of scientific research and of the national science policies in the countries of North Africa and the Middle East

5. Structures, agencies and methods of national science policy

6. Formulation of national science policies on a quantitative basis

7. Objectives and methods for integrating science policy and overall policy for economic and social development

8. Development of scientific and technical potential, and selection of priority research programmes in relation to the National Development Plan

9. Co-operation of national research organizations

   among themselves, based on the common objectives of the science policies of the countries of North Africa and the Middle East

   with the national research organizations of the scientifically advanced countries, by the establishment of bilateral institutional links

   Rôle of the Unesco Science Co-operation Centre for the Middle East

10. Adoption of resolutions and recommendations, and closing of the Meeting.

ANNEX IV

LIST OF PARTICIPANTS

I. EXPERTS ATTENDING IN THEIR PERSONAL CAPACITY

Dr. Abdul-Aziz K. AL-MAHDI (Iraq)
Assistant President, University of Baghdad
Baghdad

Dr. Fadhil AL-TAI (Iraq)
President, Supreme Council of Scientific Research
Baghdad

M. A. AYACHI (Tunisia)
Ingénieur Principal, Chef de Recherche au
Secrétariat d'Etat à l'Agriculture
Tunis

M. Djelloul BAGHLI (Algeria)
Directeur de l'Institut Algérien du Pétrole
Alger

M. Lassad BEN OSMAN (Tunisia)
Ingénieur Directeur, Sous-Secrétariat
d'Etat à l'Agriculture
Tunis

M. Mohamed BENBLIDIA (Algeria)
Directeur de l'Hydraulique,
Ministère des Travaux Publics
Alger

Professeur Hikmet BINARK (Turkey)
Membre, Conseil National de la Recherche
scientifique et technique
Ankara

Professeur Resat GARAN (Turkey)
Faculté de Médecine, Université d'Istanbul
Istanbul

Dr. Mustapha HAFEZ (United Arab Republic)
Vice-President, High Council for
Scientific Research
Cairo

M. HAMADI (Algeria)
Directeur Adjoint de l'Institut de la
Recherche Agronomique
Alger

Dr. Wasfi HIJAB (Jordan)
Professor, American University
Beirut (Lebanon)

Professeur Mustafa Hassan ISHAK (Sudan)
Dean, Faculty of Science
Khartoum

Mr. Zuhair KARMI (Kuwait)
Senior Science Inspector,
Ministry of Education
Kuwait

M. Abdul Rahman LABBAN (Lebanon)
Vice-Président, Conseil national
de la Recherche scientifique
Beyrouth

Dr. Amin MAJAJ (Jordan)
Senior Member, Jordan Research Council
Amman

M. Youcef MENTALECHTA (Algeria)
Directeur du Département de Physique
de la Faculté des Sciences
Alger

M. Mahmoud MESSAOUDI (Algeria)
Secrétaire général adjoint de la commission
nationale algérienne pour l'Unesco, chef de
service des relations extérieures, Ministère
de l'Education Nationale
Alger

M. Hajjoub MSOUGAR (Morocco)
Maître de Conférences, Faculté
des Sciences, Université de Rabat
Rabat

Professeur Joseph NAJJAR (Lebanon)
Président, Conseil national
de la recherche scientifique
Beyrouth

M. Abdelaziz OUABDESSELAM (Algeria)
Président du Conseil de la
Recherche scientifique
Alger

M. Ramdane OUAHES (Algeria)
Directeur du Département de Chimie, Faculté des Sciences, Université d'Alger
Alger

M. Rachid OUSSEDIK (Algeria)
Président du Comité des Sciences Exactes, Commission Nationale Algérienne pour l'Unesco
Alger

Dr. Shapour RASSEKH (Iran)
Directeur du Département de Planification sociale à l'Organisation du Plan
Téhéran

Dr. Mohammed Hafez SALIM (Jordan)
Director of Agricultural Research, Jordan Research Council
Amman

Mr. Salah SUREILY (Yemen)
Head, Follow-up Division, Ministry of Education
Sanaa

Mr. Ahmed TASHKANDI (Saudi Arabia)
Head, Planning Organization and Budget Department, Ministry of Petroleum and Mineral Resources
Riyadh

M. Rachid TOURI (Algeria)
Doyen, Faculté des Sciences, Université d'Alger
Alger

Mr. Mohamed YAHIA (Algeria)
Conseiller des Affaires Etrangères, chargé des relations avec l'Unesco
Alger

M. Adnan ZMERLI (Tunisia)
Doyen, Faculté des Sciences, Université de Tunis
Tunis

II. OBSERVERS

1. Member States

France. Mlle. Claire JANON
United States of America. Mr. P. HEMILY

2. International Organizations

United Nations Economic Commission for Africa: M. BEN-AMOR
World Health Organization: Dr. F. MORTARA
Food and Agriculture Organization: M. Aslam ZAFAR

3. Intergovernmental Organizations and Institutions

League of Arab States: Dr. Ali Ibrahim ABDOU

III. UNESCO

A. Secretariat of the Meeting

Mr. Yvan de HEMPTINNE
Chief, Science Policy Division, representative of the Director-General

Mr. Jan SMID,
Director, Middle East Science Co-operation Office
Cairo

Mr. Marc CHAPDELAINE
Science Policy Division

Mr. Ratchik AVAKOV
Economic Analysis Office

B. Consultants

M. Jacques DEFAY
Chef de service de la programmation scientifique dans le domaine des sciences exactes et de la technologie, Conseil national de la politique scientifique
Bruxelles

M. Robert DESCLOITRES
Président, Centre africain des sciences humaines appliquées
Aix-en-Provence

Dr. Rolando V. GARCIA
Vice-President, Executive Council, International Council of Scientific Unions

Professeur Charles GUILLAUD
Directeur scientifique au Centre national de la recherche scientifique
Paris

Professor Victor KOVDA
Chairman, Soil Section, Biology and Soil Faculty, Moscow State University

Professor A. Riad TOURKY
President, Supreme Council for Scientific Research
Cairo

IV. LIAISON COMMITTEE OF THE ALGERIAN GOVERNMENT FOR THE MEETING

M. Youcef AMMAL
Sous-Directeur de l'Hydraulique du Ministère des Travaux Publics et de la Construction

Mme. Zehira BELAID
Chef du Bureau des Relations avec l'Unesco du Ministère de l'Education Nationale

M. Mohamed KALLACHE
Division du Protocole, Ministère des Affaires Etrangères

ANNEX V

LIST OF DOCUMENTS

1. Working documents

UNESCO/SPRAL/1 prov. - Provisional Agenda
UNESCO/SPRAL/2 - Aims - Scope - Organization
UNESCO/SPRAL/3 - The Activities of Unesco in North Africa and the Middle East in the Field of Science and Technology
UNESCO/SPRAL/4 - International Co-operation for the Advancement of Scientific/Technological Research in the Countries of North Africa and the Middle East through Bilateral Institutional Links
UNESCO/SPRAL/5 - Considerations on the Concept of Science Policy
UNESCO/SPRAL/6 - Rules of Procedure
UNESCO/SPRAL/7 - Structures, Organs and Means of National Science Policy
UNESCO/SPRAL/8 - Objectives and Methods for Integrating Science Policy and Overall Policy for Economic and Social Development
UNESCO/SPRAL/9 - Co-operation of National Research Organizations Based on the Common Objectives of the Science Policies of the Countries of North Africa and the Middle East
UNESCO/SPRAL/10 - The Place of Social Sciences in the National Science Policy, Especially in Relation to National Development Plans
UNESCO/SPRAL/11 - Formulation of National Science Policies on a Quantitative Basis
UNESCO/NS/ROU/84 Annex I - Some Typical Bilateral Institutional Links Between Developing and Scientifically Advanced Countries
UNESCO/NS/ROU/107 rev.1 - Promotion of National Science Policies - Unesco Programme
UNESCO/NS/ROU/130 - Loss of Highly-Trained Personnel in the Developing Countries through Emigration to the More Developed Countries
E/4178 - Economic and Social Council (ECOSOC) Advisory Committee on the Application of Science and Technology to Development - Third Report (May 1966)
UNESCO/SPRAL/16 rev.1 - List of Recommendations Adopted Unanimously by the Meeting during its Last Session

2. General information documents

UNESCO/SPRAL/INF/1 - General Information
UNESCO/SPRAL/INF/2 rev.1 - List of Participants
UNESCO/SPRAL/INF/3 - Organization of Work

ANNEX VI

COUNTRY REPORTS

Exposés made by participants on the present situation of science policy and research organizations in their respective countries

1. ALGERIA

The Algerian delegation would like to preface this statement by reiterating the words of welcome voiced by the Minister of Education in his inaugural address. Algeria has particular pleasure in acting as host to the Third Regional Meeting on Science Policy and Research Organization in the countries of the Maghreb and the Middle East.

The following very concise remarks provide a picture of the status of scientific research in our country, of its structures and fields of activity, and of our projects in that connexion.

To avoid what might be a lengthy and tedious enumeration and description, we have presented each delegation with a document (red cover) giving detailed particulars of the scientific investigation and research institutes and laboratories in our country. They are as follows:

Department of Applied Hydrological Research - Hydrology Division, attached to the Ministry of Public Works and Construction;

Scientific Research Department, Central Laboratory Division for Highways and Communications, attached to the Ministry of Public Works and Construction;

National Institute for Agronomic Research, attached to the Ministry of Agriculture and Agrarian Reform;

Algerian Centre for Forestry Research and Studies, attached to the Ministry of Agriculture;

Institute of Nuclear Research, Bd. Frantz Fanon, Algiers, attached to the Ministry of Education;

Institute of Meteorology and Terrestrial Physics (IMPGA), attached to the Ministry of Education;

Oceanography Institute, Jetée Nord du Port, Algiers, attached to the Ministry of Education;

Cancer Research Institute of the Pierre and Marie Curie Centre, Avenue Battandier, Algiers, attached to the Ministry of Education;

Department of Chemistry, Faculty of Science, attached to the Ministry of Education;

Institute of Solar Energy, Algiers, attached to the Ministry of Education;

Algerian Petroleum Institute, attached to the Ministry of Power and Industry.

The list is not exhaustive, but to give you some idea of the extent of the work being done, it can be stated that the appropriations for research in our country amount to nearly 20 million dinars.

The training of research workers, engineers and technicians is conducted at the Faculty of Sciences and the National Polytechnical College.

You will note that apart from the university, scientific research is also carried out at institutions coming under ministries other than the Ministry of Education - in particular, the Ministries of Public Works, Agriculture and Agrarian Reform, Health, and Power and Industry. These institutions already work in liaison with the university.

It was at a very early stage, however, that we became conscious of the need for close co-ordination of all research work at the national level.

The word "science", in fact, should be understood in its broadest sense. For example, disciplines formerly described as arts disciplines, such as geography, history, philosophy, law and economics, have during recent years become known as human sciences and economic sciences. This major step has been taken thanks to mathematics, which has made it possible to get to closer grips with realities which were formerly difficult to apprehend.

Furthermore, there is a continual, many-sided and intimate interaction between the fundamental sciences, on the one hand, and the applied sciences, on the other. The results obtained in fundamental sciences lead to progress in technology, and the latter, in fair return, stimulate research in the former.

It is appropriate, therefore, that steps should be taken in the interests of efficiency to give direction to scientific research.

Inventorization of our resources, co-ordination of the work of all research laboratories, direction of that work in accordance with our needs, study of the conditions and determination of the means for developing research - such are the main objectives before us.

All these requirements led us to propose the establishment of a Higher Council for National Research. The Council, set up by Government Decree in April 1965, is composed of representatives of all the fields of activity covered by scientific research in our country.

The task of this recently established Council is to develop, direct and co-ordinate scientific research work. Our present concern is to integrate its research programmes as effectively as possible with overall national development planning.

The Algerian delegation attaches great hopes to the work of this Meeting as a factor for promoting its science policy and developing co-operation between all countries.

2. IRAN

efore starting to discuss the subject listed as
1.em 4 in our agenda, namely, the state of affairs as regards decision-making and planning for science policy in Iran, I should like to give you very briefly an idea of the way in which the various functions involved in the execution of research are organized in my country.

I shall start with the ultimate foundation of all research, that is, the training of the scientific workers. This training is carried out not only in our own seven universities, which every year turn out more than 3,500 graduates at bachelor or higher levels, but also in foreign universities, where more than 18,000 Iranians are pursuing their advanced studies. Out of 29,000 Iranians taking university courses during 1964-1965, in Iran or abroad, whose subjects of study are known to us, 10,200 were studying medicine or related sciences; 9,800 were studying human and social sciences; 6,700 were studying pure sciences or engineering; 1,600 were studying agricultural sciences; and about 900 were studying the fine arts. These figures give a clear idea of the composition of the future intellectual élite in Iran. Ten years ago there were, at a very rough estimate, only about 32,600 people in the country holding a university diploma. Today, the number holding university diplomas has nearly doubled.

In this respect, Iran is located among the "relatively developed" countries in the table drawn up by Mr. Harbison, since, according to that American expert in education planning, countries may be grouped in four categories according to the degree of advancement of their educational system and, among other factors, according to the number of scientists per 10,000 of the population:

For non-developed countries:	0.6
For developing countries:	3
For relatively developed countries:	25
For highly developed countries:	42

For my country, the figure is about 26 to 30 holders of university diplomas per 10,000 of the population.

The second function involved in the execution of research relates to the conducting of research operations properly speaking. There are in my country a considerable number of research institutions, most of them being attached to the government, as for example the university research institutes, the institutes belonging to various ministries, etc. For economic and social reasons whose explanation would be too long to discuss here, no research is as yet supported by the private sector. My colleague, Dr. Mofidi, who had the privilege of attending the Beirut Conference in 1963, listed the names of most of our research institutes; some new names have since been added to this list, but I shall not use up time by mentioning them now.

Since the private industries in Iran have not shown any particular interest in research, the government has concerned itself with this question and has established a Standards Organization which is making a great effort to improve the techniques and methods of operation employed in private industry, leading to an improvement of their products.

As regards government expenditure in the field of research, both for the operation and the development of the machinery for government research, the funds provided in the budget for the current year amount to 1,470 millions of rials, which represents about 0.7% of the government's total expenditure. Only 9% of this is allocated to university research, while agricultural and veterinary studies and research receive the lion's share (about 40%); next come the research and studies conducted by other ministries, such as the Ministry of Labour, the Ministry of Water and Electricity, and the Ministry of National Economy (32%); and then come studies and research in the field of medicine and hygiene (18%).

The government effort this year in the field of research represents about 0.7% of the total of ordinary expenses and investment expenses taken together. However, there are certain government institutions whose studies and research are not shown explicitly in the budget, thus it is likely that

the percentage allocated to research is even larger. In Dr. Mofidi's report mentioned above, it was shown that under the Third Plan, about 1.2% of the total allocation was devoted to research of various kinds, hence it is likely that some 0.4% to 0.5% of our gross national product is devoted to research.

We have just seen that in Iran the government is the principal agent for financing research. This financing task is one of the prerogatives of our central planning organization, since it is that organization which fixes not only the total of public investments but also the whole of the government's budget. In this way the Planning Organization of Iran is able to act as co-ordinating agent between all the research organizations, and to try to direct these researches more accurately towards the most urgent needs of the rapidly expanding economy. As regards co-ordination inside the universities, which are still jealous of their academic independence, an important innovation was made two years ago with the creation of a Higher Research Committee, whose members include a representative of our Planning Organization.

As regards the auxiliary services for research, one important thing to note is the creation two years ago, of a Central Bureau of Statistics, attached to the Planning Organization, having responsibility not only for conducting periodic censuses, but also for collecting, standardizing and disseminating all statistics that could be useful to researchers and students in any field.

Note should also be taken of efforts recently made in various other auxiliary services for research, such as the National Meteorology Service, the Cartographic Organization, the seismology stations, etc.

As regards scientific information, the Planning Organization of Iran intends shortly to establish the first National Documentation Centre, which will probably be located within our oldest university, that of Teheran. The Faculties of the University of Teheran and of provincial universities issue bulletins, and there are also scientific journals regularly publishing the results of research. The University of Teheran alone has published, since its creation 30 years ago, more than 1,200 volumes including many dealing with the independent studies and researches of the academic staff. Scientific works are reaching a wider and wider public. Seminars on a national, regional or international scale afford continually improving facilities for the exchange of information between scholars and research workers.

We turn now to the evaluation and recording of research results. We have already pointed out that the State is the main sponsor of scientific research in Iran. The research results are evaluated sometimes by the competent government departments, in particular by the Programming and Study Offices established three years ago in nearly all the ministries classed as "development ministries". The same Offices utilize and apply the results obtained.

After this brief account of new developments in the sphere of research operations in Iran, we come to decision-making and planning for research in the responsible bodies.

We have just seen that most of the research undertaken by or for governmental agencies are financed and co-ordinated by the Central Planning Organization of Iran. However, it has been decided by the Prime Minister that the country shall, in the very near future, be endowed with a very high-level body for decision-making and planning in the field of science policy. The organization envisaged could have the following structure: first, a High Council for Science Policy, comprising a dozen eminent scientists; next, a Secretariat for Scientific Research attached to the President of the Council, with a Permanent Secretary elected by special decree; and lastly, a ministerial committee responsible for deciding the place to be allocated, in the detailed budget, to each individual research project or institute.

I shall conclude this statement with a very brief explanation of the state of science policy in Iran, i.e. the content of this policy as distinct from its organizational structure.

It is true that there does not yet exist in Iran any well integrated science policy co-ordinating all the research activities of the country. Nevertheless, it may be said that, by virtue of the control exercised by the Planning Organization of Iran, certain priorities have been established in relation to the objectives of the socio-economic development programmes of the country.

In this respect, agricultural research occupies a very important place. Since the introduction of the agrarian reforms in Iran, the government is paying very great attention to all kinds of applied research aimed at increasing agricultural production for the benefit of the new land-owners; the subjects include soil studies, research on water resources, improvement of the quality of seed, control of parasites, etc.

Another priority field for research in our country is the improvement of public health - the control of endemic contagious and other diseases, particularly malaria, bilharziasis, cancer, etc. - as well as the study of the nutrition of the population and the examination of changes that could be introduced.

A further priority relates to the industrialization of the country. A very large number of investigations have been made of the possibilities and potentialities of the country in this new direction. Petroleum research naturally still occupies an important place in the sphere of industrial research.

In the field of the exact sciences, attention may be drawn to the creation and development of the Nuclear Centre and laboratories for physics, biochemistry and chemistry.

Another field to which particular attention has been given recently is the reform of the educational system and the raising of the level of education of the population by new pedagogic methods. The office

for studies and programming in the Ministry of Education, and the department of social affairs in the Planning Organization are highly active in this connexion.

Mention may also be made of sociological and economics research aimed particularly at identifying and solving problems associated with the rapid advancement of a country undergoing complete transformation.

Lastly, various projects are in hand relating to "developmental research", e.g. projects for ameliorating the conditions of life and accommodation in cities, for town planning, for the creation of a national network of communications, for the electrification of the country, and others figuring importantly in the budget designed for the economic progress of the country.

I must not conclude this statement without enumerating rapidly the problems tending to prevent the rapid development of research in my country.

Most important is the problem of "brain drain" in favour of those countries able to pay higher salaries to their research workers. Salaries in our country are not sufficient to enable workers to devote themselves full time to research. The status of the research worker is not yet sufficiently recognized by the authorities.

As regards the execution of research operations, there still exist many complicated and formal administrative regulations which reduce the tempo of these operations. To purchase a simple piece of equipment for a laboratory sometimes takes months of negotiations, involving the obtaining of tenders and formalities difficult to overcome.

Another problem arises from the individualist nature of certain research workers, who even today not only refuse to work in a team but will not accept any discipline. This leads to employment of redundant personnel and waste of manpower and financial resources.

There is no doubt that lack of equipment and financial means is one of the causes of the slow progress of science in Iran and similarly placed countries. Nevertheless, it is recognized that the existing resources are not fully utilized.

I shall return later to the analysis of these problems and other less important ones, and to the solutions which could in my humble opinion, be proposed.

3. IRAQ

Scientific research in Iraq is only beginning in comparison with developed countries. Even if compared with some developing countries, one notices that the authorities have only lately realized the importance of research. Real scientific research could be associated with the university, the Supreme Council of Scientific Research and a few departments in the concerned ministries. If we remember that the University of Baghdad was established with the existing colleges in 1957 and the Supreme Council of Research was born only a couple of years ago we realize that we are only on the threshold of scientific research. As for the Departments in the Ministries of Industry, Agriculture, Communication and Works, Health and Oil, the problems they are concerned with do not exceed some applied problems related to their fields. Some of these departments' work might be classified as routine work.

In the following paragraphs a short account on scientific research in the above centres of research is given.

RESEARCH IN THE UNIVERSITY OF BAGHDAD

The University of Baghdad, in addition to being the source of scientific personnel to the other centres, is taking active part in carrying out scientific research mostly in the field of pure science and humanities. There are two kinds of research work carried out in the university:

(a) Research work carried out by post-graduate students leading to higher degrees

The University of Baghdad encourages post-graduate students in various fields of pure and applied science. In addition to free education, the university provides all research material, laboratories and equipment. Moreover, a full-time post-graduate student receives the sum of 300 I.D. per year while carrying out research. Nearly all these post-graduates are employed by the university after graduation as demonstrators. Though the post-graduate work in our university is only for the degree of Master of Science, the authorities are seriously considering the doctorate work.

The following table shows the number of post-graduate students in different fields for the last five years:

Table I

Field of Study	Academic year	No. of postgraduate students	
Chemistry	1961-62	8	28
	1962-63	8	
	1964-65	7	
	1965-66	5	
Physics	1965-66	8	8
Mathematics	1962-63	2	10
	1964-65	3	
	1965-66	5	
Geology	1965-66	2	2
Zoology	1964-65	2	2
Civil Engineering	1960-61	2	5
	1962-63	3	
Agriculture	1960-61	2	2
		57	

Post-graduate studies in humanities are not tabulated.

(b) Research work carried out by members of staff in addition to their teaching duties

To encourage individual members of staff in the various fields, the university - and in particular the Academic Council - has established rules and regulations for the promotion of research. A member of staff who would like to engage himself to carry out a research project would place his request with the university. Two committees are formed, one for the promotion of scientific research and the other for the promotion of research in humanities. Either of the committees would check on the originality of the project and its value. The worker would receive 180 I.D. in three instalments, the first being after putting in the general

survey of his project, the second after his first progress report, and the third after submitting his second progress report. He will then receive 120 I.D. after having his paper published or accepted for publication in a reputed journal, making a total of 300 I.D. per piece of research per year.

The following table shows the number of projects financially supported in this way in different fields for the last academic year:

Table II

Field	Number of Projects
Engineering	4
Mathematics	1
Chemistry	4
Geology	2
Parasitology	1
Pharmacy	2
Pathology	1
Zoology	2
Surgery	1
Agriculture	3
Medicine	2
	23

A number of humanities projects have also been financially supported by the university - details are not mentioned as they are out of the scope of this paper.

It will be noticed from Table II that the number of members of staff engaged in research is rather small, the reason being the heavy teaching duties undertaken by them.

In the field of science there exist no full-time research workers or institutes. The Arid Zone Institute (converted into the Natural Resources Institute), the Petroleum Research Institute, the Biological Research Centre were attached to the university but lately these have been connected to the Supreme Council of Scientific Research.

THE SUPREME COUNCIL OF SCIENTIFIC RESEARCH

As it appears from Article II of the Law no. 116, 1963 of the Supreme Council of Scientific Research "The Council shall act for the advancement of pure and applied scientific research and in particular that which is connected with industry, agriculture, public health, petroleum and other fundamentals of the national economy within the general plan of the State" - the S.C.S.R. is concerned primarily with applied research for the promotion of the national economy.

The Council, since its origination, was part of the University of Baghdad and according to Article XII B of its Law it has been detached from the university and connected to the Council of Ministers only about two months ago.

The research institutes, which constitute the nucleus of the Supreme Council of Scientific Research and which were formerly part of the University, have been also detached from the university and are now part of the S.C.S.R. The institutes are the Natural Resources Institute (Arid Zone Research Institute), the Biological Research Centre and the Petroleum Research Institute, the latter still being in foundation stages. Thanks are due to Unesco being the executing agent of the United Nations Special Fund's technical assistance for the establishment of the Petroleum Research Institute. We are also grateful for Unesco's assistance in converting the Arid Zone Research Institute into the Natural Resources Institute, which is another Special Fund project.

The Supreme Council of Scientific Research is in the course of finalizing the building plans of the National Research Centre generously financed by the Gulbenkian Foundation. This Centre will undertake, to start with, researches in the fields of chemistry and petroleum, building materials, agriculture and biological sciences, eventually expanding to other fields of scientific interest.

The Gulbenkian Foundation is financing the training of scientific personnel in European and American universities to strengthen the staff and technicians in the S.C.S.R.

In the meantime, the Council is planning to co-ordinate research in the different governmental departments and provide them with the necessary scientific personnel, equipment and any other scientific assistance required.

4. JORDAN

The first research station in Jordan was established in 1952 for studying the agricultural problems involved in irrigated farming. This was enlarged to a department of research within the Ministry of Agriculture in 1958.

The need for a National Research Body to organize and co-ordinate all research activities in the different scientific disciplines was felt since 1956. After that there was an exchange of correspondence between the research station and the Prime Minister's Office.

As a contribution to the impetus generated by the first Unesco Meeting on Science Policy and Organization of Research in North Africa and the Middle East, held in Cairo in December 1960, the Jordan Research Council was officially approved in February 1961. This approval was by a decision of the Prime Minister, but no law or ordinance was passed to this effect. In September 1964, the Jordan Research Council was officially established by an ordinance depending on the Education Act (Appendix 1).

The steps taken by the Jordan Research Council to further research after its legal creation in 1964 are:

1. Drafting an independent Research Act to ensure:
   (a) The independence and autonomy of the Council;
   (b) Scientific freedom;
   (c) Budgetary flexibility to the investigator;
   (d) Administrative flexibility to the investigator.
2. Establishment of the first documentation centre in Jordan.
3. Supporting financially some active research projects.
4. Encouraging new research projects.
5. Surveying the potential scientific power in Jordan.

Research in Jordan has been so far supported to a large extent by international agencies and by governments and institutions from outside the region. A new development has occurred whereby the governments and institutions within the region have started to help themselves and help one another.

Although research activities are still limited in Jordan it is hoped that major leaps will take place to help research in the near future. His Majesty King Hussein, inaugurating a private research laboratory in 1963, decorated one Jordanian and two American scientists for the scientific achievement in Jordan. His Majesty recently decided to, and is, personally supporting a private research project in Jordan. His Majesty's Government also spares no effort in helping research.

It pleases us to report that already two associate Professors of Medicine and Biochemistry from the American University of Beirut are spending their Sabbatical years in Jordan.

Another good example of bilateral aid within the region is a partial support of a private research project in Jordan by the Lebanese National Research Council.

The regional centre for the use of isotopes in Cairo and which is supported by the Arab countries is providing training facilities for scientists and technicians from the region.

It is proposed that this Meeting takes note of these important and new developments in the region.

The Jordan Research Council is trying to create public awareness in Jordan and in the neighbouring friendly states, with the purpose of encouraging private and official support of research.

APPENDIX 1

THE JORDAN RESEARCH COUNCIL

The first Research Council in Jordan was established on 3 September 1964 by the legislative act no. 53 for the year 1964 issued in accordance with article 117 of the Education Law.

Article 1 - This act is called "The Jordan Research Council Act for the Year 1964", and is applicable from the date it is published in the official gazette.

Article 2 - A council to be called "Jordan Research Council" hereinafter called the Council will be formed. The Council will consist of representatives of the following ministries, departments or authorities. Representatives are recommended by their ministers or heads of departments, and approved by the Prime Minister:

1. The University of Jordan;
2. Hussein Agricultural College;
3. Ministry of National Economy;
4. Ministry of Public Works;
5. Ministry of Social Welfare and Labour;
6. Ministry of Education;
7. Ministry of Health;
8. Ministry of Defence;
9. Ministry of Agriculture;
10. Ministry of the Interior (for the City and Rural Affairs);
11. One representative from the Agricultural Private Sector;
12. One representative from the Industrial Private Sector.

Article 3 - The Council can recommend to the Prime Minister an increase in the number of Council members when found necessary.

Article 4 - The Prime Minister can exchange any member in the Council or fill in any vacancy in accordance to a recommendation from the concerned minister or head of the concerned department.

Article 5 - The Council has the following objectives:

(A) The supervision of planning, organization and co-ordination of scientific research in order to raise the scientific, economic, social and health standards in the kingdom.
(B) To encourage scientific research whether official or public and to support it materially and morally.
(C) To co-operate with the countries of the Middle and Near East, and with the international organizations like Unesco in order to co-ordinate research in the region and to secure exchange of knowledge.

Article 6 - The Council is directly responsible to the Prime Minister.

Article 7 - The Council has to carry out the following:

(A) To advise the Prime Minister on matters relating to science policy in the country.
(B) To review and follow up the research projects carried out by government departments and public establishments in view of co-ordination and support.
(C) To establish priorities for the applied research projects in accordance with the national interest.
(D) To recommend to the various ministries ways and means for the development of scientific research.
(E) To take care of the development of human resources in the field of scientific research through providing scholarships for specialization in the various science fields; also through raising the standard of living for those already working in research in order to keep up the scientific standard. This can be done in co-operation with the other departments concerned.
(F) To encourage dissemination of knowledge and to raise the scientific standards in the kingdom through all possible means and methods.
(G) To plan the establishment of a documentation centre attached directly to the Council. The centre would then be available to all research workers.
(H) To establish specialized committees through the Council for conducting special detailed studies for each subject in view of defining the scientific standards needed, as well as the best methods for their carrying out.

Article 8 - The seat of the Council will be in the Ministry of Education.

Article 9 - The Minister of Education is the Chairman of the Council.

Article 10 - The Council members elect the Vice-Chairman from the members for one renewable year.

Article 11 - The Prime Minister appoints a Secretary to the Council upon the recommendation of the Chairman which is based on a decision taken by the Council.

Article 12 - The Chairman or Vice-Chairman (in case of the absence of the Chairman) conducts the following:

(A) To call the Council meeting, and to supervise the agenda.
(B) To supervise the office and give the necessary instructions.
(C) To submit the Council budget proposals to the Prime Minister.

(D) To sign all the decisions taken by the Council, and refer them to those concerned.

Article 13 - The Council holds one ordinary meeting each month. It may be called for more meetings if found necessary.

Article 14 - The meeting is considered legal when more than half the members are present.

Article 15 - Decisions are taken by absolute majority of the members present. In case of equal votes, the Chairman tips the scale.

Article 16 - The decisions become effective after approval by the Chairman. The minutes of the meetings are recorded in a special book. The Council approves the minutes of the previous session and the Chairman signs it.

Article 17 - The Council can accept contributions and aid from any source after the approval of the Council of Ministers.

The following amendments were later added:

Article 1 - This is called the amended act of the Jordan Research Council act for the year 1966. This is to be read with the act of the Jordan Research Council for 1964 as part of it; it is applicable upon publication in the official gazette.

Article 2 - Article 4 is to be amended by the addition of the following two paragraphs B and C, and considering the original article 4 as para. A:

(B) Loss of membership in the Jordan Research Council is effective through:
   1. Death.
   2. Resignation, after being accepted by the Council, and approved by the Prime Minister.
   3. Leaving the country for more than three months, except if the Council decides differently.
   4. To be absent for more than three consecutive sessions without any reason acceptable to the Council.

(C) If membership is lost through any of the above reasons, the Council recommends the appointment of a new member from the concerned department in the first session following.

The Council now consists, in addition to the members mentioned under Article 2 of the act, of one representative of each of the following departments:

1. Water resources authority
2. Geological Research Department (Now called Natural Resources Authority)
3. Meteorological Department
4. The Central Co-operative Union
5. The Engineers Union
6. Four members on personal merits.

5. KUWAIT

In the second Meeting on Science Policy and Research Organization we said that Kuwait being a new State, is still a beginner in this field. But, nevertheless, we had some plans and policies for a good start.

In the past three years since that meeting, we came across some successes and disappointments.

In the first instance, the university is starting this fall, but scientific research is not envisaged within the framework of the university for some years to come. In this respect, we feel that a university which confines its activities to instruction alone rather than instruction and research is outmoded and has dropped one of the major fundamental bases which justify its existence as a modern university in this scientific age. I believe that it is rather incomprehensible to shield university students from research and then on graduation start training them in research. Furthermore, where can one hope to find a continuous stream of human scientific potential to do scientific research other than in a university? Coupled with this is the atmosphere of intellectual freedom which prevails or should prevail in the university. All these factors are conducive to productive research in the university.

In the second instance, the Scientific Research Institute which Kuwait is starting in collaboration with the Arabian Oil Company of Japan, in accordance with the provisions of the oil concession to that company, has gone a good step forward. A Board of Directors of six, three representing the Government of Kuwait and three representing the oil company, has been given full powers regarding planning and execution by a special ministerial decree. The building site has been allocated and the Board now is deliberating the submitted building plans. The Institute will engage in three main branches of research: petroleum and petrochemistry, marine biology and arid-zone agriculture. There are some differences of opinion between us and the Japanese members on certain aspects of this Institute, but we have confidence that these could be resolved.

The Department of Agriculture and Fisheries is starting in the very near future, with the help of FAO, a survey of the Gulf with a view to promote fisheries research. Next month a conference for the States bordering the Gulf will be held in Kuwait to plan this survey and give it the official sanction of the States concerned. We hope that this survey and the ensuing oceanographical and fisheries research by the Fisheries Department will be tied in with marine biological research of the Research Institute.

In the field of water desalination, Kuwait has done a great deal of research, not of an original or creative nature, but rather of the nature of the application of scientific notions to mass production procedures.

Similarly, there are researches on the effect of the harsh weather of Kuwait, especially sandstorms on dairy milk and cows.

I should like to dwell here on a point which seems not to have been stressed, if at all, by all papers. This is the question of science teaching, which is the first and basic step towards the preparation of researchers. Most papers dealt with the subject of training researchers to do research. This is, needless to say, a necessary prerequisite to any type of research. But I believe that rarely, if ever, did a research planner look into the problem of what science is given and how scientifically it is given to children in their formative years, i.e. in the primary and intermediate stages of schooling. It should never be forgotten that these children are the raw material of future researchers - the child is father to the man. I believe that this subject is of prime importance if we want good quality researchers; because science and scientific research are more of an attitude of the mind than mere technical skill in research procedures or acquisition of a certain volume of factual knowledge. If we are to instill in a young man the right scientific attitude to help him do original creative research, and not merely critical or assessment research, we have to do that in his formative years when he is still a child. Hence, I believe that in planning scientific research, sufficient emphasis should be made on the subject of teaching science -

both curricula and methods - all through the schooling years. It is high time that scientific planning is done from the bottom rather than the top - from the basis rather than the super-structure.

We have done some experimentation in this field in Kuwait. Our syllabuses emphasize the scientific method and way of thinking rather than mere factual knowledge. I believe the results which started to show warrant the experiment. I wonder if it is in order to request Unesco to consider planning a symposium on a regional basis for this subject in Kuwait preferably. If such a meeting materializes, I hope that people like you gentlemen, responsible for scientific research, will attend it, together with science educators.

As we proceeded with this experiment, another problem faced us, viz. the widening gap between the schoolchildren and their parents at home. Some parents started to complain that we are teaching their children heresy and some children began complaining that their parents urged them not to believe a word of the science master. For fear of arousing a divided loyalty problem in the child with all its ensuing complications, psychological and otherwise, we started a popular science programme on television, entitled "Science in our Lives". Its main purpose is to arouse the interest of the general public to the vital rôle which science plays in our lives, in an effort to narrow the gap between parent and boy.

Again, I wish to emphasize that, although the last two points I raised seem to a callous observer to be outside the scope of scientific research organization, they are, on the contrary, of the essence of organizing and planning scientific research, and should be taken seriously in any science policy of the region if we are to forge ahead in this essential and vital field.

6. LEBANON

By virtue of the existence of two old-established universities of higher education, which number has now grown to four, and the creation of research institutes for agriculture, industry and health, research in Lebanon has been a reality for several decades; however, this research has hitherto remained individual, isolated, sporadic and entirely unco-ordinated.

The development of a science policy which would have a co-ordinating influence on scientific research and guide it to contribute to the harmonious development of the city dates from the first meeting organized by Unesco, at Cairo, for the purpose of examining the usefulness and the possibilities of such a policy for the countries of the Middle East.

The Government of Lebanon decided from then onwards to keep firmly to this path, and requested the assistance of Unesco in formulating such a policy and organizing its implementation.

In conjunction with the Scientific Commission for the Lebanon, which was set up for the purpose, Mr. de Hemptinne, whom we are happy to welcome here as the Representative of the Director-General of Unesco, and to whom we offer our thanks for his enlightened assistance which communicated itself to his collaborators, drafted a basic policy report and a proposal for the creation of an organization for planning and co-ordinating research.

Drawing its inspiration from this proposal, the Lebanese Government adopted and promulgated a legal document which constituted the charter of the organization responsible for science policy in the Lebanon.

INSTITUTIONAL BASIS

By the law dated 14 September 1962, there was created a National Council for Scientific Research whose tasks were: first, to place before the government the broad lines of a science policy aimed at developing scientific research with a view to the optimum utilization of the scientific resources of the country in the general interest; next, to work out the details for executing this policy within the framework of a five-year plan; and finally, to carry out executive functions for the promotion of research.

The Statutes of this Council are characterized by the following essential features:

a large measure of administrative and financial autonomy with a posteriori checks,

direct attachment to the President of the Council;

financial resources fixed at not less than 1% of the budget, i.e. about 0.25% of the gross national product;

rôle of adviser to the government planning body, research co-ordinator, and finally, when necessary, executive body for the promotion of research.

ORGANIZATION

The Council has already established its operating regulations: rules of procedure, financial regulations, status of the Council's officers.

As regards the last-mentioned point, the Council has obtained from the government a substantial improvement in the rates of pay for the scientific officers attached to it, thus initiating an up-grading of the research function.

SCIENCE POLICY

The Council has drafted a basic document for presentation to the government, showing the broad lines of the science policy which it proposes should be adopted.

The essential points of this document are as follows:

Conception of the progress of a human society as a whole, in which the intellectual and material components interact and tend to amplify each other;

need to develop research as an end in itself and at the same time a powerful force for economic and social progress;

need for co-operation between all the national bodies concerned, in order to apply this policy and especially to propagate a scientific attitude among the people, so as to ensure the possibility of a wide recruitment for research personnel;
selection of certain general priorities and indication of provisional percentages for allocating funds between fundamental and applied research, and between oriented and non-oriented research, as follows:

Oriented fundamental research:	20%
Non-oriented fundamental research:	5%
Oriented applied research:	60%
Non-oriented applied research:	15%

The conclusions and recommendations of this report are as follows:

In concluding the preceding statement, the National Council for Scientific Research has the honour to request the government to be kind enough to approve the broad lines of the science policy defined above.

The general principles of this policy have already been adopted by the government and sanctioned by the legislative authority in the law dated 14 September 1962.

The ways and means set forth in this report relate to the application of these principles by the general organizations of the State and by the specialized organizations guided and co-ordinated by the National Council for Scientific Research.

With the aim of achieving an overall policy directed towards long-term objectives, the governmental decision should include affirmation of the following essentials:
great stability in conducting this policy and a steady increase in the funds allocated to it;
a unified conception and a close co-ordination of the actions of different public departments and other bodies concerned, resulting from the responsibilities devolving on the National Council for Scientific Research;
a satisfactory status to be granted to qualified research workers, within research units having a national structure;
a high degree of flexibility in conception and execution, in order to take account of the intrinsic nature of scientific research;
the need for very wide international co-operation between Lebanese research and that of all other countries.

ACTIVITIES UNDERTAKEN BY THE COUNCIL

These activities have three objectives:
to train research workers to a high scientific level;
to provide documentary information as a basis for exercising options;
to initiate pilot activities.

Training of research workers

For the last four years, the Council has been awarding annually some 30 fellowships for training abroad, for doctorates or equivalent degrees.

Candidates are selected according to qualifications at the B.Sc. level (licence ès-sciences).

The appropriate period of training appears to be four years, and the cost of the order of 40,000 £L.

This figure should be doubled to allow for failures and wastages.

An essential condition for success is that the research worker should be of high quality; research cannot accept mediocrity.

Preparation of options

An inventory of the scientific potential has been prepared with the help of Unesco.

Two Unesco expert missions have made preliminary reports on the requirements of the country in the field of research and have sketched out the broad lines for a five-year plan of action.

Pilot activities

Applications for grants for research projects have been invited and received from existing research organizations; they number at present over 60.

Research workers have been sent on missions abroad, either to participate in conferences and colloquia, or to undertake research in foreign institutions (France, U.S.A.), or to collaborate in research in nearby countries (Jordan).

EXISTING SPECIALIZED RESEARCH ORGANIZATIONS IN LEBANON

Universities: American, French, the new universities (Lebanese, Arab), have not yet started on research.
Agricultural Research Institute of the Ministry of Agriculture;
Industrial Institute;
Public Health Laboratory;
Ministry of Public Works Laboratory;
Ministry of Water Resources research project on subterranean waters.

RESEARCH EXPENDITURE

The global budgets of these various organizations may be estimated as follows:

	£L.
Universities and foreign institutions:	2,000,000
Lebanese institutions, governmental or para-governmental:	6,000,000
	8,000,000

The National Council for Scientific Research receives, theoretically, 5,000,000£L. a year, but in fact the funds made available to it since its foundation in 1963 do not exceed 8,000,000£L.

As a proportion of the gross national product, which is estimated at 2,500 million £L., this

research expenditure represents: specialized institutions - 0.32%; National Council for Research (theoretical) - 0.2%.

If we exclude the administrative and lateral or non-implemented expenditure, these figures fall to: specialized institutions - 0.15%; Council - 0.5%. Total - 0.20%.

I. RESEARCH STRUCTURES AND RESOURCES IN MOROCCO

Scientific research is conducted:
(A) in the university;
(B) in the research departments of some ministries, having the status of non-autonomous research organizations;
(C) in certain government offices or establishments enjoying financial autonomy;
(D) in certain private organizations.

In practice, the infrastructure required for research exists only for cases A, B and C; in this brief statement we shall leave aside C and D.

A. THE UNIVERSITIES OF MOROCCO

1. The traditional university

This is represented principally by the Quaraouyine at Fez and the Youssoufia at Marrakesh. At this type of university, the language used is Arabic, and the subjects taught are literary, juridical or religious. No scientific research is conducted.

2. The Mohammed V University is the modern university of Morocco. Its Rectorate is at Rabat; it includes the following faculties:
Juridical, Economic and Social Sciences;
Arts and Humanities;
Medicine and Pharmacy;
Methematical, Physical and Natural Sciences;
Mohammadia Engineering School;
Faculty Institutes:
- Institute of Arabization;
- Institute of Political Studies;
- Institute of Sociology;
- Institute of Science.

(a) The Faculty Institutes:

The Institute of Arabization studies the possible ways of giving the Arab language the place it deserves in our country. It is not directly concerned with scientific research.

The Institute of Political Studies is in fact a section of the Faculty of Juridical Sciences.

The Institute of Science, while it has its own premises and its own Director, constitutes a part of the Faculty of Sciences; it will be discussed in the paragraphs dealing with that Faculty.

The Institute of Sociology is the only autonomous institute. Recently inaugurated, it is still caught up in its teaching work.

(b) The Faculties themselves:

The Faculty of Juridical, Economic and Social Sciences. This Faculty has the largest number of students (about 4,500). It includes an Arabic-language division and a French-language division. Its headquarters is at Rabat, but there are units also at Casablanca and at Fez. The research conducted relates to Moroccan affairs, and the results furnish the material for Advanced Studies Diplomas and Doctorates.

The Faculty of Arts and Humanities. This Faculty includes a fairly large Moroccan teaching staff, but they are at present overloaded with the task of training teachers for secondary education; these teaching duties leave little time for research.

The Faculty of Medicine and Pharmacy. This Faculty was created only recently (in 1962); for the time being it is primarily concerned with teaching.

The Faculty of Mathematical, Physical and Natural Sciences. Courses given in the French language, mainly by French teachers, are intended primarily for producing degree-qualified teachers for secondary education. Of the more brilliant graduates, a number stay on in the Faculty of Sciences as assistants and do scientific research in preparation for an Advanced Studies Diploma and subsequently for a doctoral thesis; acquisition of this latter entitles Moroccans to apply for the position of faculty teacher. Most of the theses at present in preparation in the Faculty of Sciences are being supervised by professors residing in France.

The scientific research conducted in the Faculty of Sciences relates to various subjects:

In natural sciences, oriented research is conducted on specifically Moroccan problems (study of the flora and fauna, soil microbiology, regional geological studies, etc.).

In chemistry, fundamental research is being done (on the chemistry of quinones, for example), having no direct relation to the existing industrial chemistry in Morocco.

In physics, while up to the present mainly pure research has been conducted in the Faculty of Sciences (relativity, nuclear physics), it is now planned to establish a laboratory for solid-state physics which should be of great interest to industry; this laboratory will be directed by a young Moroccan professor, a Doctor of Science.

The Institute of Science. This Institute, created in 1920, and at present attached to the Faculty of Sciences, is concerned only with research. It comprises the following divisions: zoology, entomology, phanerogamy, cryptogamy, physical geography, geology, seismology. The scientific research is conducted not only by members of the teaching staff of the Faculties of Sciences and Arts (e.g. geography) but also by non-teaching specialists. This research relates exclusively to Moroccan problems and equipment. The Institute does its best to maintain close relations with other research organizations (National Agricultural Institute, Division of Mines and Geology, etc.).

Mohammadia Engineering School. This college was created recently, for the purpose of providing the trained technical personnel previously non-existent in the country; it devotes itself entirely to this task. Up to the present, no scientific research has been undertaken, but in view of its contacts with industrial circles this college should play an important part in the future in establishing programmes for research applied to industry.

3. Obstacles to the full development of research inside the university

In relation to equipment. The provision of equipment is very uneven; while in some cases it is new and substantial, in many other cases it is out of date and insufficient. Funds have been cut down considerably.

In relation to operation. The reduction of funds compels some laboratories to be satisfied with a mere existence.

In relation to the budget generally. The budget of the university is controlled by the Minister of National Education; this results in a very long drawn-out procedure which may perhaps be satisfactory for the central administration, but which is not adapted to the needs of the faculties.

In relation to staff. Both on the teaching and research sides, there are still a large number of French personnel. There is a high turnover of this personnel. These changes of personnel introduce difficulties for formulating and executing medium-term or long-term research programmes. The replacement of the expatriates by nationals can only take place very slowly; there are two main reasons for this, it would appear. The first reason is the priority given to the training of teachers for secondary education, to satisfy the enormous requirements of the grammar schools and colleges; this means that research is relegated to second place. The second reason is the inadequacy of the emoluments paid to Moroccan teacher/researchers; this has the effect of deterring university people from taking up careers in research, and leads them to prefer more remunerative employment, in offices or in administration. The small number of Moroccan teachers at present in the faculties are mostly preparing theses for the Doctorate, under the guidance of French professors residing in France. This separation gives rise to a certain isolation of the Moroccan research workers. In addition, the latter are very fully occupied by their teaching work and other responsibilities, thus their conditions are far from being ideal for the satisfactory accomplishment of their research.

B. THE RESEARCH DEPARTMENTS OF THE MINISTRIES

These will be reviewed rapidly. A detailed study will be found in a document issued by Unesco (UNESCO/PEAT/MOR/SP).

Division of Mines and Geology. This comes under the Ministry of Industry and Mines. Very active, and having a substantial budget, this Division has one section for geological cartography and one section for research on mineral deposits. It has well equipped laboratories and qualified personnel, and very important results are obtained.

Institute of Marine Fisheries. This comes under the same ministry. Situated at Casablanca, this Institute is destined to play a big part in a country where fisheries have great economic importance, provided it is given adequate funds and more staff.

National Institute for Agricultural Research. This comes under the Ministry of Agriculture. The structure of the Institute comprises central and regional units. It is soon to house an important agricultural college.

The rôle of this Institute is extremely important in a country where agriculture takes the first place.

The Institute of Hygiene. This comes under the Ministry of Health, and is directed by the Dean of

the Faculty of Medicine. Being used both for teaching and for inspection purposes, the Institute is at present overloaded with routine work. However, given satisfactory equipment and a better definition of its duties, this Institute could nevertheless develop its research activities.

C. RESEARCH DEPARTMENTS OF STATE OFFICES

The Chérifien Office of Phosphates. Morocco, with a production of 10 million tons a year, is the world's second largest producer and leading exporter of phosphates. By virtue of the size of its financial means and its infrastructure, this Office is able to play a major part in conducting programmes of applied research.

The Office of Mining Research and Activities. This Office has close relations with the Division of Mines and Geology and with the Chérifien Office of Phosphates. It conducts mineralogical and mining investigations and has a research laboratory for mineral processing. It has a well-trained corps of Moroccan engineers and technicians.

Office of Agricultural Development. This Office has substantial means, and should play a leading part in applied agricultural research. If the overlapping between its duties and those of the National Institute for Agricultural Research can be completely eliminated and if relations with the Faculty of Sciences can be strengthened, this Office can become one of the pillars of a programme of applied research.

Co-ordination of research activities: University Centre for Scientific Research. This Centre was established in 1962, with the duty of co-ordinating research activities in Morocco. It comprises a Publications Department and four Research Divisions (Social Sciences, Historical Sciences, Geography, Islamic Sciences). Since its creation, however, the University Centre for Scientific Research has encountered a number of difficulties which have not yet been overcome:

its organization and operation are controlled by provisional legal texts;
its budget is provided largely out of the budgets of the faculties;
it does not have a sufficient number of staff.

The University Centre for Scientific Research has been the subject of two detailed studies by Unesco experts (UNESCO/NS/ROU/18 rev.1 and UNESCO/NS/ROU/MAROC/1).

II. CONCLUSIONS

As will have been seen from the foregoing statement, Morocco is endowed with numerous and varied structures in the sphere of scientific research. Important practical results have already been achieved (particularly in the field of mining and geology). While some of the organizations have adequate budget and staff, others find the development of their activities inhibited by a number of obstacles, of which the main ones are as follows:

the frequent structure and replacement of expatriate staff, and the difficulty of replacing them quickly by nationals;
insufficient funds;
the absence of a definite science policy at the national level.

An improvement of the present situation could thus be obtained by:

increasing the number of Moroccan research workers; this in turn involves:
- increasing the number of university diplomas;
- upgrading the function of post-secondary teaching;
- an information campaign addressed to students, in order to stimulate their sense of vocation;

increasing the funds provided for the under-endowed research organizations;
making an inventory of the scientific potential, and co-ordinating the research activities of the existing organizations;
formulating research programmes in the light of the country's needs, but nevertheless, without eliminating fundamental research.

To overcome the above-mentioned obstacles it will be necessary:

to provide more funds;
to upgrade the functions of post-secondary teaching and research;
to establish closer contacts between the university and the other research organizations, in order to make possible the formulation of research programmes and the formation of teams working on a limited number of subjects but aiming at the solution of concrete problems.

It may be mentioned that there was recently established within the Ministry of National Education an Office of Cultural Activities and Research, whose task it is to sort out the problems of higher education.

8. SAUDI ARABIA

INTRODUCTION

Although the Kingdom of Saudi Arabia did not participate in the two previous meetings which were held at Cairo in December 1960 and at Beirut in May 1963, for Science Policy and Research Organization in the Countries of North Africa and the Middle East, the Kingdom of Saudi Arabia was following all the decisions and recommendations undertaken at those two meetings.

The Kingdom of Saudi Arabia took part at the fifth regional meeting for the National Arab Committees which was held at Kuwait and which was sponsored by Unesco on 19-22 February 1966. At that meeting the Kingdom of Saudi Arabia participated in the studies on the Scientific and Technical Planning (Policy) and Technical Vocational Training issue in the countries of the Middle East and North Africa.

The Kingdom agreed on all the decisions and recommendations reached at that meeting; these recommendations and decisions will be pointed out later.

The Kingdom of Saudi Arabia takes a great part in developing and promoting the present scientific institution and organization in the Kingdom, especially those institutions and organizations that are in the process of being established or those that have been already established lately; a detailed discussion on those institutions and organizations will follow later in this report.

RECOMMENDATIONS OF THE FIFTH REGIONAL MEETING

The following recommendations were among those reached at the fifth regional meeting for the National Arab Committees held at Kuwait from 19 to 22 February 1966.

1. It was recommended that the Governments of the Arab States pay considerable attention to the scientific surveying of its present and anticipated natural resources and manpower.
2. It was recommended to prepare special studies on the scientific planning for the necessary manpower, for the programmes concerned with development and promotion in those Arab countries.
3. It was recommended that the Arab States should link its sciences and scientific researches at its universities with those projects concerned with scientific promotion and development.
4. It was recommended that a special fund be created to finance the establishment of research centres to study the main problems that are faced by the Arab States and especially the issues on desalting sea water economically, and also the studies on petroleum and its by-products.
5. It was recommended to improve aquifer and its quality in remote areas.

These recommendations that were reached at the fifth regional meeting were actually dealt with by Saudi Arabia long ago; this will be clear when discussing what the ministries in Saudi Arabia have accomplished. Here we are referring to ministries which deal with promotional and developing activities, ministries such as the Ministry of Petroleum and Mineral Resources, the Ministry of Agriculture and the Ministry of Education and also the scientific institutions and organizations such as Riyadh University, the College of Engineering and the College of Petroleum and Minerals, the commercial agencies such as the Saudi Arabian Monetary Agency, the General Petroleum and Mineral Organization.

The Kingdom of Saudi Arabia with the help of the United Nations aims to expand in establishing, developing industrial programmes and also technical and vocational institutions in the Kingdom.

THE ACTIVITIES OF THE SAUDI ARABIAN MINISTRIES AND ORGANIZATIONS

The Ministry of Petroleum and Mineral Resources

The Ministry of Petroleum and Mineral Resources of the Kingdom of Saudi Arabia is conducting different

researches and projects and initiating different studies which aim at developing the petroleum and mineral industry.

An example of that is the utilization of the most modern techniques for the establishment of the National Geodetic Net of Saudi Arabia. This very huge project will be supplemented by other projects such as the Aerial Triangulation, Airborne Profile Recorder, aerial photography. The object of these projects will be the production of topographic maps needed for several vital projects such as mineral exploration, highway engineering, irrigation, town planning and military operations.

The Ministry of Petroleum and Mineral Resources established the General Petroleum and Mineral Organization in order to develop the field of industry in the Kingdom of Saudi Arabia and especially the petroleum and minerals industry.

In order to do that the Ministry of Petroleum and Mineral Resources also issued a special mining code in order to exploit the natural resources economically for the purpose of creating new industry to fulfil the needs of the Saudi Arabian markets. By doing this the Kingdom of Saudi Arabia is following the process of industrial diversification in the petroleum and minerals industry in order to develop the Saudi Arabian economy as a whole.

The General Petroleum and Minerals Organization

The statutes for the General Petroleum and Minerals Organization was issued under the Royal Decree no. 25, dated 22 November 1962.

Objectives and functions of the Organization:

1. Conduct, on its own or through others, theoretical and practical studies and research relating to petroleum and minerals.
2. Co-operation with private organizations and companies carrying on petroleum and mineral activities, with the purpose of facilitating prospecting exploration, and exploitation operations, including distribution or marketing.
3. Conduct, on its own or through others, such operations as the State may entrust to it in (the field of) searching for production, refining, purchasing, selling, transporting, distributing and marketing petroleum and mineral substantial whether inside or outside the Kingdom of Saudi Arabia.
4. Establishing, either inside or outside the Kingdom, companies or enterprises in whose capitel it will participate, with the purpose of engaging in all phases of the industry of petroleum and minerals, and their derivatives and by-products, and of trading in, transporting, selling, distributing and marketing them.
5. Invest its funds in securities pertaining to objectives similar to its own.

The General Petroleum and Mineral Organization already established the Arabian Drilling Company, the Arabian Fertilizers Company (SAFCO) and a steel and iron factory and also a petroleum refinery in Jeddah.

The General Petroleum and Minerals Organization participates in all phases of commerce related to the petroleum and minerals industry with other private organizations with 51% of the capital of all these organizations and corporations that were established and those that will be establish d in the future.

College of Petroleum and Minerals

This College was established under the Royal Decree no. 397 dated 23 September 1963. The following were among its functions:

1. The College shall undertake all that is related to various petroleum and mineral studies.
2. The College shall endeavour to promote petroleum and mineral knowledge in the Kingdom of Saudi Arabia and provide it with experts in the different branches of petroleum and mineral industry.

This College is an example of the Scientific Research Centre that the fifth regional meeting asked to establish in each Arab State.

The Saudi Arabian Monetary Agency

The Saudi Arabian Monetary Agency devotes cash rewards for those experts that prepare outstanding reports on areas such as economics, money, banking, finance and commerce.

This idea has succeeded lately in the Kingdom when several economists and financial experts submitted a good number of reports, the thesis of which was:

(a) The best alternative to reach for an economic development in Saudi Arabia.
(b) The best methods to endeavour the promotion of thrift knowledge among Saudi Arabian people and the encouragement of savings.

The Saudi Arabian Monetary Agency also issues an annual booklet which deals with a specific economic and scientific subject each year.

The College of Engineering

The College of Engineering was established in 1962 as a joint project of the Saudi Arabian Government and the United Nations Special Fund, acting through Unesco.

After successful completion of five years, the College will be handed over to the government.

The College of Engineering offers courses leading to the degree of Bachelor of Science in the following: civil engineering, mechanical engineering, electrical engineering. The curricula of the College provide thorough training in mathematics, the physical sciences, engineering. Principles of application of these fundamentals to problems encountered in engineering practice.

The Central Planning Organization

The Central Planning Organization was established under Royal Decree no. 19 in 1964. Its main functions and objectives are as follows:

1. The issuance of a periodic economic report which contains an economic analysis and also the progress that the Kingdom achieved in the area.
2. The preparation of an economic development plan for the Kingdom of which the first plan should be for a period of five years.
3. To assist the different ministries and government agencies in the related area of planning.

Technical Education in the Kingdom of Saudi Arabia

1. Eight industrial schools were established between the years 1947 and 1960.
2. Five agricultural schools were established during the year 1960, with an enrolment of 522 students.
3. And during the same year, four schools of commerce were established with an enrolment of 808 students.

The scale of teaching in these technical schools:
(a) The industrial education: four years following elementary stage and three years after the intermediate for the secondary industry.
(b) Agricultural schools: four years following the elementary stage in all agricultural schools.
(c) Commerce schools: four years also following the elementary stage.

The Kingdom of Saudi Arabia had a budget amounting to two thousand million Riyals in the year 1965 for projects only. This is a good indication of industrialization and science in the Kingdom of Saudi Arabia. The Ministry of Education initiated a six-year project in 1965 in order to reinforce the industrial and scientific awakening in the Kingdom of Saudi Arabia. This six-year project is summarized as follows:
1. Work for the amendment of the scale of industrial education and to review the trades taught in these schools.
2. The formation of a national, technically competent teaching force.
3. Preparation of technical books and building up the technical references at these schools.
4. Providing the different workshops with equipment and instruments, and with technological laboratories as well as reviewing the condition of the present building for these schools.
5. Solving the financial problems and establishing the administrative body.

The Ministry of Education has started to deal with these problems following the extensive study and discussion with a large number of international experts. The Ministry invited four experts from three different European countries to define these problems. The Ministry concentrates its efforts on the following:
1. Development of the already existing industrial schools.
2. Preparation for opening the Royal Vocational Institute in Riyadh.
3. Development of industrial education and opening up of new schools.

The Ministry of Education has also worked out to prepare academically competent teachers by:
1. Raising the standards of national teachers working in the industrial schools.
2. Giving scholarships to the graduates of industrial schools in order to cover part of the existing shortage.
3. Working to create a teacher's institute to prepare industrial teachers for the Kingdom.

Research and Industrial Development Center

Under special provision granted by the Council of Ministers an agreement was signed with the United Nations Special Fund for the establishment of a Research and Industrial Development Center in the Kingdom of Saudi Arabia.

Under this agreement the Government of Saudi Arabia will co-operate with the United Nations Special Fund in financing and supervising the establishment of this Center.

One of the main purposes of establishing such a Center is to create a scientific body to be concerned with the studies and research related to the industrial development, and also for the purpose of presenting and offering advice and recommendation in those related areas.

At the present time, the concerned authorities which in this case is the Ministry of Commerce and Industry in the Kingdom, are in the process of staffing this Center with national and foreign experts.

The Ministry of Commerce and Industry is planning to establish three industrial centres in the industrial areas at Jeddah, Dammam and Riyadh.

The Ministry of Commerce and Industry signed an agreement with associate consulting engineers of Pakistan to accomplish this purpose.

The agreement calls for the economic and technical benefits on the part of the Pakistani consulting firm and also the preparation of the designs, models and necessary maps for the construction stage of this project.

The construction of the industrial centre in Jeddah will follow the selection of a suitable area for this purpose, under the supervision of the United Nations experts as part of the agreement signed between the government and the United Nations Special Fund.

The Kingdom of Saudi Arabia appreciates very much the services and assistance rendered by Unesco for the development of the science policy and research organization.

The Kingdom of Saudi Arabia is, through its different ministries and governmental agencies, making great plans to accomplish these scientific and research goals, and our government would like to thank Unesco for its generous invitation as well as the participants at this Meeting.

Thank you and God bless you.

9. SUDAN

A. INTRODUCTION

The history of scientific research in the Sudan dates as far back as the organization of the civil service in its present form in the early days of 1900. The need of the civil service for information, relating to a proper scientific definition of the environment, was and still is the major spur behind the research activity. Like in all developing countries, we have concerned ourselves mainly with the acquisition of pertinent results of fundamental research carried out in the affluent societies, the modification of the information gained and the dissemination of useful data to the citizens. Thus the start of research in the Sudan has taken the meaning of acquisition of knowledge of a practical nature in relation to its immediate benefit to the country. During the course of such research activity through the last 60 years, a number of fundamental facts have also been discovered, together with new and novel ideas resulting from applied research. Research in its fundamental sense that is the advancement of frontiers of knowledge is given much emphasis by the institutions of higher learning in the country.

The environment has naturally dictated the fields of such research activity and it is thus not surprising that research in the Sudan has taken a well-known bias towards agriculture, and animal wealth. Thus agricultural and veterinary research represent the oldest disciplines which were encouraged and nourished by the government.

In so far as the health of the population affects the productivity of the individual and thus the gross national yield, an early start in routine medical activity was undertaken and because of the specific medical problems posed by a country of different climatic conditions, wide distribution of flora and fauna and the consequences that they have on the health of the population; medical research likewise found an early start.

Thus the three main areas of research, that is agricultural, veterinary and medical research, have grown side by side with the growth of these essential services. One characteristic, however, is that they remained as an integral part of the departments to which they belong. This was necessitated by the fact that these research units within each ministry provided and still provide vital information necessary for carrying out essential services and that they are being partly used to carry out investigations of routine nature. These two facts, however, are limiting the time devoted for carrying out original research or research necessary to further the aims and objects of the ministries themselves.

B. AGRICULTURAL RESEARCH

To review the amount of agricultural research work that has been done and is being done in the Sudan satisfactorily, is, I am afraid, beyond the scope of this short paper. Fortunately, however, the results of such research have been published, in part, in some of the scientific journals and in the annual reports of the Ministry of Agriculture. However, a vast amount of information gained has remained unpublished.

The work is carried mainly by the Research Division in the Ministry of Agriculture. At its inception at the beginning of the century, the need was for definition of the environment in scientific terms. This included the collection of information on geology and soils, the flora and fauna of the country, and the interpretation of traditional experience of cultivators.

The early experiments concentrated on important food crops and their production. The importance of cotton as a cash crop emerged, and by 1925 the experimentation on cotton cultivation dominated the research activity of the department of agriculture. With increase in the area under cotton cultivation, and the increase in its importance, agricultural research on cotton was given the highest priority as it has since become the major and, perhaps, the only cash crop in the Sudan.

The dependence of the country on cotton, however successful it had been, posed the importance

of diversification of research into other areas of crop production. This necessitated research on a wide variety of crops ranging from tropical plantation crops to, e.g. tea to temperate field crops, like wheat. To this end, research was given the following emphasis:

(a) The scientific definition of the environment concerned;
(b) the interaction of particular crops with environment; and
(c) the adjustment of environmental conditions to improve crop production.

With this end in view, a large number of surveys are being carried out with a view to better knowledge of the environment. Further crop production is being improved by testing a range of varieties and agricultural practice in field experiments. This, however, does not exclude research in introduction of new varieties or new practices arrived at through original research.

While research on a single agricultural product aims at production of the highest yield, it is becoming increasingly important to look on farm production as a whole. Production of cash, food and fodder crops is being integrated into the farming system in order to ensure the maximum and most efficient use of the land and other resources, and this is providing fertile and useful grounds for both original and applied research.

Whereas the agricultural research carried out under the auspices of the Ministry of Agriculture, dealt mainly with applied research, fundamental research in agriculture and in the tropical disciplines in general is being carried out in the scientific faculties of the University of Khartoum, mainly the Faculty of Agriculture.

Development and organization in agricultural research

Most of the agricultural research in the Sudan has been carried out by the Research Division in the Ministry of Agriculture; but this by no means is the only such institution of its kind in the Sudan.

The first organized research in the Sudan was undertaken in the Wellcome Tropical Laboratories established in 1903. The work included chemical, medical and entomological research work related to agriculture. In 1904, an agricultural research station was started in Shambat for agronomic and botanical research work. Work in the station was concerned mainly with routine analysis of soil, its identification and classification; identification and classification of plants, study of pests and diseases and their casual organisms, both for crops and livestock. A number of crops were tried and sample experiments were made on cultivation, irrigation and cultivation of selected crops, especially wheat and cotton.

In the early thirties, the Gezira Research Farm, established in 1919, became the Gezira Research Station and was and still is in the headquarters of Agriculture Research in the Sudan.

There are five principal sections; these are:

1. Soil service.
2. Agronomy and plant physiology.
3. Botany and plant pathology.
4. Entomology.
5. Cotton and plant breeding.

These five departments are integrated under a Director of Research and co-operating closely with each other. There are the usual facilities for any modern research station and the division has an excellent library.

The Gezira Research Station now functions as the headquarters of the Research Division of the Ministry of Agriculture. Its other function is mainly administrative, but has final say in all research matters. Other regional sub-stations have their senior scientific officers, answerable to the Chief of the Research Division. The chiefs of sections in the Agricultural Research Division also act as consultants for work on their discipline in the regional or sub-stations.

Other selected research stations of the Ministry of Agriculture

There are about 11 research stations, some of these are:

1. Kadugli Research Station

It is a cotton-breeding and entomological research station, opened specifically to cater for the needs of rain-grown cotton.

2. Yambio Research Station

Located in the southern Sudan, with the emphasis on agro-ecological agronomy, soil and entomological research work. Work has been done on a range of crops including cotton. It has also taken an interest in other crops besides cotton, mainly coffee, tea and cocoa.

3. Kenana Research Station

As a result of the war, efforts were made for production of local food crops and other local products. Measures were taken at the time of the war to ensure adequate supply of staple crop millet (Dura). The station was run mainly to experiment with mechanical crop production. This opened the way for the tremendous possibilities and potentialities for agricultural developments in the central rain-lands. The station also carried agro-ecological, agronomic, soil, plant breeding, plant pathological and entomological research on a number of important crops. All its activities were geared to mechanized farming.

The buildings of the new dam at "Roseires" has given new emphasis to the station and makes it possible to irrigate some of the rain-lands for which the station was originally designed to serve. Its activities have spread over a much greater field and it was found necessary to move the station much nearer the river. Its laboratories are now fully equipped with all sections including units of agronomy,

botany, chemistry, plant pathology and entomology. The findings should be of the greatest importance to a large area of the Sudan.

4. Hudeiba Research Station
In the northern province, research is carried out under units of agronomy, chemistry, plant breeding, plant pathology, entomology and on the soils and crops of the region.

5. Two research stations are planned, one for Kordofan (western Sudan), for American cotton, and another in the southern Sudan as a rice research unit.

Like all developing countries, the Sudan has received assistance from outside bodies, either national or international. Such aid has always gone to financing or assisting investigations based on country-wide surveys. These investigations have called for employment of personnel and use of equipment not found locally and which had to be contracted to outside bodies.

Such investigations dealt with water storage (dams, e.g. Roseires and Jongroli project in the Upper Nile, collection of data on the agricultural environment, crop and animal husbandry practices of selected regions, soil survey projects, hydrobiological and ecological surveys, e.g. the Jebel Murra and Kordofan projects). These surveys are being largely financed through bilateral agreements or by the United Nations or one of its agencies.

In addition to research carried out in the Sudan by national research units, research contributions to agriculture in the Sudan have been made from time to time, by academic institutions abroad, e.g. the Rothamsted Experimental Station in England, the Tropical Research Institute, "U.K.". In conjunction with this station, outstanding agronomic research has been carried out.

The planning and organization of agricultural research

Finally, a word must be said about planning of agricultural research and its organization.

With such diversity in agricultural research, the need for co-ordination naturally becomes manifest. Regular meetings and standing committees have achieved a certain measure of co-ordination, but since these committees do not possess any executive power much remains to be desired.

The most important committee is the Advisory Committee on Agricultural Research which enjoys the membership of eminent scientists from inside the country and prominent foreign scientists. It meets every two years. The present committee has experts in agriculture and its services, forestry, horticulture, agricultural engineering, animal husbandry and agricultural economics. It has representation from Egypt, Germany, U.S.A., Britain and India. The formal meetings are held in Khartoum under the chairmanship of the Director of the Ministry of Agriculture, and is attended by senior representatives from the Ministry of Irrigation, Animal Resources, Finance, the Sudan Gezira Board, the Cotton Growers Association, the Faculty of Agriculture of the University of Khartoum, the Rural Water Supply and Development Corporation, the Department of Forestry, the Department of Meteorology and Research Division.

The committee reviews reports, research programmes of all stations and sub-stations. It then advises on new lines of research in the light of problems to be solved and advises on training of personnel. It is not within the terms of reference of this committee to co-ordinate research, but its function here is only in its advisory capacity.

However, in working forward to a comprehensive research service there is an obvious need for greater co-ordination and it is envisaged that in future a more effective administrative machinery is necessary to bring this co-ordination. It has already been suggested that this may be admirably achieved by creation of an agricultural research council. This, together with associated scientific and specialized councils, will be amplified later in the paper.

C. MEDICAL RESEARCH

In view of the vastness of the country and the differences in climatic conditions, it becomes imperative that the distribution and nature of disease should differ from region to region. This, coupled with the fact that the majority of the people of the Sudan are nomadic, makes medical care in its broadest sense difficult and expensive. This is more so in relation to control and the preventive side of medicine.

None the less, a start was made as early as 1903, when the Wellcome Tropical Research Laboratories were inaugurated. The aims of the Tropical Research Laboratories were:

(a) to promote technical education;
(b) to promote the bacteriological and physiological studies of tropical diseases, especially the infective diseases of both man and beast peculiar to the Sudan, and to render assistance to the officers of health, and to the clinics of hospitals;
(c) to aid experimental investigations in poisoning cases by the detection and experimental determination of toxic agents;
(d) to carry out such chemical and bacteriological tests in connexion with water, food stuffs and health and sanitary matters as may be found desirable;
(e) to undertake the testing and assaying of agricultural, mineral and other substances of practical interest in the industrial development of the Sudan.

These research laboratories specialized in bacteriology, pathology, chemistry and antomology.

Much time was then devoted to identification of pests, e.g. mosquitoes, sand flies and early attempts were made at the control of locusts.

With increase in services offered by the various government ministries, the work undertaken by the Wellcome Research Laboratories expanded to the extent that it was necessary to split the Wellcome Research Laboratories. Some of the sections served the Ministry of Agriculture, others the Sudan Medical Service and others the Geological Survey.

In 1928, the Stack Medical Research Laboratories were built. The function of these may be classified under three main headings:

1. Research

Research work in the Stack Laboratories is of a practical nature and has always been initiated as definite problems connected with endemic diseases. Ad hoc research is carried out as and when required to reveal the cause of an epidemic or to help control measures. Research work carried in the last quarter of the century includes research on malaria, Kalazar yellow fever, relapsing fever, schistosomiasis and other related subjects.

2. Routine activities

These may be divided into two:
(a) routine examination of specimens;
(b) preparation of vaccines.

Routine specimens are sent in from all parts of the Sudan. They include tumours for histopathology, brains for rabies, bloods and the like for culture or biochemical tests. They are characterized by their diverse nature and purpose of examination. A recent feature is the large and steady increase in the number of specimens sent for examination. Although such increase is gratifying, there seems to be a certain risk in allowing it to choke the essential research activities of the laboratories.

The vaccines prepared in the Stack Laboratories are small-pox vaccine, anti-rabic vaccine, cholera and T.A.B. vaccines. In the past these vaccines used to be imported from abroad at a high cost. Moreover, most of them suffered on the way during transport, and by the time they reached the country, they were either completely useless or only of very poor potency. The vaccines produced locally have the double advantage of being both potent and cheap.

The Wellcome Research Laboratories continued to serve as a chemical section under the government analyst. The work of the Chemical Laboratory may be classified as follows:
(a) Examination and analysis of goods and materials for government departments and other establishments for quality control and to ascertain whether they fulfil specifications and other requirements.
(b) Work in connexion with public health administration, e.g. with regard to foods, waters, effluents and economic poisons;
(c) Penal Code analysis for detection of adulteration, false description and labelling and fitness for public sale and human consumption.
(d) Forensic work in connexion with criminal investigation.
(e) Examination of agricultural materials and products.
(f) Information and advice of a chemical nature, e.g. laws and regulations for drug control; excise and food standards; advice on specifications and standards for materials and goods, etc.
(g) Research, separately or in conjunction with other government and academic scientific establishments, and the examination of products and processes which are or may be of economic or social importance to the country.
(h) Training and instruction of technicians for various government and semi-government departments.

D. THE INDUSTRIAL RESEARCH INSTITUTE

In view of the need of the country to foster the well-being of its people and in order to further its economic prosperity by bringing more natural resources in utility for the home market and for export abroad, it was necessary to foster industrial research. The aim is twofold. One is to achieve a certain measure of self-sufficiency. The other is to increase the country's export trade by the processing, even to primary condition, of natural products which are likely to have a receptive market abroad. With the sponsorship of the Special Fund, the country is now in the process of establishing an industrial research institute, the primary aims of which are:
1. To encourage industrialization by giving advice to prospective investors.
2. To serve as a means for quality control and to lay minimum specifications for commodities that would guarantee its suitability to the home market and abroad.
3. To carry out research in methods that guarantee quality, economy of production and increasing utility of the natural resources of the country.
4. To foster training of personnel to achieve the purposes for which the Institute is set up.

E. ACADEMIC RESEARCH

The above remarks dealt with research in the applied fields with solid economic objectives. Research has, of course, a much more fundamental aspect - the measure of knowledge for its own sake. No seat of learning can ignore this and must not only keep up to date with it, but also participate in it.

For the Sudan, there is a fully-fledged university, with 60 separate departments in nine faculties.

This has opened up the way for fundamental research in the Sudan, and with an increasing number of Sudanese graduates taking higher degrees, academic as well as applied research will be done in ever increasing amounts.

Apart from the departmental research, there is incorporated within the university four research units which are engaged in applied research, namely:

1. The Hydrobiological Research Unit.
2. The Arid Zone Research Unit.
3. The Building Research Station.
4. The Sudan Unit for Research in Social Studies.

A good deal of the activity in research incorporates, in many disciplines, field experiments, the results of which are being used increasingly to illustrate relevant scientific facts. In this way, a thorough knowledge of our environment is being integrated in our teaching curricula and will certainly serve as a basis for applied research in the future. Research in the university leads towards the normal post-graduate qualification, i.e. Ph.D. or M.Sc. Such activity has been established for some time, thus making the university a seat of learning and training of personnel required to serve the need of the country. This, as has already been mentioned, gives a feedback from research into syllabuses and teaching curricula. To enhance this, the university has now made plans for award of external post-graduate degrees on work carried out in the field (in viz. medical, agricultural, veterinary, natural, social sciences, etc.). Such work must of course be carefully supervised by a university professor and a qualified member of staff in the civil service. In this, more and more information relating to the country is brought to light.

F. VETERINARY RESEARCH

The nucleus of research in the fields of veterinary sciences could be traced back to the year 1913. At that time, research was directed towards elucidation of facts concerning the identity of diseases affecting livestock. As it happened the etiology of many diseases was uncovered. Early in the twenties, research efforts were directed towards development of adequate control procedures in order to stop the extensive losses. In a period of approximately 20 years, the achievements of research had adequately contributed towards fulfilment of its goals.

For the past 20 or 25 years, veterinary research continued to be directed towards protection of livestock from devastating epidemics to ensure survival of livestock while some efforts were made in quality improvement.

The history of veterinary research in the Sudan found its way to documentation in the various annual and special departmental reports, local publications, in addition to a stock of over 200 articles in scientific journals.

The research projects presently considered by the Ministry of Animal Resources are designed to serve the economic development of the country. The plans aim at critical evaluation of the currently used methods and their improvement, investigation into the potential qualities of livestock in order to augment them and finally the overall stepping up quantitatively and qualitatively of livestock and their products. Such plans closely follow and serve the government policy which realize the value of the vast potential in animal wealth and works consciously for its development. No doubt they also meet an international move toward increased food production.

The research division within the Ministry of Animal Resources comprises a number of departments dealing with bacteriology, virology, entomology, parasitology, pathology and biological products, biochemistry and includes a unit financed by the Special Fund for research in pleuropneumonia. In addition, the Ministry has specialized units engaged in research in animal breeding, pasture and livestock production and hydrobiological research. Remoteness of some of the cattle-breeding areas has necessitated the services of mobile laboratories. These, coupled with modest extension services, hope to give some quick results in relation to utilization of existing animal wealth.

Perhaps one of the most important fields of activity of veterinary research is the preparation of vaccines and other biological products aimed primarily at the eradication of disease. It is envisaged that in future the restrictions which have for some time stood against exploitation of a potential source of wealth could be removed. Efforts in this direction are already under way and the government has in more than one occasion indicated its readiness to make available all possible facilities in terms of equipment, international experts and personnel.

However, the research division itself has a very ambitious programme of training personnel both in its own laboratories and by scholarships and fellowships overseas.

G. FUTURE DEVELOPMENTS

The research organizations mentioned above remain to a large extent semi-autonomous units within government ministries or departments. Almost all of the organizations are entrusted with some routine work that at times tends to grow over their original function of research. This has been particularly encountered in the field of medical research where routine is taking an ever increasing rôle over fundamental or applied research. Further, any co-ordination between these organizations if not incidental, is lacking. Lately, attention has been drawn to the possibility of co-ordination of all research activity under one central council to be called the National Research Council. It is envisaged that it is to be independent of any ministry, falling directly under the Council of Ministers. Under the National Research Council are to be

created four research councils, one medical, one for agriculture, one for veterinary research and the fourth to be known as the Science Research Council.

Each specialized council will have its separate departments. The Science Research Council will cater for the physical and biological sciences (pure and applied), the Industrial Research Institute, and will have under its control research departments concerned with mineral wealth and nature conservancy.

It is also envisaged to establish a Documentation and Information Centre with the usual library and reproduction facilities which would also serve as a national depository for matters pertaining to scientific development.

These plans are now before the Council of Ministers and it is hoped that when the plans are approved a more thorough and comprehensive note embodying the constitution, functions and organization of the proposed council will be available to those interested.

It emerges, from an examination of the status of scientific research in Tunisia, that research is centred in the University of Tunis (Faculty of Science, Faculty of Medicine) and the higher educational establishments (Agricultural College, Tunis), on the one hand, and in the technical departments (agriculture, public health, atomic energy, industry, etc.), on the other.

One of the principles followed in framing the decree of 31 March 1960, setting up the University of Tunis, was that the closest possible unity should exist between teaching and research.

It is self-evident, in fact, that a higher educational establishment divorced from research is doomed sooner or later to stagnation or even recession.

In order, therefore, to ensure this unity between teaching and research within the university, the administration made provision in the plans for the new university (the construction of which was begun in 1965) for a research unit attached to each science-teaching unit.

Again, while developing the faculties and colleges designed to provide higher education and promote fundamental research in accordance with normal university traditions and along the most liberal lines, the administration made a point of coupling them with the centres in which research work, both theoretical and applied, is subject to the type of guidance and direction which can hardly be imposed within a faculty itself.

The following are a few of the many examples of coupling:

Soil Physics Laboratory with the Centre of Research on the Use of Saline Water;

Faculty of Law and Economic Sciences and Faculty of Arts and Human Sciences with the Centre for Economic and Social Studies;

Faculty of Medicine with the Pasteur Institute, Tunis;

Agricultural College, Tunis, with the Tunisian National Institute for Agronomic Research (INRAT).

The research work conducted in the faculties concerns the exact sciences, the natural sciences and the economic and social sciences alike. As a result of the introduction in October 1962 of special subject certificates in the Faculty of Science, which previously awarded diplômes d'Etudes Supérieures only, it has become possible to engage in an increasing number of research efforts.

The result is that the various university laboratories have been able to provide room for research workers, often operating in teams under the direction of professors, and the initial results can be regarded as promising and as justifying the creation of a Science Faculty Bulletin, the first issues of which are due to appear very shortly.

The subjects studied, while presenting the pure research features characteristic of university work, nevertheless remain capable, especially in the field of natural sciences, of more or less direct practical application.

At the same time, it often happens with applied research of a technical nature, that the technicians from the technical departments are confronted with theoretical problems coming within the province of fundamental research, which is peculiarly that of the research workers at the university and the higher educational establishments.

It is therefore essential that between the applied research centres and the higher educational establishments, there should be close and frequent contacts.

These contacts, which take the form of links between the professors directing the research and their counterparts and colleagues at the applied and technical research centres, have so far made it possible to ensure acceptable de facto co-ordination of the research work undertaken.

Still in connexion with research at the higher educational establishments, it should be noted that the professors at the Agricultural College are engaged in fundamental and applied research work of sufficient importance to warrant the publication by the College of a quarterly bulletin (it has been appearing since 1963).

As regards medical research, Tunisia has much to its credit, thanks to the work of the Pasteur Institute, the results of which are published in the Institute's records.

Since the introduction of the full-time system, doctors are able to engage in medical research in hospital laboratories; and the first signs of the intensification of medical research can already be seen.

The establishment and progressive expansion of the Faculty of Medicine since 1963 has enabled close links to be forged between advanced medical training and research, thereby permitting optimum use of existing resources and the reinforcement of the instruction given at the university by the personal research work of the university staff.

As regards the research work done by the technical departments, this was given special attention by the government in connexion with the execution from 1962 onwards of development plans based on ten-year planning.

One consequence of preparing economic development plans has been the identification of the main lines of research and the formulation, on the basis of the plan targets, of research programmes adapted to the problems and future requirements of the various sectors of the national economy (agriculture, industry) with specifications of the time-tables for their execution.

In agriculture, for example, Tunisia already had a research infrastructure which has enabled it to make rapid progress in devising agronomic techniques designed to increase soil productivity.

During the period of the Three-Year Plan, the government very substantially increased its physical potential in agricultural research by enlarging the volume of material and human resources and by diversifying the programmes.

The programming of agricultural research is effected on the basis of the following objectives flowing from the National Plan for Agricultural Development:

(a) To ensure Tunisia's self-sufficiency in food by intensifying basic agricultural production and progressively eliminating traditional techniques.
(b) To provide for the diversification of crops, and to that end:
    to draw up an inventory of plant varieties best calculated to provide maximum resources;
    to increase the productivity of varieties for main crops and grazing;
    to devise the most effective techniques for deriving high profits from new investments.
(c) To take account of the growing importance of irrigation.
(d) To ensure the continuous integration of agriculture in a market economy by reducing the production costs of agricultural products.

The Tunisian National Institute for Agronomic Research has been modernized, in this connexion, and equipped with new laboratories enabling it to extend its activities to bioclimatology, zootechnics and the improvement of industrial and fodder crops.

Similarly, the government has set up a Rural Engineering Research and Experimentation Centre for the purpose of producing improvements in the techniques of water and soil conservation, agricultural hydraulics (irrigation and drainage) and the utilization of farm machinery.

A Forestry Research Centre, set up in 1959, was transformed in 1965 into a Reforestation Institute, administered in co-operation with the United Nations Special Fund and responsible for dealing with all problems of sylviculture in Tunisia and in the Mediterranean Basin.

Mention should also be made of the National Institute for Veterinary Research, which was set up in 1963 and is certain to develop considerably, in view of the important place occupied by stock-breeding in Tunisia's agricultural economy.

The Pedology Laboratory, now converted into a Special Section for Hydrogeology and Pedology (SSHP), has intensified its work considerably during the past few years: apart from making a systematic soil inventory, it conducts research on various problems of pedogenesis (action of gypsum, crusting and salination; hydromorphy; soil amelioration; changes in soils consequent on irrigation).

The Hydraulic Resources Inventory Office (BIRH) was set up many years ago for the purpose of keeping the administration's data concerning the country's water resources up to date.

In view of the capital importance of this inventory for the national programming of national hydraulic development work, the administration has considerably increased the means at the Office's disposal: in addition to a systematic and detailed analysis of water resources, the Office now makes statistical studies of variations in rainfall for the whole of the country and has embarked on a programme of intensive hydrological and hydrogeological experimentation.

Apart from the key establishments, there are various agencies of the administration which contribute to agricultural research in Tunisia: the OMVVM experimental station, at Sidi Thabet, the stockbreeding station at Sidi Thabet, Warning Centre for Parasite Control at Mégrine, the Research Centre for the Utilization of Saline Water for Irrigation (agricultural pilot project in central Tunisia).

To ensure close and systematic co-ordination between the activities of the various organs of agricultural research, the implementation of integrated or co-ordinated interdisciplinary programmes of agricultural research and the selection of priorities in accordance with the country's real needs, the Department of Agriculture has set up an administrative body known as the Agricultural Research Section, with the task of ensuring the effective co-ordination of the research, controlling the execution of the set programmes and apportioning the funds required for equipment and operation.

Meanwhile, it was deemed useful, in preparing the plan, to provide for the establishment of a Higher Committee for Agricultural Research,

comprising agricultural research specialists in the various disciplines, the engineers of the Department of Agriculture who apply the research results, the officials responsible for agricultural economy and development, and representatives of the farmers.

Pending the constitution of this Committee (at present proceeding) the Agricultural Research Section acts in its place by arranging for periodical gatherings of research workers, research instructors, the Department's engineers, and specialized farmers.

Thanks to the dissemination of information about the pilot methods through the medium of publications and lectures, systematic and extensive briefings and the rapid incorporation of research results in agricultural teaching programmes, effective links have been developed between instruction, research, development and popularization.

Lastly, mention should be made of the particularly valuable research work done by the Atomic Energy Commissariat, which has set up a well-equipped research centre with a large staff of Tunisian workers.

As regards the training and production of increased numbers of research workers, the government has to pay particular attention to finding and recruiting persons with a research vocation.

Investigative ability, patience, steadfastness and good judgement are essential qualities for those who engage in research.

Given the need for research workers at different levels, it is necessary to develop, when providing guidance for young students, an adequate and planned policy of selection and identification designed to meet those needs in good time. This policy should allow for subsequent wastage among those chosen, whether during their studies or even during the first years of laboratory training.

In this connexion, it should be mentioned that the Tunisian Government has made a very considerable effort since 1961 to train high-level specialists in all fields in order to fill posts at the faculties and research centres.

The national scholarships designed to permit university study and the research fellowships awarded to young research workers to compensate for the time and money outlay involved in their work have been supplemented by specialization fellowships awarded to students who undertake specialized post-graduate studies.

The status of scientific research workers is fixed by a decree of 29 January 1963: they are placed on the same footing as university staff as regards recruitment, salary scales and rate of advancement. It should be stressed that the salaries are high, and are a definite encouragement to engage in research.

Furthermore, the principle of awarding research bonuses for success in producing high-quality work is calculated to induce large numbers of young people to go in for research and to prevent the dispersal of research teams.

The consolidation of the present material infrastructure of research and the creation of new research centres are also matters of prime necessity.

This work of consolidation should be consciously made on a broad and forward-looking basis with a view to meeting the country's long-term requirements, adopting the most suitable methods for research (integrated programmes) and arranging, in particular, for geographical regrouping by technical sector (agriculture, industry). Apart from promoting creative exchanges of views between research workers, regrouping facilitates the subsequent establishment of technical or administrative co-ordination bodies (higher committees for specialized research, etc.).

Pure research themes which it would not be possible to study in Tunisia would be entrusted to specialized centres abroad.

All this brings out the major importance attaching to an increase in the university's research potential which would enable the maximum number of themes necessary for the development of applied and technical research to be dealt with, while maintaining the freedom of choice characteristic of pure research, as the sole factor capable of ensuring the continued development of the research worker's creative faculties.

To sum up, research work in Tunisia is in process of rapid expansion consequent, firstly, on the development of the university and, secondly, on the construction, in 1962, of a ten-year model for the developing of Tunisian economy, given a more concrete form by the adoption of a Three-Year Plan, followed by a Four-Year Plan.

New research bodies with specific programmes have thus been created, while the existing ones have considerably increased their work and have a staff which, though young, is constantly increasing in number in a most gratifying way.

A de facto co-ordination, facilitated by the limited size of the country and the still narrow circle of research workers, exists between the higher educational establishments and the applied research centres and technical departments. This co-ordination, which should be encouraged and developed, should be given an organic structure and become systematic.

The Decree of 31 March 1960, setting up the University of Tunis, made provision for a University Council for Scientific Research.

The Council, which includes representatives of the University, the research institutions and the various technical departments concerned with scientific research, has the task, inter alia of:

ensuring co-ordination of the research work conducted in the various sectors and institutions;

giving advice on the general themes and procedures for research;

arranging for the conduct of research of recognized importance for the advancement of science of the national economy.

However, Tunisia's adoption in 1962 of a policy of planned economy and the formulation of specific

plans for economic development had the effect of promoting technical and applied research programmes and activities on the basis of specific development targets.

The formulation of a science policy and the organic co-ordination of scientific research is now seen as a prime necessity, and the Tunisian administration is arranging for the study and institution, without delay, of a suitable co-ordination structure.

This involves the preparation of an inventory of the country's scientific and technological potential - an operation for which the co-operation of Unesco experts would be invaluable.

One of the co-ordination body's tasks would be to promote a planned policy for recruiting and classifying research workers in accordance with the real needs of research institutes and programmes, avoiding duplication in the latter, and ensuring the allocation of the necessary funds for the implementation of those adopted.

It is already clear that the harmonious development of research in Tunisia would be facilitated by suitably organizing the documentation and publication offices of each of these centres, and setting up, within that co-ordination framework, a National Scientific Documentation Office in which all the research publications issued or received by the country's research bodies would be deposited.

Thanks to the progress made by the university, following on a radical reform of education and an intensive staff-training policy as one of the directives of the development plans, the research bodies will henceforward, it is hoped, be in a position to ensure the full exploitation of science in the interests of national development.

11. TURKEY

I will try to give some idea about the present situation of scientific research in Turkey in the limited time available.

Since of old the arts and sciences have benefited from government aid. Education is also largely financed by government. Under the Constitution, the University of Istanbul and Ankara, the Ege University in Izmir and the Technical University of Istanbul possess autonomous status. They submit their accounts directly to Parliament. The Ataturk University of Erzurum is attached to the Ministry of Education. The Middle East Technical University and the newly-established Technical University of Trabzon have special status. The number of university students is about 100,000.

Besides teaching, research is also conducted in these establishments. Generally, research in the universities is mainly concerned with fundamental studies and a part of these is work leading to the award of academic distinctions.

There are some obstacles in the way of scientific research in the universities. It can be noted that it is a consequence of improper utilization of their talents, such as the assignment of professionals to excessive administrative work, or heavy teaching loads. Other obstacles, such as shortage of equipment, lack of laboratory technicians, were also detrimental factors. The greatest impediment in this respect is the lack of interest on the part of young engineers and graduates for a university career, resulting from salary disparities, based on existing possibilities in industries.

There are, however, many highly fitted and well educated and trained scientists and technologists in the universities. The productive employment of them is absolutely essential.

In industry in Turkey, a certain amount of applied research takes place in connexion with the development of products. In industry, one is primarily concerned with cutting down costs and improving quality. To realize these objectives, researches may have to be carried out to explore the use of new or cheaper materials, components or devices. During the last years there have been certain trends in many firms to establish, even if small, research departments, like some pharmaceutical factories, glass industries, textile concerns and factories for electrical appliances. For example, the present-day Turkish pharmaceutical industry could well serve as a model for the development of other industries.

Recognizing the fact that the volume of business will not allow elaborate chemical research facilities, but still being fully aware that research is necessary for a growing industry, the pharmaceutical manufacturers have availed themselves of connexion with foreign firms and purchased a part of component research facilities to do their own research. It is about the same with the glass industry. They also do their own research to produce better and new products.

Generally, the large companies, already well developed, and the State Economic Enterprises can afford to conduct their own research. At present, there appears to be no alternative for developing industries except to rely on universities and research institutes. Owing to the structure of European industry, in which small firms predominate, particularly in the manufacturing industries, a co-operative type of research has been established.

There are no co-operative research activities in the real meaning for the various sectors of industry in Turkey. The research institutes and agencies of the Istanbul Technical University have been set up to establish co-operation with the relevant institutions. Thus, the Institute of Materials and Processes conducts quality control tests for the Turkish industry. The Institute of Internal Combustion Engines serves to the new engine industry. The Turkish Ship Building Research Institute serves to the ship building industry of the nation. Model testing and designs for the navy yards were undertaken in this Institute. Also some problems, which can be considered as being basic research, were taken up in the programme.

Apart from universities, there are some 40 governmental agencies, which are research connected. The main scientific research organization

outside the universities is the Atomic Energy Commission. The Commission, a separate executive organ within the Ministry of Energy and Natural Resources, aims at fostering and co-ordinating research in the field of atomic energy.

In the Five-Year Plan it is stated that research as a whole is an important factor underlying and speeding up development in economic, industrial and technical fields. It provides the most effective and rapid methods of solving the various problems. In preparing the Plan, the present stage of research activities in all fields was ascertained and the direction to be given to such efforts in the coming years determined. According to the Plan, the Scientific and Technical Research Council in Turkey was established in 1963.

In the first two years of its existence, the Research Council concentrated its work on stimulating the research climate in the country through various means.

As included in the Establishment Law, one of the most important duties of the Council is "to bring up and train researchers in the field of basic and applied sciences". (Accordingly, the Council awards a large number of scholarships and fellowships.)

To encourage and develop basic and applied sciences, research projects (until May 1966, 160 projects) had been granted.

A National Research Centre is now being established. The preparatory work for the founding of such a centre has been completed. It is envisaged that eventually both fundamental and applied research will be carried out at this Centre. However, during the first five years covered by the Plan, our efforts will be concentrated on establishing the applied research section, where the main areas of study will be:

1. Materials research: finding methods of utilization of existing materials and the development of new ones for the existing and new applications.
2. Research on process and technological systems. Studies of process dynamics and systems engineering.
3. Chemicals research. Chemical processes, such as pharmaceuticals, fertilizers and so on.
4. Nutrition and food technology.
5. Machinery industry research.
6. Research in electronics.
7. Operations research.

The Centre, located near Istanbul, will be completed in two or three years and some 300 full-time researchers will work in it.

It is unnecessary to explain to you the need for governments to have a science policy. We have already noticed the reasons for devicing a policy, but every day, we are discovering new reasons. The fact is that science is, at an increasing rate, changing the life of mankind and consequently that of States.

No doubt, a small or medium-sized country cannot do everything. But at least, if it wants to play its part in the community of nations, it can promote research and scientific applications in one or several sectors. This applies on the economic level, for a country whose technology is not up to date will quickly be reduced to helplessness.

In a country where research workers are lacking, and funds to be devoted to research activities are in short supply, the determination of the objectives and the content of scientific and technological research, together with a research policy in the context of a research programme, could be one of the significant factors that would contribute to development.

Efforts to programme research activities on the basis of their relevance for development acquire a particular importance for different types of research. The general social objectives of the country give a first qualitative guide to where the emphasis should be put in a science plan. In the case of our country, the social objectives of the greatest importance should be the economic ones. It follows that in our country, scientific research should be planned in such a way that it makes the maximum contribution to the rate of growth of income per capita. This means that the main emphasis should be placed on research with defined economic objectives. Our scientific activities should give results which lead to desirable technological change; then we must assess whether research and development work is necessary to achieve the desired change. This is of course only the first step in the operation. The next is to determine that it is possible. That is to say, we need to take into account the factors limiting the size and character of the plan for science which finally emerges. The most important of these constraints are:

1. The number of researchers available,
2. the financial resources available.

To obtain quantitative information on the total research potential of Turkey, a survey was started in 1963 by a pilot team sponsored by OECD and the Turkish State Planning Department. This project was later taken up and continued by the Science Policy Unit of the Research Council. The preliminary results of this survey are given in a report by the Council published in 1965. The survey was made in three different ways:

1. By sending questionnaires to directors of research units and obtaining information about the performances of such units.
2. By sending questionnaires to research personnel directly.
3. By collecting information about the research expenditures of all the institutions, through interviews and study of budgets.

A research unit is an administratively defined unit which has a specific field of interest; examples are departments or independent institutes in the universities, research departments of various state enterprises or of industrial firms. On the average, a research unit employs seven researchers. The total number of such research units is estimated to be about 400. During the survey, answers were

obtained from 254 research units, so the conclusions are believed to be quite dependable.

From these 254 research units, 196 units are in the higher education sector, 47 in the State sector and 11 in the private sector.

In this survey, answers have been received from 2,100 researchers. Of those researchers, 1,600 are working in the higher education sector, 460 in the public sector and about 40 in the private sector.

From these researchers, 19% are in fundamental sciences, 19% in engineering, 30% in medical sciences, 32% in agriculture.

As the total number of all researchers is estimated to be around 4,000, the information obtained from 2,100 answers is believed to be fairly indicative of the general characteristics of our research personnel.

It is useful here to give some information about research expenditures in Turkey.

The total expenditures on research and development in 1964 are 213 million Turkish Lira. One would like to know the proportion of basic research in the total figure of 213 million Turkish Lira. It is estimated that 20 million of it are spent on basic research, which makes about 10%.

To summarize our impression of the effects of all negative and positive factors, in the near future, we may state, that the worst times for research in Turkey seem to be over. From now on, in spite of all the difficulties, our research performance will regularly improve.

For that purpose, we should work on a national science policy and for the science policy we have to put down our objectives.

(a) The long-term objectives or the final goals of our science policy may be stated in a few lines.

1. In fundamental sciences, to reach the capacity for conducting productive research in all the main fields of contemporary sciences. The level of research must be high enough to receive international recognition; scientists must be contributing steadily to international journals in all the topical fields.
2. In applied sciences, to reach the capacity for carrying out all the oriented or development research needed for the solution of our technical problems in national defence, health, industry, agriculture, etc. which cannot be dealt with by a simple importation of the known techniques. Again the success of this research must be measured by international standards; for example, in agriculture, research must be effective enough to enable our production to reach standards (in quality and volume) comparable to those in more developed countries.

(b) Short-term objectives. Since our final goals are rather far away and indefinite, we should state some more specific targets. As our short-term objectives, we settled the following:

1. To evolve our universities into centres of learning, where teaching and research are conducted on the same basis of equality, as is seen in the well-known universities of our times; where teaching and research follow the development of modern sciences quite closely and in fact contribute to this development.
2. To ensure that the research institutions of the public sector carry out research to the utmost of their capacity and that this research is well coordinated with the needs of the country, with the work of the other institutes and that the results are really applied.
3. To promote research in the private sector to such an extent that all those companies which can actually profit from the results of new applied research and which can afford to allocate some funds for this purpose either engage in research themselves or have it done by other institutions.
4. To train research personnel at all levels (scientists, engineers, technicians) and as rapidly as the supply of graduates of lower schools will allow. To concentrate massive support on the training of basic scientists in the beginning.
5. To establish independent national research institutes for basic and applied research in fields which have been rather neglected so far.
6. To create service and supporting facilties for research, such as documentation centres.
7. To advise and help the Ministry of Education in a continuous revision and modernization of science education in the secondary schools; carry out experimentation in this field.
8. To participate actively in a number of international research organizations and contribute to the joint international research effort in proper balance and harmony with the national programmes.
9. To have international research institutes or advanced study centres established in the country where researchers of all nations would engage in fundamental research of the highest quality.
10. To promote the general understanding of science in the country by various publications, conferences and symposia.

I tried to give you some idea about the present situation of scientific and technical research and science policy in Turkey. There are some weaknesses, but their are also signs that we have a fair chance of putting them right.

12. UNITED ARAB REPUBLIC

When I first prepared my paper for this meeting, I was guided by what was given in a Unesco document limiting the object of the study to the changes which have occurred during the last three years in the national science policies. But we have noted with satisfaction that the delegates have not limited themselves to this, thus giving us a more complete picture of science in their own countries. I am, therefore, going to follow suit in order to give such a picture, but without going into details as to the actual topics of research carried out in the different institutions.

Science in the UAR has started in the universities with all its classical faculties about 40 years ago, and even earlier in some ministries such as the Ministry of Agriculture, Industry, Public Works and Public Health. True to tradition, the bulk of the university research was of the basic type, while that in the ministries was of the short-term nature.

In the universities, the research work is done by the teaching staff and their post-graduate students. In our five universities and the university colleges, we have now about 140,000 students. This is apart from about 45,000 in the higher technical colleges. About 10-15% of the students in the universities are registered for higher studies. In Cairo University alone, with 45,000 students, we find 9,000 doing post-graduate work. Those of them doing scientific research from a small army of research workers who can achieve a fair amount of results.

However, we can hardly say that there was in the past any policy behind all this. The term "Science Policy" has come to the forefront only during the past two decades with the fundamental principles underlying it.

The general definition given to the term "Science Policy" in the resolutions and recommendations issued after the Meeting of Co-ordinators of the Science Policy Studies in Karlovy Vary during June 1966, is as follows:

"Science policy consists of the sets of general guides, actions and organizational arrangements through which countries undertake to develop science - basic and applied - in harmony with their economic, cultural and political circumstances."

This means that there might be as many different policies as there are prevailing combinations of economic, cultural and political conditions. We here outline the science policy in the United Arab Republic, together with the organs and institutions which are responsible for the execution of this policy, and the manner in which it is executed.

Our present concept of science policy and the philosophy behind it came with the Revolution in 1952, but was crystallized out in our National Charter ten years later, in 1962. This is how we look on science and what it can achieve:

"If the revolution were to relinquish science it would become a mere nervous outburst enabling the nation to let off steam, but it would not change its stage.

Without science popular authorities may inflame the enthusiasm of the people. With science, alone, can they hope to realize the demands of the people."

This is how we look on science, but what are the ends which will be served by the scientific machinery? What will be our science policy? This also was set in the National Charter when it says:

"Science for society should be the motto of the cultural revolution at the present stage.

The scientific research centres are required at this stage of the struggle to develop themselves so that science would be in the service of society. At this stage, science for its own sake is a responsibility which our national potentiality cannot shoulder.

The achievement of the objectives of the national struggle will enable us at a further stage of our development to make a positive contribution to the world in the domain of science for its own sake."

These directions given in the Charter have served as the broad outline of our science policy, but the details and means of execution have been through a number of stages of development. I begin with a historical review which will serve as the background of the present state.

From the very early days of 1952, it was realized that the problems which have direct bearing on the society cannot always be solved by the type of scientific research which is carried out in the universities or ministry laboratories. Therefore, it was decided to start on a big research institution, which was to be considered as the central research laboratory of the State where research will be directed to serve industry, agriculture, public health and all matters related to the national economy. This big institution was the National Research Centre which started to operate late in 1955.

It is a multidiscipline type of a research institute, where the chemist works next to the physicist, to the agriculturalist, and so on, making use of the common experience and common facilities. For a developing country with limited resources of experienced manpower and of funds, this has proved to be a most useful arrangement. The Centre has five main departments:

1. physics,
2. chemistry and chemical technology,
3. earth sciences,
4. biology and agricultural sciences,
5. medical sciences.

Each one of these departments has a number of divisions, which in turn are made up of a number of laboratories which we call units. According to plan, there are about 150 units in the Centre, out of which about 80 are actually working at the present time.

Together with these laboratories there is a pilot plant in which laboratory experiments are carried out on a semi-industrial scale.

To serve these laboratories there is a Documentation Centre which has a central science library serving scientists in the National Research Centre, the universities and other research establishments in the country. It runs a bibliographic service, micro-film service and it is planned to provide it with a scientific printing machine. Its library has about 3,000 journals received by subscription or exchange of publications and a fair number of books which does not exceed 50,000.

There is also a Scientific Instruments Centre which is well equipped to build up increasingly complicated types of apparatus and which maintains and repairs existing apparatus in the laboratories. It also helps to build machines needed for the pilot scale experiments. The total number of workers in the Centre is 1,780, out of whom there are 1,300 engaged in research.

Now, if we go along with the historical review of events in the scientific fields in fulfilment of our science policy, we mention the creation of the Science Council in 1956. This was an advisory body whose function was to co-ordinate research work between the different scientific organizations in the country. During its fairly short life it was able to accomplish a number of valuable things, amongst which was the start on a plan of research on a national scale.

In 1961, it was decided to create a Ministry of Scientific Research in which was dissolved the Science Council, and to which was affiliated the National Research Centre (NRC) and a number of research institutes which originally belonged to the university or different ministries, or which emerged from existing laboratories at the NRC.

In 1964, there was created within the Ministry of Scientific Research a new body which was called the Supreme Council for the Promotion of Research with two main functions. The first was to identify the major research projects which have direct bearing on the national production, and therefore should be given priority, and try to mobilize all the country's potentialities to solve the research problems within these projects. The second main function of the Council was to provide aid to any serious research worker whose means are found to be short of what he needs. We shall come back later to these functions which were passed over to another body, and follow our review of the organizational structure of science and research.

As the Ministry of Scientific Research proceeded to execute its functions it was apparent that the body which is to co-ordinate research work amongst a number of ministries should not itself be a sister ministry. So, in 1965, a new body was created, directly responsible to the Prime Minister, under the name of "The Supreme Council for Scientific Research". We shall dwell a little bit longer on the constitution and functions of this Council, being the existing body responsible for the execution of the National Science Policy.

The Board of this Council, under the chairmanship of its President who has the rank of minister, is composed of the Under-Secretaries of State of the concerned ministries, for example, the Vice-Rectors of the universities and a number of distinguished scientists. Its functions are those previously set for both the Ministry of Scientific Research and the Supreme Council for the Promotion of Research. These can be summarized as follows:

1. To prepare a plan of scientific research based on the National Development Plan.
2. To direct and follow up the research work connected with this Plan.
3. To organize scientific publications.
4. To supervise the granting of State prizes and all means of encouraging scientific workers.
5. To participate in organizing scientific conferences, symposia and training courses.
6. To support scientific unions and societies.
7. To promote relations in the fields of science with other countries.

In this general review, we have given in a chronological order, the development of the organizations responsible for science in the UAR. Within the broad outlines of our scientific policy, each organization had its own system and its ways of executing this policy and had geared its machinery to fulfil its aims. There might have occurred some slight differences between the different systems but

the essence was always there, so we want now to extract the main features of our science policy and how it is executed, and sum them up in the following way:

1. The philosophy behind our science policy is that science should primarily serve the society.
2. The planning of scientific activities and policy-making is the responsibility of one central body in which all the organizations concerned with research are represented. At present, this is the Supreme Council for Scientific Research.
3. This body has its own laboratories which fall immediately under its own supervision. These are of two types: a multi-purpose type of research institute which is the National Research Centre, and a number of specialized institutes each dealing with a certain field of research. There are 17 such specialized institutes at different stages of development; for example, the well established institutes for oceanography, building research, medical research, desert research and the observatories. There are also a number of expanding institutes for standardization and metrology, petroleum, textile and metallurgy. The rest of the institutes have their nuclei in the laboratories of the National Research Centre. These institutes are for bilharzia, opthalmology, for plant production, animal production and ceramics. The two institutes for electronics and transport are in the process of planning.
4. A research plan is worked out to include a number of priority projects which are directly related to the national economy and development; we have now 14. In order to ensure the mobilization of all the human and material resources of the country, each of these projects is split up into a number of research problems to be tackled in the different research institutes according to their possibilities. Thus, for example, the combat of cotton pests is done at the National Research Centre, the Ministry of Agriculture and the Faculties of Agriculture. Similarly, with other priority projects, such as the combat of bilharzia, the High Dam, water requirements, water desalination, geological mapping and family planning.
5. The follow up of these projects is another responsibility of this central body.
6. One important facet of the science policy is the creation of a strong link between the research laboratories and the industries which are served by these laboratories.

This is achieved through a number of channels:

to delegate some research workers to work part time in industry;

to receive some scientists from industry to work in the laboratories;

to create some research laboratories in certain industries;

to keep continuous liaison with industry through joint committees to discuss how industry can utilize laboratory results, and in what way can the research laboratories solve the problems of industry.

7. Training of junior scientists takes a prominent place in our science policy. Each year, a number of young university graduates, between 300-400, are granted fellowships to work in the N.R.C. or the research institutes, or even to help scientists in the universities.

These fellowships run for one renewable year with a maximum of three years. This training includes advanced lecture courses, the mastering of certain techniques and doing research leading to a higher degree. Training may be completed abroad.

Every year, a number of research workers are sent abroad to finish their studies. The total number for the whole country is about 5,000 at the present time. This number is decreasing because of the increasing possibilities in the research institutions in the country to grant the Ph.D. degree in more fields of specializations. Missions abroad are limited now to studies which cannot be followed in the country. Opportunities are open to holders of Ph.D. degrees to go abroad for fairly short periods to broaden and widen their experience.
8. Realizing the very important rôle of documentation in the promotion of scientific research, it is our policy to continuously strengthen the existing Scientific Documentation Centre.
9. The same policy is adopted with the existing Scientific Instruments Centre for which expert aid is received from Unesco.

Concerning the research budget, it would be difficult to give an exact figure representing our total expenditure on research carried out in the different research institutes and those laboratories belonging to the universities or government departments, where in most cases the research budget is not separated from the general budget. In some cases, this is beneficial to research as it can be provided with all the funds which are needed, but in other cases, research cannot find the needed funds. There is also research for the national security whose budget is not known. All this makes it difficult to give an estimate of the research budget, and consequently its relation to the general budget or national income or expenditure.

But in this connexion, I would like to mention that in last year's session of parliament, it was discussed the allocation of 1% of the total profit of industry to research which may be carried out in the industry laboratories, in the universities or in the research institutes. This is expected to be passed this year.

In conclusion, I would like to add in this connexion, that our figures given for expenditure on research should not be compared with those given for big countries. As developing countries, we do not carry out big research requiring prohibitive equipment and expensive experiments. We are to reach good results in useful fields with much less expensive equipment and smaller salaries.

I wish to say that in spite of what has been achieved during the last 15 years, we are well aware of the fact that we still have a long way to go, and that more effort must be devoted to reach our goals.

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