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PERFORMANCE REVIEW OF SCIENCE AND TECHNOLOGY POLICY INSTITUTIONS IN GAMBIA, MADAGASCAR, MALAWI, SENEGAL, SIERRA LEONE AND ZIMBABWE

Science and Technology Section,

Natural Resources Division

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This review is a synthesis of six national studies carried out by eleven researchers: Dr. James H.A Maida (Malawi), Mr. L.M. Sesay and Dr. Nana Pratt (Sierra Leone), Mr. B. Drame and Mme. A.T. Sylla (Senegal), Mr. F.L. Jatta and Mr. S.B.W. Jaiteh (Gambia), Mr. C. Razafindrakoto and Mr. S. Rakotofiringa (Madagascar) and Mr. C. Mzezewa and Mr. R.S. Maya (Zimbabwe). The United Nations Economic Commission for Africa is deeply indebted to these researchers and thanks them both for the studies and for their assistance in the preparation of this review.

Thanks are also due to the staff of the institutions reviewed here for providing the information on which the national studies and, therefore, this review are based.

FOREWORD

In the last two decades a number of African member States have set up national mechanisms for co-ordinating and promoting science and technology. In view of the fact that science and technology have assumed a central role in socio-economic development, these national mechanisms set for themselves ambitious goals and functions, which were in line with their national aspirations. However, because of international economic pressures and internal structural weaknesses these goals and functions have so far not been adequately realized.

Owing to concerns expressed at international fora, and by donor agencies on the apparent lack of impact of these institutions on socio-economic development, the United Nations Economic Commission for Africa with the support of the Carnegie Corporation of New York undertook a study on the performance evaluation of selected national science and technology policy institutions with a view to bringing out their strengths and weaknesses, and making suggestions as to how they could be improved. This pilot study covered Gambia, Madagascar, Malawi, Senegal, Sierra Leone and Zimbabwe and examined in depth the historical background of their institutions for science and technology policy, the legal framework within which they operate, the organizational structure, the statutory powers and their activities. An attempt has also been made to evaluate the extent to which they have attained their stated goals and objectives in respect of policy development and execution of programmed science and technology activities. A similar exercise was carried out with the support of the Canadian International Development Research Centre (IDRC), covering Ghana, Guinea, Kenya, Nigeria and Tanzania.

The study has revealed that limited efforts have been made to apply science and technology in a practical way to solve socio-economic problems. This has been due mainly to the lack of integration of explicit science and technology policies with the broader socio-economic policies. Nor have science and technology plans and programmes been integrated into national socio-economic development plans and programmes in all the countries studied. The study has also confirmed the lack of intra and inter-sectoral linkages within which science and technology could be made to contribute effectively to the development process.

It is hoped that this study will contribute to creating a greater awareness of the role of science and technology within the African continent, where, so far undue stress was given to high-level manpower training and quality research, and the practical application of available science and technology has been marginal. This led to the underdevelopment of small and medium scale industries which form the backbone of the new industrializing countries.

The commentaries and recommendations at the end of each chapter, and specially the final recommendations of the eighth chapter of national institutions in charge of science and technology policy, and for a rapid development of the national socio-economic environment.

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CHAPTER 1

INTRODUCTION

1.1 About the Review

No pronouncement can match the seriousness of purpose and direction as the Lagos Plan of Action for the Economic Development of Africa, 1980-2000, which was adopted by the African Heads of State and Government at their Second Extraordinary Session that was held in Lagos, Nigeria, from 28 to 29 April 1980. In adopting the Lagos Plan of Action for the Economic Development of Africa, the Heads of States and Government showed their determination to take the necessary measures that would ensure the development of an adequate science and technology base and the appropriate application of S&T in spearheading development in various productive sectors.

Preceding this pronouncement was the Vienna Programme of Action on Science and Technology for Development that was adopted in 1979 at the United Nations Conference on Science and Technology for Development, and which was an important step in bringing into sharp focus the attention of the world community to the need for fostering and sustaining the development of S&T in the developing countries. The Vienna Programme of Action on Science and Technology for Development was adopted after almost decades had elapsed during which African countries had tried to encourage the development and utilization of S&T as tools for development. One of the ways in which they decided to achieve this objective was through the creation of national institutions that were responsible for science and technology policy. The functions of the institutions for S&T policy (ISTPs) were expected to entail:

(a) Planning, including development of S&T policy and programming of S&T activities;

(b) Co-ordination; that is, seeking coherence and consistency among S&T activities, as well as compliance of those activities with S&T policy, where such policy exists;

(c) Execution; that is, management of S&T activities in general and implementation of specific S&T programmes, alone or in collaboration with other S&T institutions;

(d) Advice; that is, providing information to government and the general public on S&T issues; and

(e) Advocacy; including popularizing S&T, and mobilizing support for S&T activities.

Today, more than a decade after Lagos, questions about the effectiveness of Africa's institutions for S&T policy in performing their functions have multiplied, not diminished. More recently they have begun to give rise to expressions of mounting skepticism regarding the effectiveness of all African public institutions generally.

More and more common has become the suspicion that, were one to measure the achievement of such institutions (in terms, for example, of the extent which they have been able to perform their functions and to achieve their stated goals), save in few cases, one would find those achievements to have been very limited. So strong has this sentiment been that more and more African Governments have lately found in it sufficient grounds for either restructuring them or banishing them into obscurity.

Some of the sentiments have resulted from systematic reviews of these institutions' past performance. In the majority of cases, however, systematic evaluations of performance have been rare. Most of such evaluations as have been made have only been statements of either praise or censure, commonly made during parliamentary debates, more often than not, for the limited purpose of facilitating or obstructing approval of the institutions' annual budgets. Clearly, more dispassionate assessments are required as a basis for sound decisions. That, in any case, is the rationale for this review.

Two circumstances coincide to make it both important and timely. First, institutions for S&T policy have been in existence now long enough to invite scrutiny regarding whether they constitute effective arrangements for achieving their stated aims. In the absence of previous local experience at the time of their

inception, it can be taken for granted that they were established through acts of faith. But their existence since then now provides empirical information in the light of which initial assumptions can be examined.

Second, whether or not they have been in existence long enough, there is already a presumption, in need of a systematic verification, that African S&T institutions have not been effective in performing their functions, and consequently, that new arrangements are required. Whether or not such a presumption is justified, it is producing changes in both the local and foreign attitudes towards them. So far this process has occurred largely without a systematic review of those institutions' performance.

Objectives of review

Since its inception, the United Nations Economic Commission for Africa has championed the need to have viable S&T policy-making bodies. It was, therefore, in this context that the Natural Resources Division of ECA through its Science and Technology Section, decided to assess the past and present programmes of the ISTPs created by African countries, by initiating a project, the main objectives of which were to identify past strengths and weaknesses, indicate present and potential obstacles, and then search for viable future reforms and improvements. Its specific objectives were:

(a) To examine the statutory characteristics of selected institutions for S&T policy, including their stated aims and functions, prescribed organizations'structures, compositions of their Councils or Boards, links with other institutions, promised legal powers and resource allocations;

(b) To review the institutions' past and present activities, highlighting their ways and means for attaining their stated objectives, in order to establish their actual characteristics, to compare these with those indicated by local need and by the institutions'statutes, to account for disparities, if any, and to relate these disparities to the institutions' past and present performance;

(c) To compare the institutions' statutory and actual aims and functions with those of other relevant national institutions, including government departments, in order to determine the extent to which similarities in statutory and actual aims and functions spawned rivalries or encouraged cooperation between those and other institutions;

(d) To study the nature and working of the local power structure, now and in the past, especially with regard to authority for allocating resources, to institutions for S&T policy;

(e) To review the performance of the institutions by estimating the extent to which actual achievements represent attainment of stated goals, or elimination of obstacles against the attainment of those goals; and

(f) From the emerging conclusions and from comparison with successful institutions for S&T policy in other parts of the world, to suggest ways in which African institutions for S&T policy could be strengthened and/or to propose new arrangements, alternative to those institutions, that would be more effective than they are in promoting and utilizing S&T for development.

CHAPTER 2

HISTORY OF INSTITUTIONS FOR SCIENCE AND TECHNOLOGY

2.1 Research Council of Zimbabwe

The explicit commitment to science and technology development dates back to the days of the Federation of Rhodesia and Nyasaland when the then Federal Government was advised, among other things, to have a Research Act that would promote and sustain scientific and industrial research development and to establish research foundation plus research councils. A Research Act was subsequently enacted in July 1959.

In pursuance of the provisions of the Research Act and following the secession, first, of Nyasaland and then of Northern Rhodesia from the Federation of Rhodesia and Nyasaland which became the sovereign states of, respectively, Malawi and Zambia, the then Government of Rhodesia established the Scientific Council of Rhodesia in 1964, Agricultural Research Council of Rhodesia in 1970, and the Medical Research Council of Rhodesia in 1974.

The Scientific Council of Rhodesia was placed directly under the office of the Prime Minister where it was perceived as an advisory organ to the Prime Minister. Its mandate was:

(a) To undertake a review of the areas of research then carried out in the country; identify other areas of research which, in the national interest, could be usefully investigated; and to "suggest suitable lines of research with such areas, together with responsibility for this research";

(b) To recommend ways and means whereby the review mentioned in (a) above could be carried out on a continuing basis;

(c) To keep under review those areas of science for which responsibility is not clear cut and to make recommendations thereon;

(d) To provide when required advice on scientific priorities to the Treasury and to the Ministry of Commerce and Industry; and

(e) To advise Government on matters affecting overall national scientific policy.

2.1.1 Statutory functions

On gaining political independence in 1980, Rhodesia became Zimbabwe. Chapter 336 of the 1959 Research Act was repealed by the Scientific and Technological Research Act (1986) which conferred on the Scientific Council of Zimbabwe statutory powers to undertake:

(a) "The promotion, direction, supervision and coordination of scientific and technological research including agricultural, industrial, health and mining research", and

(b) "The provision for the establishment of research councils and research institutes to conduct research and for the control of such research councils and research institutes by the Council".

The statutory functions of the Scientific Council of Zimbabwe, among others, are:

(a) To recommend to the Prime Minister in relation to:

(i) the formulation and implementation a national science policy,

(ii) the research needs of Zimbabwe and the priorities to be observed in the allocation of funds and other resources,

(iii) the establishment of research councils or research institutes required to conduct research,

(iv) the constitution under which a research council or research institute should be established, and

(v) the overall management of research programmes and the allocation of funds and other resources for research;

(b) To consider for approvals research programmes submitted to it by a research council or research institute;

(c) To exercise general supervision and control of the research council or research institute concerned and to ensure that the research council or research institute observes the

provisions of the Scientific and Technological Research Act (1986) and of its constitution and the research programme as approved or amended by the Council;

(d) To give the research council or research institute general directions on matters of policy;

(e) To keep under review those areas of science for which responsibility is not clear cut and to make recommendations thereon;

(f) To provide, when required, advice on scientific priorities to the governments;

(g) To advise government on matters affecting over-all national scientific policy; and

(h) To consider for approval and to monitor research conducted in Zimbabwe by scholars and other persons who are not citizens or residents of the country.

The Scientific and Technological Research Act (1986) conferred upon the Scientific Council of Zimbabwe powers to establish and be directly responsible for research centers, and widen its scope of operation to include such areas as mining and industrial research. In 1988 the Scientific and Technological Research Act was amended and as a result it ceased to be known as the Scientific and Technological Research Act but as the Research Act (1986), and the Scientific Council of Zimbabwe corollarily changed its name to become the Research Council of Zimbabwe.

The mandate of the Council was revised and widened to cover all research activities carried out in the country. The Research Act (1988) conferred upon the Council statutory control over all research activities conducted in the country by all institutions or persons, and statutory powers to levy and collect fees from foreign researchers who may wish to carry out research in Zimbabwe.

2.1.2 Structure and Organization

The membership of the Research Council of Zimbabwe includes scientists and engineers involved in every sphere of development selected from higher institutions of learning, government and the private sector. The scientists appointed to the membership of the Council are those who are prominent nationals who are known to have pioneered important developments in energy, agriculture and other scientific fields. The membership of the Council is for a period of three years.

The council has, at any one time 10 to 15 members. At present the Council has fourteen members. Four of the members are engineers, two are agricultural scientists, one is a mathematician, one is a physicist, one is a medical practitioner, one is a biochemist, one is a biologist, two are social scientists and one is a remote sensing specialist. One member of the Council also serves as a Scientific Liaison Officer.

2.1.3 Secretariat

The Research Council of Zimbabwe is directly responsible to the Office of the President and Cabinet where its Scientific Liaison Office is placed. The Scientific Liaison Office presently has one professional officer who has a Master Degree in Health Administration, one librarian with a BA general degree, two typists and one messenger.

2.1.4 Committees of the Council

The Council has nine standing committees which serve as its operational arms for, among other things, the coordination of research nation wide. The composition of each of the committees includes representatives of all the relevant national institutions as well as individuals specialized in relevant disciplines. The Committees are:

(a) Agricultural Sciences

(b) Natural and Environmental Sciences

(c) Industrial Development

(d) Mineral Resources and Earth Sciences

(e) Health Sciences

(f) Remote Sensing

(g) Social Sciences

(h) Informatics

(i) Foreign Researchers Committee

2.1.5 Research Councils and Research Institutes

Some of the research councils and research institutes whose research and development (R&D) activities are coordinated by the Council and over which the Council has some statutory control are:

(a) Health Professions Council

(b) Blain Research Laboratory

(c) Traditional Healers Council

(d) Zimbabwe National Family Planning Council

(e) Department of Mining Research

(f) Institute of Mining Research

(g) Department of Geological Survey

(h) Department of Metallurgy

(i) Department of Veterinary Services

(j) Agritex

(k) Tobacco Research Board

(l) Research and Specialist Services

(m) Pig Research Board

(n) Forestry Commission

(o) Department of Natural Resources

(p) Department of National Parks and Wildlife

(q) Standards Association of Zimbabwe.

2.2 The National Research Council of Malawi

With the advent of independence in 1964, the Malawi government declared its intention to develop a prosperous Malawi, with much better economic performance, improved standards of living, and enhanced quality of life. It was realized then that such human progress could only come from the expansion and more efficient use of the country's capacity; that is, the country's human skills, capital, technology and human resources. It was mainly because of the Government's desire to expedite the process of human resources development that, barely three months after the country became independent, Malawi's premier institution of learning, the University of Malawi, was established under an Act of Parliament, and more primary and secondary schools were established.

To propel the endogenous development of science and technology for national development, the Government encouraged lecturers in the science faculties at each of the constituent colleges of the University of Malawi to conduct R&D activities. Because of the economic importance of the agricultural industry to the Malawi nation, R&D for this primary industry has since independence been a priority area for research in the country. This has as its basis the recognition that an improved and sustained agricultural production is dependent upon the establishment of an active research organization that is mandated to investigate and develop methods of increasing and sustaining the yield and quality of plant and animal products required on the internal and external markets. It was in recognition of this fact that the Agricultural Research Council of Malawi was established by an Act of Parliament in July 1964 with the main objective of reinforcing the existing government research and technical services.

It was observed later, however, that with an increase in R&D activities in the fields of agriculture and natural resources there was a fragmentation and duplication of research effort. The government, therefore, instituted the National Resources Research Committee (NRRC) in 1969 and charged it with the responsibility of coordinating the research activities and giving advice on priorities for research to research organizations and to the then National Development Council (NDC). The NRRC was chaired by the Secretary for Agriculture and Natural Resources. Its members were the Dean of the Faculty of Agriculture in the University of Malawi and representatives of the Ministry of Finance and the Economic Planning Division of the Office of the President and Cabinet.

While a particular emphasis has been on production research in the primary industries R&D programmes, and while the need for this research will continue, there has increasingly been a requirement for additional R&D into post-production issues such as improved market access and better ways of storing, handling and distributing products, as well as those areas that will promote and sustain industrial activities and facilitate the adaptation of imported technology for local use. To achieve this objective and to ensure that the R&D

activities conducted in the country were in consonance with national goals and aspirations, a need was felt during the early 1970s for the establishment of a national apex body that could be entrusted with, inter alia, the responsibility of formulating national S&T policies and facilitating their implementation. It was, therefore, in 1974 that the National Research Council of Malawi (NRCM) was established by a Presidential decree as a national apex S&T body, charged with the responsibility of charting out national direction and priorities in S&T, fostering the integration of S&T activities within the broader framework of national socio-economic development objectives, and coordinating all R&D activities in order to ensure that maximum dividend was obtained from the national investment in science.

The NRCM was placed in the Office of the President and Cabinet where it was under the chairmanship of the Secretary to the President and Cabinet, and had its members drawn from the Ministries of Agriculture, Education, Finance, Forestry and Natural Resources, and Trade, Industry and Tourism; the Department of Economic Planning and Development; the Tea Research Foundation of Central Africa; and the University of Malawi. It had a Secretariat comprising only one scientist at the rank of Principal Scientific Officer and one copy typist. When the first ever national seminar for policy-makers on the "Role of Scientific Research and Technology in Malawi's Development" was held in the country from 29 to 30 August 1986, the complement and gradings of the NRCM Secretariat staff were as follows:

1 x Principal Scientific Officer (P7)

1 x Administrative Officer (AO)

1 x Copy Typist and

1 x Messenger

It was at this seminar when, after reviewing the functions of the NRCM, it was appreciated that the complement of the NRCM Secretariat staff was far inadequate to service the demands of both the scientific community and the private sector and that the grades of the posts created for the Secretariat were not commensurate with the duties and responsibilities placed upon the Secretariat personnel. After these weaknesses had been identified, the Government instructed the Secretary for Personnel Management and Training to review the complement and gradings of the Secretariat relative to the duties and responsibilities the personnel of the NRCM Secretariat were charged with.

A review team formed by the Department of Personnel Management and Training (DPM&T Review Team) produced a report on the performance of the National Research Council of Malawi in 1986 in which it was observed, among other things, that Malawi was "at a stage of industrial development take off" and that the process of "industrialization must proceed according to well defined national science and technology policies, plans and strategies in order to ensure maximum benefit".

It was recognized that there was need to have a body that was effective enough to foster the integration of science and technology in economic and social development through linkages with development goals. It was felt that this integration was more important and fundamental than the mere consideration of mechanisms to be employed to promote the development of science and technology, and that it was through this integration, both conceptually and in practical terms, that the application of science and technology could make the most effective contribution to industrial and economic development.

The DPM&T Review Team observed that for the National Research Council of Malawi Secretariat to improve its performance there was an urgent need for it to be restructured and re-organized and for it to have its staff strength improved. The recommended numbers and grades of the Secretariat's staff which were regarded by the DPM&T Review Team as a bare minimum consisted of the Secretary to the Council at the rank of Deputy Secretary, Chief Scientific Officer at the rank of Under Secretary, four posts of Principal Scientific Officer, a Senior Administrative Officer, an Executive Officer, one senior Clerical Officer, one senior Copy Typist, and three Copy Typists.

On receiving the report, the Malawi Government not only approved the proposal to restructure the NRCM Secretariat but also decided to improve the Secretariat's staff strength by seeing that it is headed by a Principal Secretary and creating more posts at senior grades. This underscores the Government's recognition

of the fact that science and technology are the primary vehicle for development and that maximizing the potentially beneficial impacts of scientific and technological developments within the national economy requires focussed and specific effort to integrate scientific and technological considerations into national development planning.

Recognizing the cross-sectoral dimension of the environmental issues, the Government later directed that environmental programmes and activities designed to ensure the protection and conservation of the environment should be placed under the charge of the NRCM Secretariat. It was after the NRCM Secretariat had been restructured and re-organized, and its staff strength improved, that a directive was made by the country's leadership at the highest level that the NRCM Secretariat be elevated to the status of a ministerial apex body for S&T concerns and placed in the Office of the President and Cabinet. The body thus created is the Department of Research and Environmental Affairs. It became functional on 1 April 1991.

The directive by the country's leadership that the Department of Research and Environmental Affairs be created underlines a desire that the research which is conducted and managed in the country is guided by an effective policy framework that ensures the R&D activities to be relevant to the needs of sustainable physical environment and to the needs of users.

The National Research Council of Malawi (NRCM) comprises twelve appointed members who are specialists in the main scientific disciplines including social science or persons involved in technology-related activities plus:

(a) The Secretary to the President and Cabinet who is the Council Chairman;

(b) The Secretary for Education and Culture-Ex-Officio;

(c) The Secretary for Agriculture-Ex-Officio;

(d) The Secretary to the Treasury-Ex-Officio;

(e) The Secretary for Trade and Industry-Ex-Officio;

(f) The Secretary for Forestry and Natural Resources-Ex-Officio;

(g) The Secretary for Health-Ex-Officio;

(h) The Secretary for Works-Ex-Officio; and

(i) The Secretary for Economic Planning and Development-Ex-Officio.

Both the NRCM and the Department of Research and Environmental Affairs are placed in the Office of the President and Cabinet and their responsible Minister is the Head of State.

2.3 The Ministry of Scientific and Technological Research for Development (Madagascar)

In Madagascar the national body responsible for science and technology policy is the Ministry of Scientific and Technological Research for Development which was established in 1983 by a Decree No. 83353. Before the country gained its political independence in 1960, however, S&T activities were carried out by the French Government. From 1960 to 1972 the scientific research conducted in the country continued to be controlled by French R&D institutions and the R&D activities were concentrated in the agricultural field. The Madagascar Government did not control the R&D activities carried out in the country.

It was in 1972 when the Government created a Scientific and Technological Research Committee (STRC) which was placed under the office of the Vice President and managed by a General Secretary. The membership of the STRC was composed of a small number of scientists who were entrusted with a consultative role. The STRC was not, however, charged with enough power to manage and coordinate the R&D activities conducted in Madagascar.

The country's seven agricultural research centres were merged in 1972 into one centre called CENRAPERU/FOFIFA while the centres belonging to ORSTOM (the Overseas Office for Scientific and Technological Research) and those belonging to the National Geographical Institute (IGN) were nationalized. The Bureau of Geographical and Mining Research became a prospecting institution while the National Public Work Laboratory became a national body. The Pasteur Institute, however, retained its original status.

The STRC then became an Interministerial Committee and was directly under the Head of Government. The Committee had as its members representatives of the relevant Government Ministries and was managed by a Director for Scientific and Technological Research. This was a precursor to a national S&T policy body. It was in 1976, however, when the Government abolished the Interministerial Committee and created the Ministry of Scientific and Technological Research. The Ministry was entrusted with the function of coordinating the activities of all the research centres supported by public funds. In 1977 the Government created the Ministry of Higher Education and Scientific Research and charged it with the control of R&D activities conducted by the University and public research centres.

After observing that more attention was attached to higher education issues than to R&D activities, the Government created in 1983 the Ministry of Scientific and Technological Research and Development whose powers, responsibilities and general organization were promulgated in 1989 by Decree No. 89139.

The Ministry of Scientific and Technological Research for Development (MSTRD) is entrusted with the following functions:

(a) policy formulation and decision making,

(b) planning, programming, monitoring and evaluation,

(c) logistical and financial support,

(d) valorization,

(e) promotion and protection of results, and

(f) execution.

The first function is executed by the Deputy Minister with the assistance of his Cabinet and directors. The four other functions are executed by Technical Divisions of the MSTRD while the last function is discharged by national research centres.

The main research centres are:

- CENRADERU-National Centre of Applied Research for Rural Development
- CNRP-National Centre for Pharmaceutical Research
- CNRO-National Centre for Oceanographic Research
- CIDST-Information and Scientific and Technical Documentation Centre
- CNRIT-National Centre for Industrial and Technological Research
- CNRE-National Centre for Environmental Research

2.4 Bodies Responsible for S&T Policy in Senegal

In Senegal efforts to establish a national body for S&T policy date back to 1960. The country has since then progressively set up and improved its institution for science and technology policy in order for it to discharge the function of framing and executing government policies in the area of scientific and technological research.

From a coordinating office for S&T research in 1960, it became an office of S&T matters in 1966. In 1970, it became a Directorate for S&T attached to the Planning Ministry; in 1973 it became a Secretariat for S&T research; in 1983 a Ministry for S&T research; in 1986, a directorate for S&T affairs in the Ministry of Planning and Cooperation; in 1990 this was transferred to the Ministry National Education. Finally in 1991, it was attached to the Prime Minister's office in charge of State modernization and of technology.

The main organ responsible for S&T policy has developed and is now identified with the Directorate for S&T matters. In Senegal, the execution of research programmes is undertaken by S&T research institutes, that cover almost all the fields. Thus, in the field of agriculture, there is the Senegalese Institute of Agricultural Research; in the field of agro-industry, there is the Food Technology Institute.

As for formulation of government policy in S&T Research, the following are the bodies that are entrusted with this responsibility:

- 2.4.1 The Interministerial Council for S&T research (CIRST), which is an institution grouping ministries interested in research and utilization of results.

- 2.4.2 Consultative Commissions; these are purely advisory bodies, made up of scientists and users of R&D results. They advise the directorate and make recommendations to it. There are six of them covering different fields.

- 2.4.3 Regional Committees for Development. These committees are devoted to scientific and technological research relevant to different regional development in Senegal.

2.5 Science and Technology Policy Institution (Sierra Leone)

In Sierra Leone, currently there is no institution responsible for science and technology policy. The results of the present study show, however, that the need to set up such an institution in the country is appreciated.

Presently the Ministry of National Development and Economic Planning is in charge of S&T policy issues, and advises the government accordingly. A non-statutory body, the Interim Committee on Science and Technology for Development, set up in 1979 to coordinate and organize Sierra Leone's contribution to United Nations Conference on Science and Technology for Development (UNCSTD), is called upon, when required, to fulfil some of the functions of an institution for science and technology policy. In 1985, a focal Unit was set up in the Ministry of National Development and Economic Planning to coordinate S&T activities in the country.

2.6 Science and Technology Policy Institution (The Gambia)

The country does not at present have an institution responsible for science and technology policy. Any co-ordination and monitoring of S&T activities are done by the Ministry of Economic Planning and Industrial Development. Because of lack of trained and skilled manpower, this task is next to impossible. Research and development activities are ministry/department specific.

It is hoped that the results of this study will encourage the Gambia government to set up an institution for science and technology policy.

CHAPTER 3

GOALS AND FUNCTIONS

3.1 Mission of the Institution for Science and Technology Policy

The mission of the institutions for science and technology policy (ISTPs) selected for the present study has been spelt out implicitly in policy documents (Madagascar and Senegal) and explicitly in both a policy document (Malawi) and a statute (Zimbabwe) governing the activities of the ISTPs.

The statute creating the Research Council of Zimbabwe (RCZ) stipulates that the mission of RCZ is to promote innovation, self-reliance and development and to ensure that the scientific and technological research conducted in Zimbabwe is in consonance with the interests of the country. The constitution of the National Research Council of Malawi (NRCM) shows that the basic mission of the NRCM is to contribute to Malawi's quest for enhanced sustainable economic performance, living standards, environmental quality and community understanding of science and technology through excellence, leadership and teamwork in research and experimental development R&D.

The mission of the other ISTPs under study (Madagascar and Senegal) is implied in their functions. With the exception of the functions of RCZ, those of the other ISTPs are not statutory. Some of the functions of the institutions are advisory while others are executive.

3.1.1 Advisory Functions

Unlike the previous performance review of ISTP (UNECA, 1990), the present review shows that the advisory functions of the ISTPs selected for the present study are found in situations where the institutions concerned are either ministerial (Madagascar, Malawi and Senegal) or statutory (Zimbabwe) bodies.

The principal areas in which advice is given are eight and these are: advice on the formulation (Zimbabwe) and implementation (Malawi and Zimbabwe) of national science and technology policy; advice on research needs (Zimbabwe) and on priorities to be observed in the allocation of funds and other resources for the purposes of meeting the research needs (Senegal and Zimbabwe); advice on suitable organizational arrangements for planning, managing and coordinating scientific activities at various levels (Malawi) including the creation of new research establishments and technical services (Malawi and Zimbabwe); advice on the overall financial requirements for effective implementation of the national science and technology policy (Malawi); advice on eligibility of person(s) or institution(s) for an honor or award for outstanding achievement, innovation or invention in the field of scientific or technological research (Malawi and Zimbabwe); advice on the scientific and technological requirements for the conservation of the national and social environment (Malawi); and on the training needs (Senegal).

3.1.2 Executive Function

The Executive functions of the institutions selected for the present study are less than the advisory ones and fall into six categories. The first category comprises functions whose main objective is to articulate policy. The functions include formulation of national science and technology policy (Madagascar, Malawi and Senegal); coordination of research priorities (Madagascar, Malawi, Senegal and Zimbabwe); monitoring all research activities (Madagascar and Senegal); valorization, promotion (Madagascar and Senegal) and popularization of science and technology (Malawi and Zimbabwe); and monitoring the utilization of research results.

The second category of functions is that whose main objectives are essentially promotional. The functions mainly entail identifying and promoting the execution of R&D activities (Malawi and Zimbabwe) that were consonant with national science and technology policy - hence with national development goals and aspirations (Malawi); identifying and fostering the application of results emerging from R&D

activities (Malawi and Senegal); promoting the dissemination and commercial exploitation of the results of scientific and technological research through appropriate institutional arrangements for the commercialization of the S&T results (Malawi and Senegal); promoting the creation of an environment that encourages both the public and private sectors to participate more in R&D activities, particularly by identifying and utilizing a wider range of local natural resources for development (Malawi); fostering the establishment (Zimbabwe); strengthening and dissolution (Senegal) of research institutions; promoting cooperation and coordination between various agencies involved in the machinery for making national S&T policy (Malawi); and encouraging the development and use of local consultancies in the design of development projects with technological inputs (Malawi).

The third category is that of coordinating functions which mainly involve coordination of R&D activities (Madagascar, Malawi, Senegal and Zimbabwe), sectoral allocation of financial resources (Senegal); and liaising and maintaining cooperation in S&T with similar bodies in other countries and with international bodies connected with S&T (Madagascar, Malawi, Senegal and Zimbabwe).

The fourth category is that of regulation functions which involve the control of research institutes and sectoral research councils (Zimbabwe); the protection through patents or research results endogenously generated (Madagascar); and establishing mechanisms that facilitate the control of R&D conducted by foreign research scientists in order to ensure that the R&D activities being carried out are in the national interest (Malawi and Zimbabwe).

The fifth category comprises functions that are of educational nature, and these entail acquisition, storage, retrieval and dissemination of scientific and technological information (Malawi, Senegal and Zimbabwe) and making grants in support of the publication of local science news and quarterly scientific journal (Zimbabwe) and of scientific associations (Malawi).

The sixth category is that of functions whose main objectives are to generate, foster, nurture and give a fillip to science popularization with a view to inculcating a scientific culture into the populace (Malawi).

3.1.3 Analysis and Commentary

Science and technology are now widely recognized as potentially potent development assets which should be properly nurtured and harnessed. One of the most important elements which need to be considered when harnessing science and technology as tools for socioeconomic development is the linkage of these strategic variables to overall national development goals and this is successful only in the context of the formulation of relevant policy measures.

The present review shows that the institutions in 67 per cent of the countries selected for study have statute (Zimbabwe) and policy documents (Madagascar, Malawi and Senegal) which describe explicitly science and technology policy articulation as one of their functions, and yet it is only one of the institutions (Malawi) which has just recently (1990) done so. The research team learnt that another institution (Zimbabwe) was in the process of articulating its national science and technology policy.

The countries under study may find it useful to note from the experiences of newly industrialized countries (NICs) that in the absence of a commitment of political leadership to science and technology for development, the role of a national science and technology policy as an instrument to propel and sustain economic growth cannot be achieved. It is observed that in the NICs this commitment has been made explicitly at various levels ranging from public statements by leaders to statements in planning documents and enactment of laws favoring inclusion of science and technology in the constitution so as to prevent frequent policy changes.

The experiences of the NICs also show that the presence of explicit guidelines and workable methodology for integrating technological considerations into the national development planning process is a key element in the task of using technology as a motor for stimulating a sustained economic growth.

In the context of the main objectives of the present study, it may be observed that lack of well defined national science and

technology policies, plans and programmes in all the countries selected for the study is one of the major elements that constrain the endogenous development and effective utilization of science and technology for national socioeconomic development. Each of the countries under study therefore may wish to consider taking action to develop national science and technology policies, plans and programmes. It is encouraging to note that one of the institutions (Malawi) has taken the first step towards achieving this end.

The institutions which have not yet articulated their national science and technology policies may wish to consider formulating them. Each of the policies should be seen to have as its basis, inter alia, knowledge of the given country's current status of technological capability and capacity, most pressing technological needs, and areas of technology that offer the greatest promise for its specialization.

When formulating the national S&T policies, the countries may wish to ensure that the policies indicate clearly, among other things, the degree of science and technology capacities, capabilities and skills needed; the extent of utilization of foreign sources of expertise; the extent of involvement of various local scientific and technological institutions; and the mechanisms and mode of selecting, acquiring, adapting and regulating foreign technology. They may also wish to ensure that the policies provide clear guidelines on aspects such as financing of scientific and technological activities; ways of encouraging the participation of the private sector in local R&D activities; development of scientific and technological capacities, capabilities and skills; and measures for the nurture and promotion of scientific and technological activities, especially for the commercialization of R&D results.

The need for instituting mechanisms and modes for selecting, acquiring, adapting, updating and regulating imported technology is strongly felt. There is a lack of such mechanisms and institutional framework in each of the countries selected for the present study. It is pertinent to point out here that a national science and technology policy is liable to remain a mere piece of rhetoric if it is not substantiated by means of implementing it. The experiences of the NICs do in fact show that the translation of a policy from a mere rhetorical statement to an instrument for bringing about positive changes was achieved with the help of a relevant policy instrument.

In one of the countries under study (Malawi), the policy document shows the creation of an environment that encourages the involvement of the private sector in local R&D activities as one of the functions of the country's institution for science and technology policy. This function, however, has not been substantiated by means of a policy instrument. It has been observed that the Research Council of Zimbabwe which has statutory powers to identify priority areas for research does not have a supportive act that stipulates that funds be allocated to it in order for it to ensure that all the R&D activities conducted in the country are directed towards the identified priority areas.

The present study has also shown that 33 per cent of the institutions (Malawi and Senegal) are entrusted with the responsibility of promoting the dissemination and commercial exploitation of the resources of scientific and technological research through appropriate institutional arrangements for the commercialization of the S&T results. The institutional arrangements for the commercialization of the results have not, however, been established in any of the countries under study.

3.2 Operationalization of Mission

This Section is concerned with both the subjective and objective perceptions of the goals of each of the ISTPs under study as could be extracted from interviews, minutes, internal policy documents and institutional outputs of the ISTPs. The information elicited is taken to reflect what the institutions through their leaders perceive their roles to be.

3.2.1 Perceived Goals and Missions

In accord with the findings of the previous performance review of science and technology policy institutions (UNECA, 1990), the institutions for science and technology policy selected for the present study perceive themselves as having been entrusted with four main roles. These are

policy generation and channelling; linkage and delinkage, facilitation and rationalization, and a custodial role.

Regarding the policy generation and channelling role, most of the ISTPs perceive it is their mandate to contribute to their national quest for enhanced sustainable economic performance, living standards, environmental quality and community understanding of the impact of science and technology in their daily lives; to formulate policies that can foster the development of scientific and technological capabilities; to promote the generation of technologies that can help to secure commercializable processes and products and confer competitive advantage on the international market; and to generate policies that can nurture and sustain a more effective and economic utilization of human and natural resources.

The facilitative roles are perceived to entail promotion of the establishment of an enabling environment for scientific discovery and technological innovation, and for the involvement of the private sector in local R&D; fostering the establishment of mechanisms for creating an interface between science and industry and encouraging cooperation and coordination between various institutions involved in the machinery for making S&T policy, and in R&D.

The linkage and delinkage roles are perceived to include linking S&T activities to national development goals and aspirations; providing a link between policy makers, scientific researchers and industry; and providing a link between scientists, engineers and technologists of various disciplines. The delinking roles as perceived by most of the institutions purport to relate to the function of reducing dependence on the import of technologies on turn-key basis by creating a viable endogenous science and technology industry that is dynamic, responsive and efficient.

As in the previous study, the findings in the present review indicate that the custodial roles are perceived generally to relate to the acquisition, custody and management of scientific and technological information and to the allocation of financial resources with the main objective of encouraging the execution of research that is responsive to national development goals.

3.2.2 Analysis and Commentary

The acquisition and development of technology include the collection and processing of technological data from various sources and utilising them to develop a new indigenous technology. Although several of the institutions under study perceive this as their role, the findings of the present study show the absence of appropriate framework for discharging this role. The framework usually involves the establishment of a national technological information and documentation network with a well defined focal point.

It has been noted above that one of the key elements for stimulating economic growth is the integration of technological considerations into the national development planning process. Unless scientists and technologists are involved in the planning and execution of national development plans, this goal cannot be achieved. The countries under study may therefore wish to consider the involvement of scientists in the national development planning process.

CHAPTER 4

ORGANIZATION

4.1 Structure

The extent to which an institution for science and technology policy is able to discharge effectively the functions entrusted to it is governed by, inter alia, the strength of its institutional framework. It was in recognition of this fact that such variables as the structure, the composition, the linkage between each of the institutions for science and technology policy (ISTPs) and other science and technology bodies, the linkage between each of the ISTPs and productive and service organizations, and the general powers of each of the ISTPs in the policy implementation processes were reviewed. The observations obtained from the review are summarized in this chapter.

4.1.1 The Position of these Institutions in the Government Structure

The review shows that the institutions under study fall into two categories. The first one comprises government departmental or ministerial science and technology policy-making bodies (Madagascar, Malawi and Senegal). The second category is that of non-departmental statutory body (Zimbabwe).

The non-departmental statutory institution in Zimbabwe is placed under the President's Office but is headed by an appointee of the government who is outside the government hierarchy and reports directly to the country's Vice President. Since its inception in 1974 the government departmental institution (Malawi) has been placed in the Office of the President and Cabinet where, from 1988, it has until now been headed by a Principal Secretary (Permanent Secretary) who is answerable to the country's Head of State and Government through the Secretary to the President and Cabinet.

The history of the ISTP in Senegal shows that after it had been attached to the Planning Ministry as a Directorate for S&T in 1970, elevated to the status of a full Ministry of Scientific and Technological Research in 1982, reduced to the status of, once again, a Directorate for S&T Affairs in the Ministry of Planning and Cooperation in 1986, and then transferred to the Ministry of National Education, the government departmental ISTP has since recently (1991) been attached to the Prime Minister's Office in charge of State modernization and S&T matters, where it is now recognized as the main organ responsible for science and technology policy.

Whereas the institutions in Malawi and Senegal are departmental and placed under the Office of the President and Cabinet (Malawi) and in the Prime Minister's Office (Senegal), the one in Madagascar is a ministerial institution headed by the Minister of Research and Technology for Development. As pointed out in the previous performance review of institutions for policy (UNECA, 1990), the departmental or ministerial institutions take the forms of government structure. This makes it possible for the institutions to communicate directly with the government and as a result to have an easier access to information and policy formulation in other government departments and ministries.

Since national institutions for science and technology policy are entrusted with a number of cross-sectoral responsibilities, the location of an ISTP in the government structure is of significant importance. By placing an ISTP in the Office of the President or in the Prime Minister's Office where it functions directly under the Head of the Government, it serves to show an explicit commitment, at the highest level of political leadership, to science and technology as important strategic variables for stimulating sustained economic growth and it facilitates effective coordination with other development and regulatory departments or ministries.

Where both the national institutions for science and technology policy and national economic committees or councils function directly under the Head of the Government, it has generally been possible for both of these national policy formulation bodies to work in tandem and corollarily to stimulate economic growth by conjointly developing strategies for integrating technological

considerations into the national development planning process. Where such an arrangement has been put in place, generally the countries have been able to tread the path of modern technology-led national development.

The location per se of an ISTP in the Prime Minister's Office or in the Office of the President and Cabinet cannot, however, serve an ISTP to perform its catalytic role of spearheading national technology-led development in the absence of a motivated development-conscious scientific community, nor can it do so with a Secretariat staff whose strength is not commensurate with the duties and responsibilities placed upon the staff. The non-departmental institution (Zimbabwe), for example, has a small secretariat of staff based in the Scientific Liaison Office, while it was after 14 years that the secretariat staff of the institution in Malawi was strengthened. Very few of the posts created in 1988 for the institution (Malawi) have been filled.

As is evident from the discussions above, officers in the government departmental or ministerial institutions are civil servants. As pointed out previously (UNECA, op cit) terms of service in the civil service are standardized and salary scales are much lower than those in the parastatal organizations and in the private sector. This has been observed in many cases to demotivate scientists and not to be attractive enough for those with the required skills to join the government departmental or ministerial institutions. One of the institutions (Malawi) has made some proposals for the establishment of a scientific stream in the civil service with improved salaries and career paths.

4.1.2 Sectoral Articulation

In accord with the previous performance review of science and technology policy institutions, the present study has shown that the structures of the various institutions have apparently a high level of inter-sectoral linkages, intra-sectoral operation relationships and a high potential for them to increase. Mainly because of their location in government hierarchy, the institutions which function directly under the Heads of State find it easier for them to discharge the function of intra-ministerial coordination. This can be ascribed to the fact that the perceived commitment of the political leadership at the highest level to the development and utilization of science and technology as tools for development induces the ministerial S&T institutions to see the need for effective coordination.

Before the institution for science and technology was attached to the Prime Minister's Office (Senegal) all research and experimental development (R&D) centres in the country had not become hierarchically subordinated to it but to their parent ministries. The institution had no committees which could provide an opportunity for inter-sectoral and intra-sectoral linkages. Mainly because of this, the institution is now finding it difficult to execute the function of facilitating intra-ministerial coordination and inter-sectoral cooperation.

Sectoral research programmes are articulated through sectoral research councils (Malawi and Zimbabwe) in each of which the institution is represented (Malawi). Members of subject specialist committees (Malawi) are drawn from each of the scientific and technological institutions and this institutional representation has helped the institution in discharging its function of coordination. Institutional representation on the policy-making organ (Malawi) has been provided for.

4.1.3 Analysis and Commentary

The effectiveness of national science and technology policy bodies is a function of the linkage between the political and scientific system. Where it is perceived nationally that the political leadership is committed to the endogenous development of science and technology as important strategic variables for economic growth, it is much easier for ISTP's to discharge their roles effectively As also observed in the previous performance review of institutions for science and technology policy, the functions of the national institutions selected for the present study are not supported by executive powers of policy enforcement. One of the institutions which has formulated national science and technology policies (Malawi) does not have any legal instruments to enforce the requirement that all the R&D activities conducted in the country are consonant with national development goals and aspirations, nor does it have any statutory

powers to ensure that R&D activities are not continued through inertia by closely monitoring them.

One of the institutions under study (Zimbabwe) although it has statutory powers to discharge all the functions it is entrusted with, does not have the required human resources to do so. The secretariat of one of the institutions (Malawi) has been recently (1991) elevated to the status of a ministerial apex body for science, technology and environmental affairs. The review has indicated that responsibilities for implicit technology planning in the countries studied are not coordinated and that this has led them to be diffused among diverse scientific and technological institutions. Accountability among subordinate science and technology or science organizations has also been observed to be dispersed, with each accounting to its own parent department or ministries.

It is widely recognized that technology development and application is a multidisciplinary activity requiring inputs from various disciplines, institutions, sectors and activities of the economy. As nodal science and technology policy institutions, therefore, the ISTPs need to develop a network of effective linkages if their contributions are to bear the required fruits. Such linkages should facilitate the involvement of scientists in national development planning process. The exclusion of scientists from the national planning process is at variance with the prevailing view that the economic problems currently being experienced by Africa cannot be managed through economic and fiscal manipulations only. They can be resolved only when the continent is changed from a consumer group that exports mainly primary goods, which are of low technology content to a self-reliant producer of manufactured goods that, because of their high technology content, compete favourably on the international market.

It has been observed from the present study that the prevailing infrastructures for R&D and their corresponding linkages with the productive sector in most of the countries are either very inadequate or non-existent. The countries under study may wish to consider formulating science and technology policies, plans and programmes that recognize that sustained economic growth depends on the private sectors. In all the countries except two (Malawi and Zimbabwe), the private sector which is the ultimate user of technology does not feature in the science and technology policy structures. In the process of formulating a national science and technology policy in one of the countries under study (Malawi), the private sector was involved. On several committees (Malawi) and in the membership of the Council (Malawi and Zimbabwe) the private sector is represented.

4.2 Composition

In conformity with the previous study (UNECA, 1990), organizational structures, policy making bodies, committees, departments and personnel of the institutions for science and technology policy selected for the present study have been discussed albeit very briefly.

4.2.1 Organigrams

Two types of organigrams have been observed among the institutions for science and technology policy studied. The first one is the monocrotic (vertical) organigram which is typical in government departmental structures. As observed in the previous review, under monocrotic organigram there is an ascending hierarchy of institutional and human actors. In the present study one finds a Minister (Madagascar), a Prime Minister (Senegal) and Head of State and Government (Malawi) at the top of the hierarchy. The second type of organigram is the nondepartmental structure in which the subordinate organs have not been functionally integrated into the structure (Zimbabwe). At the head of the second type of organigram is a senior liaison officer who heads a small secretariat.

4.2.2 Policy Making Bodies

Several institutions under study have national science and technology policies (Madagascar, Malawi and Senegal) while one institution (Zimbabwe) is in the process of formulating one. In the departmental structures (Malawi) a draft national policy is first prepared, considered and adopted by all such relevant actors as the scientific community; the small, medium and large scale entrepreneurs; heads of government departments and ministries with significant

functions related to science, technology, economic planning and development; and heads of all constituent colleges of the university that have functions related to science and technology before it is submitted to the Responsible Minister for his consideration and approval.

As noted in the previous review (UNECA, 1990), the non-departmental model allows the policy formulation process to start at lower levels of sectors and directorates or boards. It is then screened and streamlined at committee levels, and then discussed and passed or adopted at council levels. The research team which reviewed the one non-departmental structure in the present study (Zimbabwe) has not reported on the process currently being used by the institution in formulating the country's first ever national science and technology policy.

4.2.3 Committees

As it has been observed in the previous study (UNECA, op. cit), the monocrotic departmental structures do not have statutory committees and that, as is evident in the case of one institution (Malawi) whose policy formulation process has been described above, they rely on basic organizational institutions to process policy formulation.

One of the institutions (Malawi) has non-statutory standing subject specialist committees while the other (Zimbabwe) has also standing subject committees that have statutory powers. Consideration for membership of the committees (Malawi) takes into account experience and whether or not the person being considered for membership has made a modicum mark in his or her field of specialization.

The other institutions under study have scientific research councils (Madagascar and Senegal) at each of the research centres where they are responsible for considering research projects and programmes. The research councils are accountable to their own research centres and not the national institution for science and technology policy (Senegal).

4.2.4 Departments

The present study shows accords with the observations made in the previous review that the departmental institutions for science and technology policy (Madagascar, Malawi and Senegal) have more developed departmental systems, which follow traditional government departmental type. The latter type generally has departmental structures that are different. One of the institutions (Zimbabwe) has the council type but because its secretariat is presently too small it is not divided into departments.

4.2.5 Personnel

In several institutions (Malawi and Zimbabwe) the complement of secretarial staff is presently far too inadequate to service the demands of both the scientific community and the private sector, and the grades of posts created for the staff are presently not commensurate with the duties and responsibilities placed upon the personnel. One of the institutions (Zimbabwe) presently has a liaison office manned by one professional officer who has a Master Degree in Health Administration, one librarian with a BA general degree, two typists and one messenger.

Whereas most of the posts required by one of the institutions (Malawi) were created in 1988, only a few of them have been filled. The difficulties experienced in filling the posts (Malawi) can be ascribed among other things, to what is generally observed in developing countries, which is that the strategies designed for human resources development in science and technology usually lean toward the esoteric rather than being geared to present-day view of technology as a marketable commodity. This has contributed to the failure by the developing countries to nurture and harness technology as a motor for sustained economic growth.

As pointed out above, even when the required skills are available the civil service does not generally provide an enabling environment that would attract them. It has been observed that there is need to set up an acceptable system of reward, motivation, recognition and other incentives for scientists, if they are to accept their calling as full time career scientists, ready to devote fully to their work

4.2.6 Analysis and Commentary

National institutions for science and technology policy generally are entrusted with the mandate to formulate and either implement or facilitate the implementation of national science and technology policies; to identify and promote front line areas of research in different sectors of science and technology (S&T); to develop S&T entrepreneurship; to coordinate (S&T) activities in the country in which a number of institutions in both the public and private sectors have interest and capabilities; to nurture and foster the utilization of S&T for different sectors of society and industry; to be the principal advisory organ of government on all matters relating to scientific research and technological development; and to be a nodal agency for international scientific and technological affairs.

Most of the institutions under study have been charged with these responsibilities. It has been observed, however, that most if not all the institutions do not have adequate staff to carry out these functions, nor does any of them have national machineries and institutional framework for the selection, evaluation, acquisition, adaptation and development of technologies; yet they have been charged with the responsibility of nurturing and fostering the utilization of S&T for different sectors of society and industry. The experience of one of the institutions (Senegal) purports to lend support to the argument that for sectoral articulation and for both inter-sectoral and intra-sectoral linkages to be effective, the location of a national institution for science and technology policy is of crucial importance.

After trying various forms which the national institutions for science and technology would take, and after not only placing it successively under various ministries but elevating it to the status of a full Ministry of Scientific and Technological Research, the government in Senegal finally decided to place it under the Prime Minister's Office. This decision is informed by the remarkable technological feats achieved by scientists and technologists after they have been motivated and challenged by their Heads of State and Government with vital national development tasks and goals. An explicit commitment at the highest level of political leadership to science and technology as strategic variables for stimulating sustained socioeconomic development acts as a catalyst for a propelled and sustained industrial and technological development. One of the ways in which this commitment is shown to exist is through the placing of a national institution for science and technology under an office where intra-ministerial rivalry is not given a chance to affect adversely the desire to foster and propel endogenous development of science and technology.

In some countries where Ministries of Science and Technology have been created as national institutions for science and technology policy, efforts made by the Ministries to discharge the intra-sectoral responsibilities usually entrusted to national ISTPs have been fraught with difficulties arising from intra-ministerial rivalries. Efforts by such ministries to benefit from annual budgetary provisions have often been thwarted by other government ministries. In countries where the mainstay of the economy is agriculture, Ministries of Agriculture benefit from such budgetary provisions more than Ministries of Science and Technology, particularly when agricultural research institutions are attached to their parent ministries.

In countries where R&D institutions have been moved from their parent ministries to Ministries of Science and Technology, scientific researchers have more often than not retained their layalities to their parent ministries and have generally felt that they serve with or under two masters. In the case of ministries of agriculture, such a move has not been able to facilitate a closer cooperation between agricultural scientists and extension officers. Such a close cooperation prevails where both groups serve in the same ministry under the same ministerial head.

CHAPTER 5

ACTIVITIES

5.1 Planning

It is widely accepted that in order for science and technology to play a significant role in the socioeconomic development of a country, the two variables must be integrated within the overall development strategy of the country, and that a viable correlation should be instituted between development planning and science and technology. What is currently observed in most African countries is the general lack of clearly defined and adequate national policies and legislation covering all aspects of science and technology development and acquisition.

Science and technology policy formulation, monitoring and evaluation are apparently recognized in some of the countries selected for the present review. There is, however, no evidence that in any of the countries under study, science and technology plans and programmes have been prepared. The absence of the S&T plans and programmes can be taken to explain the difficulties experienced by the countries in the development or acquisition of the technologies required to fuel and sustain economic development.

5.1.1 Policy Development

Observations made from the present study indicate that policy development in science and technology purports to the main responsibility of the national science and technology policy institutions in Malawi, Madagascar and Zimbabwe, while in Senegal there are several institutions that are reported to be responsible for S&T policy formulation.

During the review it was learned that Research Council of Zimbabwe was in the process of formulating a national S&T policy. It was also learned that in Malawi a national S&T policy was formulated and approved by the Malawi Government in 1990.

In formulating the national S&T policy, the Department of Research and Environmental Affairs which, inter alia, functions as the secretariat of the National Research Council of Malawi, drafted a policy and circulated it widely to obtain comments from local scientists, technologists and engineers, and also from those sectors where S&T are utilized. All inputs thus received were compiled and presented to a committee. Members of the committee were drawn from both the public and private sectors who were entrusted with the responsibility of examining critically the policy and proposing how best the inputs could be crystallized and incorporated into the S&T policy.

The amended S&T policy was later considered at a national conference on S&T for national development and adopted after amending it. Attending the conference were delegates from the scientific community, senior policy-makers from the public sector, and senior executives and managers from the private sector. Several of the conference's sessions were chaired by the Secretary to the President and Cabinet. It can, therefore, be said that what was adopted at the conference in 1990 and later approved by Government was a national S&T policy that reflected a high level of consensus.

While deliberating on the factors which affect economic growth in Malawi, the national S&T policy mentions, inter alia, the limitation of resources, the need to develop scientific and technological capability, the inadequate allocation and utilization of financial resources, demographic factors, the need for the integration of scientific and technological considerations with the overall development strategy of the country, and the need to train and popularize science and technology as important strategic variables. The policy also recognizes the importance of generating endogenously technologies in such strategic sectors of the national economy as agriculture and industry.

The process of policy development similar to the one employed in Malawi is currently underway in Zimbabwe. Since its inception in 1989, the Research Council of Zimbabwe has held three major conferences on S&T. The first was a

consultative meeting at which broader S&T policy issues and how they would affect the future of research in the country were discussed in addition to discussing the establishment of the proposed Scientific and Industrial R&D symposia one of which was held in 1986 and another in 1990. These conferences have had an impact on the national S&T policy which, at the time of the present study, was being drafted.

5.1.2 Programming

From the present review no evidence was adduced to show that the national S&T policy institutions selected for the study were directly responsible for the programming of R&D activities conducted in the countries. What has been observed is that R&D institute in the science and technology receive funds directly from annual government budgetary allocations.

Research and development for the primary industries has been observed to be a priority area for research in all the countries under study, and this reflects the economic importance of these industries to the nations. Because of the importance attached to these industries, particularly the agricultural sector of the economy, the annual government budgetary allocations to agricultural research and development institutes in all the countries are much higher than those made for R&D into post-production issues. The available evidence does not indicate that the R&D activities conducted by the adequately funded agricultural R&D institutes are closely monitored by the national S&T policy institutions under study. There is, however, some evidence which indicates that in some of the countries (Malawi, Madagascar, Senegal and Zimbabwe), an effort is made to coordinate the R&D activities conducted in the agricultural sector of the economy.

5.2 Coordination

5.2.1 Among S&T Institutions

In all the countries selected for the present study, R&D institutes are largely autonomous, established on either sectoral or subject basis. Mechanisms have, however, been instituted in some of the countries in order to facilitate collaboration among the institutions. In one of the countries (Malawi), the national S&T policy institution is so structured that collaboration among the R&D institutions is facilitated and close and mutually profitable relationships among themselves and with industry are maintained. This is achieved by drawing members of the subject specialist committees and of other ad-hoc committees of the STPI from the S&T institutions and industry.

A national inventory of priority areas of research and approved research projects (Malawi) serves to indicate to the scientific community, among other things, areas for possible collaborative research, and to monitor and circumvent fragmentation and overlapping of research activities between or among the R&D institutions. Collaboration is also facilitated by having the membership of the management boards (Malawi and Zimbabwe) drawn from the R&D institutes and by encouraging joint-interdisciplinary research work (Malawi).

5.2.2 Reconciliation and Harmonization of S&T Activities with National Policy

The national S&T policy (Malawi) was derived from national development goals and the R&D activities conducted in the country are in response to stated development policy objectives. The latter seems to be true for all the countries selected for the present review. As pointed out above, the R&D institutes in all the countries under study have been set up on sectoral or subject basis. They are mandated to carry out functions that are geared towards meeting objectives articulated in national development plans. The harmonization purports to be achieved directly by sectoral Ministries (Gambia, Malawi, Sierra Leone, Senegal and Zimbabwe) or by the research centres and the STPI (Madagascar).

5.3 Execution of Programmed S&T Activities

5.3.1 Programme Implementation

The programmes of the research institutes in all the countries under study are designed by the institutes themselves, and the duration of the projects is determined by the institutes. Whereas the programmes are largely long-term, the projects within the programme are of short-term duration. The national inventory of priority areas of research and approved research projects (Malawi) has been able to identify those projects whose continuation is through inertia or lack of close monitoring.

5.3.2 Monitoring and Evaluation

No evidence was obtained during this study that any of the STPIs had instituted a mechanism to monitor and evaluate the programmes or projects of research institutes; or to ensure that research projects and programmes initiated by the research institutes are completed within schedule. It was observed, however, that research institutes had a system of preparing quarterly and/or annual reports (Malawi and Zimbabwe) designed to ensure that the relevant Ministries and other interested parties are apprised of the activities conducted by the institutes during the period.

5.4 Advice

In most of the countries under study, the research institutes (Gambia, Malawi, Madagascar, Sierra Leone, Senegal and Zimbabwe) and the STPI (Madagascar) are required to publish scientific and technical reports or abstracts. These publications serve to disseminate the activities, achievements or failures of the organizations to target groups. In addition to publishing, open days are organized to show the general public the activities conducted by the institutes, and seminars, workshops, symposia and science fairs are held to disseminate the research results. These activities and feed backs from them, have contributed to advising the governments on their policy arientations.

A national information and documentation centre is established (Malawi) to facilitate the effective dissemination of the results that emerge from R&D conducted either locally or outside the country.

5.5 Advocacy

In all the countries under study, there is a gross shortage of the human and financial resources required to ensure that the programming of research activities is effectively achieved and popularized.

5.6 Commentary

It is now widely recognized that some of the main factors constraining the development and effective utilization of science and technology for economic development in Africa are the lack of well defined national science and technology policies and plans; underdeveloped technological human resources; inadequate allocation of financial resources; the lack of a well developed industrial environment; underdeveloped national machineries and institutions for industrial and technological research and development; and the underdeveloped national machineries and institutions for the selection, evaluation, acquisition and transfer of technologies.

It has been noted above that if science and technology is to play a significant role in the economic development of a country, it needs to be integrated into the national socioeconomic development planning process. This has not been done in any of the countries covered in this study. What has been observed is that although it is realized in most of the countries that technological development is the key to the countries' production problems, national planning in the countries is exclusively the responsibility of administrators and economists and scientists and technologists are not involved in the planning and execution of national development plans.

Only very few countries under study have managed to formulate national S&T policies and are reportedly in the process of preparing S&T plans and programmes. It has been observed, however, that all the countries do not at present have an in-house capacity for planning, monitoring and evaluation of R&D projects and programmes.

The present review has also indicated that the prevailing infrastructures for research and development are either

inadequate or non-existent and that strategies designed for S&T human resources development generally lean toward the esoteric rather than being directed towards the current practicalities. The latter has not enabled the countries to nurture and harness effectively technology as a potentially potent development asset.

Regarding financial resources, it has been observed that the long-term investment required for the development of science and technology is not reflected in the national budgetary allocations in the magnitude that is compatible with the role the S&T results are expected to play in the efforts to stimulate national economic growth. Investment plans in all the countries covered in this review do not have built-in mechanisms for progressive development of technological capability.

CHAPTER 6

GOAL ATTAINMENT

6.1 Planning

Although technological considerations have been implicitly considered in national development plans prepared in a few of the countries, they have not been spelt out categorically for planned action. The policy-makers in the countries should be sensitized to the fact that economic growth can be stimulated largely by developing a strategy for the effective incorporation of technological considerations into the national development planning process and that this can be achieved to involve scientists and technologists in the planning and execution of the national development plans.

6.1.1 Policy Development

Some of the countries selected for this study have prepared national science and technology policies (Malawi, Senegal and Madagascar) while one of the countries (Zimbabwe) is in the process of formulating a national science and technology policy, and the rest (Gambia and Sierra Leone) have not yet started the process of formulating a national science and technology policy.

6.1.2 Programming

In all the countries under study the programming of R&D activities at the research institute level is the responsibility of the management of the institutes. Most of the R&D institutes design the programmes in consonance with national development goals.

6.2 Coordination

In those countries which have functional national S&T policy institutions, there is no overlap between S&T institutions. Although the research institutes are managed in such a way that their spheres of activities are in their specialized sectors, collaboration between institutes involved in R&D activities in similar specialized sectors is facilitated. This is particularly true for agricultural and health sciences based R&D institutions which are encouraged to conduct collaboratively inter-disciplinary research projects or programmes.

6.3 Execution of Programmed R&D Activities

Evidence adduced during the study indicates that significant results of research and development have been obtained by research institutions in all the countries selected for the review and that this has been the case particularly in the agricultural, health sciences and social sciences fields. Although there has been a particular emphasis on the production research in the primary industries R&D programmes, and the need for this should continue, there should increasingly be a requirement for additional R&D into post-production issues such as improved market access and better ways of storing, handling and distributing products.

R&D should also be conducted in those problem areas which require solutions to enable industry to have a comparative advantage or competitive edge on the international market, and to foster rapid expansion of small-scale enterprises and self-employment. In some of the countries covered in this study (Malawi and Zimbabwe), institutional infrastructures and an environment required for the execution of post-production R&D are reportedly being explored.

6.4 Advice

Policy-makers in all the countries selected for the present review should be sensitized to the fact that because technologies are specifically generated for the purpose of achieving a competitive edge in the international market, they cannot be given away free of charge. A cost is involved in the transfer of such technologies from one economy to another and in many developing countries it is too prohibitive to permit the transfer in response to market conditions.

The attention of the policy-makers should also be drawn to the transparent fact that while the prices of the high technology

content imported by developing countries are increasing steadily, the prices of the primary commodities which developing countries export have been fluctuating widely and in some cases decreasing, and that the comparative resource advantages of some of the developing countries do not amount to anything without adequate technological input and development.

The case for allocating funds adequately to S&T institutions for the purpose of generating endogenously or adapting selected foreign technologies to local conditions should be made, among other things, within the context of these observations and with reference to the effects of the near monopoly of the developed countries in science and technology on balance of payments. With frequent reminding, the policy-makers should be able to awake to the fact that technology does serve as a motor for a self-reliant and self-sustained economic growth.

6.5 Analysis and Commentary

As was observed in the previous review (UNECA, 1990), the assessment of goal attainment has been attended with difficulties arising from the fact that there has been a general lack of inputs and indicators that can be used to define success criteria and the socioeconomic impact of the achievements. It can be averred, however, that the fact that most of the countries, in the face of rising birth-rate, have been able to produce enough under favorable climatic conditions to feed their populations may be taken to substantiate the role played by R&D in the agricultural sector of the economy.

It is generally accepted that technology content and status assessment facilitate the explicit examination of technological aspects, and can thus help in formulating policies and plans from a technological perspective. The countries selected for the present study may wish to consider this observation. To ensure that technology-based development leads to the attainment of desired macro-objectives, the countries may find it necessary to derive technological needs from national socioeconomic objectives in a hierarchical manner.

The countries may wish to know that to facilitate the formulation of action plans, the technological needs must be defined in terms of inputs required to achieve planned outputs. When preparing technology development plans, it must be recognized that technological development depends on the private sector.

The involvement of the private sector in R&D activities should be recognized as the crucial factor in determining the success to which the technologies generated are utilized.

CHAPTER 7

STRENGTHS AND WEAKNESSES

7.1 Goals and Functions

Of all the STPIs selected for the present review, there is only one (Zimbabwe) which was established by an Act of Parliament. It can therefore be stated that of all the STPIs it is only the Research Council of Zimbabwe which is empowered with statutory goals and functions.

It has been observed, however, that the effectiveness of the national science and technology policy institutions appears to be governed largely by factors other than those related to whether or not the institution has statutory functions. The lack of control by all the STPIs of funds allocated to the research institutes makes it impossible for most of the institutions to ensure that the funds are disbursed for the purpose of conducting research that is relevant to national development needs and goals.

All the science and technology policy institutions are charged with the function of coordinating all R&D activities conducted in their respective countries. One institution (Zimbabwe) is experiencing difficulties in its attempts to discharge this function because of the gross shortage of human resources in its Secretariat. Although the institution (Malawi) has no statutory functions, it finds it easier to discharge its functions with an increase in the staffing strength of its Secretariat and in the financial allocations.

7.2 Organization

7.2.1 Structure

The science and technology policy institutions in the two of the countries studied are under the Office of the President and Cabinet (Malawi and Zimbabwe) while in Senegal the institution is in the Prime Minister's Office. The science and technology policy institution in Madagascar has an overall responsibility for S&T policy formulation and planning.

By having the Head of State as its Responsible Minister, the Secretary to the President and Cabinet as its Chairman and the Secretary to the Treasury as one of the Ex-Officio members of its Board, the institution (Malawi) finds it much easier to obtain the financial support it requires to discharge its function.

Available information indicates that the national science and technology policy institutions in Malawi and Zimbabwe discharge their functions through the committee system while those in Madagascar and Senegal work through scientific research councils at each of their research centres. The research projects or programmes executed by the S&T institutions in the six countries under study are supervised and controlled by their parent organizations. The Research Council of Zimbabwe has the statutory functions, among other things, to exercise general supervision and control of the research councils or research institutes in order to ensure that the research programmes are conducted as approved or amended by the Council. The institution (Zimbabwe) is not, however, able to discharge this function because of shortage of human resources and inadequate allocation of financial resources.

The STPI (Malawi) is not empowered to exercise general supervision and control of the research institutions. It is, however, able to obtain titles and experimental details of all research projects conducted in the country for publication and distribution to all interested parties in order to foster collaboration.

7.2.2. Composition

In the four countries that have STPIs, the apex policy-making bodies are the National Research Council of Malawi, the Research Council of Zimbabwe and the Ministry of Scientific and Technological Research for Development (Madagascar). In Senegal there are three bodies that are entrusted with the responsibility of formulating policy in S&T research.

The Research Council of Zimbabwe "has, at one time, ten to fifteen members" and is "run as an extra-curriculum activity by

researchers and academics who are full time professionals elsewhere", and its Secretariat has only "two professionals".

As indicated above, the National Research Council of Malawi comprises twelve appointed members who are specialists in the main scientific disciplines including social sciences or persons involved in technology-related activities plus Principal Secretaries of Government Ministries with functions related to science and technology. These are appointed by the Head of State who is the Minister Responsible for the Council. The Chairman of the Council is the Secretary to the President and Cabinet who is also Head of the Civil Service.

No information was available to indicate the composition of the other two STPIs (Madagascar and Senegal).

7.2.3 Linkages

Since most of, if not all, the countries selected for the present study are agricultural, linkages at the level of the agricultural sector of the economy is generally strong in that the agricultural extension services systems are well established and that R&D results are disseminated to end-users either through the extension services or in some cases directly.

It has been contended in the previous study (UNECA, 1990) that the observed weakness in the linkages at the level of science and technology institutions could be ascribed partly to the fact that the coordinating role of STPI's over all S&T institutions under them to the was not backed by the requisite legislative powers. The observations made in the present study do not support this contention.

Although not backed by the requisite legislative powers, one of the STPIs selected for the present review (Malawi) has been able to forge a strong linkage with the S&T institutions. This success may be attributed to (a) the composition of the Council which has the Head of the country's Civil Service as Chairman and Heads of the Ministries with function related to science and technology as members; (b) the fact that the Council's Secretariat has been elevated to the status of a national apex body for S&T concerns and placed in the Office of the President and Cabinet, with its Head at par in rank with the Heads of S&T Ministries, thus creating an easy relationship between the STPI and the S&T institutions at the highest level of institutional leadership; (c) the involvement of senior members of STPI in the councils or committees of the S&T institutions and vice versa; and (d) the fact that the Minister responsible for both the Council and the Department of Research and Environmental Affairs is Head of State, which is an explicit reflection of the desire of the leadership at the highest political level that the country's resources must be utilized effectively by avoiding overlapping and fragmentation of R&D effort through effective coordination.

7.2.4 Powers

A stated above one of the STPIs selected for the present review has statutory powers (Zimbabwe) which puts it in a strong position, among other things, to exercise its regulatory and coordinating functions as well as monitoring and evaluation of research projects or programmes conducted in the country by S&T institutions. Lack of resources, however, makes it impossible for the institution to discharge its functions. An explicit commitment at the highest level of political leadership to science and technology as tools for socioeconomic development facilitates the STPI (Malawi) to discharge its functions effectively.

7.3 Resources and their Utilization

7.3.1 Human Resources

The findings of the present study accord with the general observation that the most critical constraint in African countries to the development and effective utilization of S&T for socioeconomic development is the acute shortage of scientific and technological capabilities not only in terms of quantity but also in terms of diversity and level of competence. The available evidence shows that in all the countries there is an acute shortage of, to name but a few cadres, industrial designers, production and process engineers, engineering draughtsmen, food technologists, and quality control personnel. This can be ascribed to several factors one of which is that national universities have not taken measures to diversify their course options so that they may respond to the needs of the economy.

Engineering training programmes, for example, continue to be geared to the production of civil, electrical and mechanical engineers.

Lack of suitably qualified personnel has led most of the countries to have persons who are not suitably qualified in positions where they make policies that in many cases adversely affect national programmes for the development of S&T capacities and capabilities. Yet, of coordinating the preparation and implementation of national science and technology plans and programmes, the development of special capabilities is needed in all the African countries. The absence of science and technology plans and programmes, prepared on the basis of well defined S&T policies, in most of the countries under study may be attributed in part to shortage of the required S&T capabilities.

7.3.2 Material

Some of the national science and technology policy institutions studied have fairly well established scientific and technological infrastructural facilities. The number of items of laboratory equipment that require repairs (Malawi) calls for the establishment of a centre where the laboratory equipment can be serviced or repaired and where technicians can be trained.

7.3.3 Financial Resources

In each of the countries under study, the government is the main source of funding for research and development activities. This is done through annual budgetary allocation to R&D institutions through their parent government ministries, universities and parastatal bodies. The funds are allocated for both recurrent and capital expenditure.

It is evident from the findings obtained from this study that the funds provided through this source are not adequate and their availability are not on predictable and sustainable basis. The latter makes it impossible for research programmes to be pursued consistently. It has also been observed that in most of the countries the bulk of the recurrent budget is spent on personnel emoluments and that as a result very little is left to fund the execution of research programmes.

The private sector which in most of the countries is largely composed of multinational companies rarely play a role in the funding of research activities conducted locally. Instead of establishing R&D facilities locally the multinational companies depend on the R&D facilities established at their home bases. In order to encourage the private sector to involve itself in local R&D activities, one of the STPIs (Malawi) has proposed the establishment of incentives.

In all the countries under review funds for R&D activities are also obtained from international, bilateral and multilateral donor agencies. The funds are used to support the execution of research programmes largely in the agricultural sector of the economy.

Proposals have been made in one of the countries (Malawi) to set up, by an Act of Parliament, a Research and Development Fund. It has been proposed that the Fund should be used to finance priority development projects identified by the Council's Committee on Scientific and Industrial Research and Development.

7.4 Comments

It is recognized that as long as governments in the countries remain the main sources of funding for R&D activities, the efforts to develop technologies that will fuel economic growth will be fraught with difficulties. An enabling environment should be created so that the private sector may see the benefits of involving itself in local R&D activities. It has been observed elsewhere that the innovative high technology base that has nurtured the success of the venture capital concept as seen in the developed countries is absent in African countries. The national science and technology policy institutions should explore the possibility of fostering the establishment of venture capital companies in their respective countries.

In each of the countries there is an urgent need for the development of scientific and technological human resources, and this should lean toward not the esoteric but present-day practicalities in order to nurture and effectively harness this potential potent development asset. The S&T human resources should have a

balanced skill structure for its effective utilization in each of the countries. The prevailing infrastructures for R&D and their corresponding linkages with the productive sector need to be either established or strengthened.

CHAPTER 8

RECOMMENDATIONS

The recommendations contained in this chapter are based on observations made from the present review. Their successful implementation will depend, in the final analysis, on the ability of the science and technology policy institutions (STPIs) in the countries where such bodies have been created, or of the scientific community in the countries which have not yet established STPIs, to create and sustain an awareness among decision-makers regarding the fact that the comparable economic advantage of nations resides not in naturally provided factor endowments but largely in the quality and quantity of human intellectual resources, as expressed through national capability in science and technology. It olso depends on in the decision-makers' will and capacity to develop and harness their national scientific power and technological prowess in order to achieve excellence in meeting national development goals.

8.1 Goals and Functions

1. The two countries (Gambia and Sierra Leone) which have yet to create science and technology policy institutions should take action to establish such bodies and, in order for them to have an impact at the national level, ensure that STPIs are nationally recognized as apex policy-making, planning, coordinating and promotional bodies of the governments for all matters connected with the development and effective utilization of science and technology for socio-economic development in the countries.

2. It has been observed that in all those countries which have created STPIs the goals and functions of the institutions have been spelt out either explicitly or implicitly. The goals and functions should be articulated explicitly in statutes and be made known to all S&T institutions in each of the countries.

3. The goals of the STPIs covered under the present review seem to reflect the desire of national governments to use science and technology as tools for bringing about socio-economic development. This can be achieved only if measures are taken to integrate scientific and technological considerations in the national development planning process. To achieve this end it is recommended that scientists and technologists should be involved in the planning and execution of national development plans.

4. The integration of the scientific and technological considerations should be predicated by the availability of well defined national science and technology policies. To achieve success in the implementation of the national S&T policies, the STPIs should prepare comprehensive science and technology plans as an integral part of national development strategy, consistent with overall social and economic development objectives and policies, and should foster the development of the required scientific and technological capabilities.

5. For the STPIs to carry out their functions effectively, the statutes of the S&T institutions over which the functions are to be exercised need to reflect this role. Accountability channels for S&T activities should, therefore, be established with a view to providing a clear hierarchy that serves to guide without any ambiguity the roles of the different S&T institutions.

6. The promotion of science and technology development and utilization is one of the functions of the STPIs. In order to achieve this objective, the STPIs should foster the establishment of national science and technology development centres at strategically selected locations where they can best propel and sustain the technology development and utilization effort.

7. It has been noted from the present review that the channels for the dissemination of scientific R&D results are mainly through annual and quarterly reports; newsletters; scientific journals; information storage and retrieval centres; participation at conferences, workshops and seminars; mass media coverage; and agricultural extension services. The extension service has not, however, been used as a channel for disseminating scientific and technological innovations obtained from the other S&T fields. The STPIs should, therefore, institute extension services in those S&T fields where this channel has not been established, and make concerted

efforts to inculcate a science culture into the populace so that it may be aware of the importance and impact of technological innovations in their daily lives.

8. One of the constraints affecting the development and utilization of S&T for development in the countries covered under this study is the absence of national mechanisms for the commercialization of scientific and technological R&D results. The STPIs should therefore establish appropriate institutional arrangements for the development and commercialization of technologies endogenously developed, as well as the creation of S&T capabilities required for the diffusion, absorption and upgrading of both the endogenously developed technologies and foreign technologies.

9. What is advocated in the latter part of recommendation 8 above is a "make-some-buy-some-technology" strategy which, if adopted, may help to expedite the process of promoting science and technology development and utilization for a sustainable socio-economic development. This strategy calls for the selection, evaluation, acquisition and transfer of environmentally sound and socially compatible technologies that are supportive of sustainable development and non-threatening to the ecological balance. Since in all the countries under study such machineries and institutions are non-existent, the STPIs should foster their establishment.

8.2 Organization

8.2.1 Structures

1. Well defined organizational and accountability hierarchies should be put in place. There is need to institutionalize technical committees in order to enable them to contribute effectively to the organization.

2. Those science and technology policy institutions which are of government departmental or ministerial type should be so organized that their functions are not constrained by the bureaucratic procedures or practices of the civil service.

3. All science and technology policy institutions should be recognized and encouraged to operate as professional bodies with dynamic organizational structures that respond readily to the changing world of technology and allow free and easy flow of information, clear responsibility and accountability, and easy upward mobility.

8.2.2 Composition

1. The STPIs should have their membership drawn from the scientific community, the relevant government departments or ministries, and the private and small-scale sectors. This should serve to encourage an evolution of an interface between researchers, government and the private sector, and to strengthen the link between policy-makers, researchers and users of technology.

2. There should be a minimum of delegation and sub-delegation of representative roles at meetings of science and technology policy institutions.

3. Centralized government funding for science and technology activities among all institutions may reduce the strains that often block agreement among institutional representatives at council level.

8.2.3 Linkages

1. National science and technology policy institutions should be conferred with the power and confidence to involve themselves not only in the preparation of science and technology plans and programmes but also in the monitoring and evaluation of all the research projects/programmes conducted in the countries. This should facilitate inter-sectoral linkages.

2. All the science and technology institutions should be made accountable to one coordinating body preferably one that is answerable directly to the Head of State and/or Government. This should increase operational linkages between S&T institutions.

3. Effective and viable working arrangements and linkages between the national science and technology policy institutions, sectoral science and technology institutions, government policy-makers, and private and small-scale sectors should be developed.

4. Networking of information and documentation centres should be established in order to facilitate easy exchange of information.

8.3.4 Powers

1. The power structure of subordinate or associate science and technology institutions should be clearly defined in order to avoid role-conflict and to make them well aware that they are accountable to national science and technology policy institutions on matters of S&T policy.

2. Those STPIs which have regulatory functions should be given more comprehensive statutory powers over the S&T institutions they are supposed to regulate.

3. In order to accelerate the implementation of set policies, the science and technology policy institutions should be given more executive than administrative powers.

8.3 Resources

1. In all the countries selected for the present study the central governments are the main source of funding for R&D activities and the amounts of funds provided through this source are far below one per cent of GDP. Action should be taken by governments of the countries to raise the level of funding.

2. In addition to the inadequacy of funds, there is also the problem of ensuring that the funds are available on a predictable and sustainable basis. A special Fund for Science and Technology Development should be established in each of the countries. The Fund should be sustained through contributions from government and voluntary donations from the private sector.

3. In each of the countries, government should enact legislation for the purpose of creating an enabling environment for the participation of the private sector in the endogenous technological development. Financial, fiscal and institutional incentives are some of the essential ingredients of the enabling environment. Financial incentives take the form of low-interest lending programmes by national banks and government commissioning R&D activities to private sector while fiscal incentives take the form of tax deductions on companies involved in local R&D activities, accelerated depreciation on R&D investment and reduction on capital tax of venture capital companies. Institutional incentives foster inter alia, the setting-up of National R&D Corporations that are used to finance the generation of technologies for industrial application and to commercialize R&D results.

4. The science and technology policy institutions should establish engineering and technological units and make concerted efforts to commercialize their technology generated products so as to expand their source of funds.

5. Infrastructure for research and application of science and technology should be given the attention it deserves through supply of all the necessary materials and inputs, and more careful use of the existing ones should be made.

6. The development and maintenance of a strong S&T base in any country depends enormously on the quality of science and mathematics teaching achieved in schools, and the creation of opportunities for gifted individuals to pursue research in science as a full-time career. A career structure in which there is a significant degree of security, and a realistic prospect for career development should therefore be established. The quality of science and technology subjects taught should be strengthened and consistent with indigenous research needs.

7. Funds should be allocated to establish access to facilities abroad for outstanding researchers in fields which will provide long-term benefits to national science and technology.

8. Since the countries share similar development problems and possess different and in some cases complementary strengths, it may be found beneficial to create the critical mass required to address common problems by exchanging and sharing resources across national boundaries.

CHAPTER 9

CONCLUSION

What has emerged from the present review is an observation which is common to most African countries that the technology environment in which scientific and technological activities can be nurtured for rapid socio-economic development is absent in the countries. This can be attributed to colonial legacies. The colonial educational system was geared towards the production of bureaucrats and technocrats who were needed to service the administrative set-up of the colonial government.

The research activities which were then conducted were aimed at increasing the production of primary commodities that were required by industries in the colonizing countries. This led to the establishment of scientific and technological institutions which were not planned, within the context of national policies and plans, to respond not to the needs of the colonies but to the needs of the colonizing countries. With the advent of political independence, most of the African countries did not modify the institutions so that they should be responsive to national needs.

Indeed when most of the African countries gained political independence no action was taken immediately to re-examine the educational systems they inherited in regard to their capacities to produce scientific and technological skills needed to transform scientific knowledge into technological goods and services. This has led to the acute shortage of scientific and technological capabilities currently observed in the countries.

The African countries cannot afford to remain complacent with a technology environment in which research and development activities are geared only towards an increased production of primary commodities at a time when the prices of primary commodities in international markets are fluctuating widely and in many cases even dropping considerably. It is incumbent upon the leadership of the national science and technology policy institutions to awaken the decision-makers in their respective countries to the fact that there is a steady shift of comparative economic advantage away from naturally derived factor endowments.

The decision-makers should be made aware of the fact that in the industrialized countries the generic technologies are now being harnessed by all branches of industry in ways which transform the nature of products and services, and that new materials, dematerialization and recycling are reducing the comparative economic advantage of resource dependent countries.

It should also be realized that technology is now a marketable commodity which is developed for the purpose of achieving a competitive edge in the international market. This type of technology is never given away free of charge. Actions to be undertaken in the African countries are: the creation of societies that are scientifically and technologically literate; the nurture of conditions that are favorable to technologically-based entrepreneurs; the re-examination of educational systems in regard to their capacities to produce the requisite scientific and technological skills; the preparation of comprehensive S&T policies and plans; the integration of technological consideration into the national socio-economic development planning process; and the strengthening of technological infrastructure.

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