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**WORLD PLAN OF ACTION**



**AFRICAN REGIONAL PLAN**

**for the Application of  
Science and Technology  
to Development**



**UNITED NATIONS  
ECONOMIC COMMISSION FOR AFRICA**

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## THE AFRICAN REGIONAL PLAN

### INTRODUCTION

#### Background

1. The objective of the World Plan of Action (WPA) is to provide a framework for the United Nations Organization and its agencies to collaborate with and to provide assistance to developing countries for the conception and implementation of action programmes, in a number of selected sectors of their economies, which will be directed towards creating or reinforcing the infrastructure necessary for the application of science and technology to development in the developing regions of the world.

2. The Global Plan for the WPA was completed by the United Nations Advisory Committee on the Application of Science and Technology (UNACAST) early this year and has been published by the United Nations as document E/4962/Rev.1. The Global Plan is an indicative plan which sets out the global objectives, the areas of priority for action, and the types of action proposed by the Advisory Committee for United Nations action and support. As such, it provides a framework for further planning and action at the regional level.

3. The second stage of the World Plan of Action is the preparation of the Regional Plans of Action. It has been decided that the Regional Plans should be in the form of selected programmes, in the relevant sectors of the Global Plan, chosen to reflect regional priorities. For the African Regional Plan, the country surveys <sup>1/</sup> of needs and priorities prepared for the member countries in the African region specifically for the World Plan of Action have been used as a guide. In addition, submissions which have been made available by relevant specialized agencies in different sectors have also been utilized as source materials in the preparation of the Plan.

4. The Regional Plan is intended to furnish the framework and provide an envelope for the different types of projects which may be identified in answer to specific needs and priorities at country level. In accordance with ECOSOC resolution 1638(LI), the Regional Plans are being prepared by the Regional Commissions. They are intended to be used as guide documents for the preparation of the country programmes for the World Plan of Action.

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<sup>1/</sup> Survey of Needs and Priorities in Science and Technology, World Plan of Action. ECA documents S&T/WPA/1-41.

### Structure of the African Regional Plan

5. The African Regional Plan is divided into ten chapters, each of which deals with one of the ten sectors adopted for the plan frame at the Fifth Meeting of the UNACAST Regional Group for Africa in October 1970.<sup>2/</sup>

6. In each chapter the importance of the sector to overall economic and social development is discussed. Similarly, the main issues in the sector, in those areas where science and technology intervene and the types of actions which are considered necessary to undertake under the World Plan of Action to promote the contribution of the sector to development are also dealt with.

7. The discussion of issues is followed in each chapter by a statement of the objectives adopted for that sector, which the programmes in science and technology within the sector will be directed towards realizing. After the statement of objectives follows a number of programmes in each chapter. The programmes are selected so that adequate coverage of the range of needs and priorities reported at country level by the country surveys, and by other source documents is obtained through a minimum number of different programmes that will satisfy the objectives envisaged.

8. Under each programme, the number of sample projects are given for illustrative purposes only. It is not intended that the projects listed under each programme are exhaustive; but they have been introduced to enable those concerned with the selection of projects for the preparation of the country plans to have a guide as to the type of projects which will fit into each programme.

### Preparation of Country Plans for the World Plan of Action

9. The next stage of elaboration of the Plan will involve the selection of projects for each country in the main sectors of the WPA and the preparation of preliminary cost estimates for their execution. It is the intention that the preparation of country plans be guided by the following principles, namely:

- (a) Each country should make a choice of its own projects within the framework of the Regional Plan;
- (b) In the preparation of project descriptions and plans, assistance will be made available on request by the United Nations system of organizations. This is in conformity with the original spirit of the World Plan of Action that the United Nations organizations assist the developing countries by providing expertise for project design.

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<sup>2/</sup> See Report of the Fifth Meeting, UNACAST Regional Group for Africa, ECA document E/CN.14/542.

10. In order to prepare the national plans for the World Plan of Action, it will be necessary to set up, as early as possible in each member country a National Committee for the World Plan of Action under the aegis of the Ministry responsible for Planning and Economic Development and subordinate to the planning commission. This Committee will include representatives from the different ministries of Government which are responsible for the different sectors of national activities mentioned in the Regional Plan. The National Committee should also include a representative of the Ministry of Finance. The regional economic commission will provide an expert concerned with the elaboration of the World Plan of Action, who will liaise with the National Committee and will assist the Committee in its work as may be required.

11. Each National Committee so formed will be charged with the responsibility of studying the proposals in the Regional Plan and, taking account of the existing national development plans, of selecting the programmes and projects which each country would like to see implemented within the framework of the World Plan of Action. As regards the institutional needs of African countries science and technology, country surveys are being conducted on behalf of the UNACAST and will be published when available.

#### Financing of the World Plan of Action

12. The question of financing the projects at country level defined within the World Plan of Action is being examined by the United Nations and in particular by the UNDP and the World Bank. Various proposals are under consideration, which range from a proposal to set up a United Nations Fund to be managed specifically for the benefit of projects under the WPA, and other proposals that existing United Nations financing organizations allocate, as a matter of policy, a definite proportion of their financing programme for projects to be submitted under the aegis of the World Plan of Action. However, further information on this subject of financing has to await the deliberations of ECOSOC at its fifty-first session as well as those of the Advisory Panel on Programme Policy of the UNDP which is also considering the question.

## Chapter I - GENERAL DEVELOPMENT OF SCIENTIFIC AND TECHNOLOGICAL CAPACITY

### GENERAL DEVELOPMENT OF SCIENTIFIC AND TECHNOLOGICAL CAPACITY

#### INTRODUCTION

13. One important information which was obtained from the field surveys <sup>3/</sup> of needs and priorities in science and technology in individual African countries is that there is widespread recognition at senior government and other levels of the fact that science and technology could contribute greatly to economic development. However, the same survey revealed that this recognition, by and large, does not reflect itself in policy-making or planning for development, and most of the government officials who recognize the importance of science and technology do not really know in what ways to use them for promoting development.

14. This absence or uncertainty of action on science and technology stems in part from the general shortage of officials with scientific training in decision-making positions in government machinery, and in part from the fact that there is, in the majority of countries, no department or section of the government administrative apparatus which has the specific responsibility for dealing with science and technology as a regular or integral part of government business.

15. If there is recognition, however unprecise, of the importance of science and technology for development at the level of senior government officials, this is nowhere in the case of the general public and with opinion leaders in the political life of the country. For most of the general public, science and technology means Russian satellites, American moon trips, and the esoteric activities of impractical scientists in university research laboratories. These impressions exist because this is the only image of science projected by mass media. It is further strengthened by the fact that science instruction is not widespread in school teaching, even at secondary level. Where science is taught in schools, it is primarily an option for those who are going into professional training for which science subjects constitute the entry requirements.

16. In order to be able to utilize science and technology for development, there must be a creation of government organs for deliberating on scientific and technological affairs, and for policy-making. Supporting departments for planning and managing the scientific and technological activities of Governments also need to be set up. However, for consistent and systematic benefits to be derived from such activities, they have to be based on a coherent plan which is related to the objectives of social and economic development. This means that each country requires to elaborate a Technological Development Plan

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<sup>3/</sup> Surveys of Needs and Priorities, WPA.

which will have two main facets: one will be the development and expansion of the country's scientific and technical potential, the second will be the orientation and expansion of research activities so as to develop or acquire the necessary technologies for the increase of productivity in all sectors of the country's economy.

17. The situation of the scientific and technical communities in the African countries and the prevailing attitudes to them at government and often at the general public level is dysfunctional for any plans to utilize science and technology more effectively for development. At government official level, decision-making power is in the hands of an administrative elite with an essentially non-science culture. Hitherto the official attitude has been that scientists and technologists do not participate in administrative policy or decision-making, but should be available to answer technical questions if asked. The prevailing attitude of benevolent tolerance towards scientists and technologists in government departments is gradually changing to one of alarm and obstruction, as the tendency of this category of persons to obtrude themselves into administrative decision-making becomes more pronounced in the definition of development plans in scientific and technical fields.

18. There exists, as a consequence, a resistance to the further entry of scientists and technicians into decision-making levels of the government administrative machinery which has all the features of a power struggle to "keep the new boys out". This resistance must be removed if the African countries are going to be able to incorporate science and technology into government business and use it to promote the well-being of their people.

19. On the side of the scientific and technological community, there are also entrenched attitudes which are not conducive to their playing a useful role in the area of development. The prevailing traditions and practices of these communities wherever they are well organized, appear to be directed towards preserving their privileged positions as an independent élite which will remain a charge on the community in terms of economic support, but which should be left independent and free to pursue what science it wants. Many scientists in universities in Africa look on their institutions as a place of refuge from involvement in the hurly-burly of the real world around them. Hence the science communities frequently have the attitudes of a priesthood which is the custodian of science for posterity rather than for today's use. This tradition of academic detachment and excessive concern with the maintenance of "scientific liberty" has resulted in a situation in which scientists and technologists have little influence on public policy. The tradition is, of course, being eroded by the impact of outside developments, but a more conscious effort is required to make the full changes necessary in the orientation of the scientific and technological community in order to mobilize them for active participation in development.

20. A subject of great importance for the African countries is international co-operation in science and technology. At present, international co-operation is largely conceived and organized in the form of attendance at conferences by established or eminent scientists and technologists, or the occasional interchange of visits, again by established scientists. This may be very useful for the future enhancement of the reputation and status of established scientists, but is almost completely unproductive in so far as contributions to the expansion of the scientific and technical potential of the African countries is concerned, or in terms of contributing to programmes for the promotion of development.

21. International co-operation in science and technology needs to be conceived of in other terms than just the provision of further opportunities to enhance the reputation of those who already have one. More specifically, international co-operation can be fruitful in the provision of further training and experience for younger scientists and technologists who will perhaps become famous tomorrow, but who have to carry out tasks defined by the research and development needs of today. International co-operation can also be of considerable assistance in the actual work of solving individual research problems and the developing or adaptation of the technologies required for production in various sectors of the African economies.

#### Objectives

22. The purpose of this sector of the plan is to promote and reinforce the development of technological independence in the countries of the region. The objectives which are selected to guide action to this end are as follows:

- (a) The development of national organs for the consideration of scientific and technological affairs and for the determination of national policies in these spheres;
- (b) The creation of an informed public, at all levels, on the importance of science and technology in human affairs, and the potential offered by the appropriate use of technology for the development of human society and the improvement of the physical conditions of life;
- (c) The institution of scientific and technological planning as a regular component of development planning. Each Government should create the organization for elaborating short- and long-term scientific and technological development plans which will be parallel in time to and supportive of the social and economic development plans;

- (d) The development of new concepts of international co-operation in science and technology by the Government and the scientific and technological community acting together. Such new concepts will take advantage of the resurgence in the recognition of the responsibility to assist the developing countries in the use of science and technology which is taking place in the developed countries both in government thinking and in the attitude of their scientific and technological communities;
- (e) The reinforcement of the national network of institutions for science and technology by the establishment of a limited number of institutions for training high-level manpower, and for research. Each of these institutions will have a mission directed to the development of new technology and the production of trained manpower for some sector of the national economy. The current popular terminology for the institutions envisaged here is "Centres of Excellence";
- (f) A considerable reorientation and mobilization of the scientific and technological communities in each country. The scientific and technological community requires to re-define a role as an integral, contributing estate in the mainstream of national life and should reorganize itself to fulfil this new role.

23. The public will also need to be re-educated on the new role of its scientific and technological community so that it can revise some of its traditional misconceptions about them, and develop the necessary attitudes to enable the nation to make the best use of its human, scientific and technological potential.

24. The following programmes are proposed in this sector for the African Regional Plan.

Programme I -- CREATION OF NATIONAL STRUCTURES FOR POLICY-MAKING AND PLANNING IN SCIENCE AND TECHNOLOGY

25. The projects proposed under this programme provide for the creation of organizations to undertake national policy-making and planning and for the training of the strategic scientific and technological personnel required for the operation of these organizations.

Project (a) : Creation of national science and technology decision-making machinery at ministerial level

Such national science and technology machinery (ministerial council or committee) will be responsible for deciding on overall national objectives and policies in science and technology, for deciding on the level of national expenditure on science and technology, and for deciding on the implications of national scientific and technological policies in such areas of government business as defence and foreign affairs.

Project (b) : Creation of government departments (or ministries) of scientific and technological affairs

The functions of such departments will include broadly the servicing of the ministerial decision-making machinery in science and technology, the preparation of matters for consideration by the ministerial council or committee, and general study, planning and administration in respect of national scientific and technological affairs which form a part of government business.

Project (c) : Creation of national research councils

Such research councils (which may be set up for all scientific and technological research, or for different subject areas) will advise and assist the government department of scientific and technological affairs in the expansion and management of the national network of research institutions.

Project (d) : Training of science administrators for the management of research institutions and research programmes

Project (e) : Training of personnel for scientific and technological forecasting and planning

Project (f) : Elaboration and definition of appropriate legal statutes for the employment of scientific workers in public service

Programme II - CREATION OF AN INFORMED PUBLIC IN SCIENCE AND TECHNOLOGY

26. The creation of an informed public on science and technology should include all levels within the nation. This should be organized in the form of continuing programmes and activities and should provide the opportunities for national discussion and debate on issues of science, technology and the public interest.

Project (a) : Study tours of government science ministries (departments, bureaux, etc.) and research establishments in developed countries for ministers and parliamentarians from African countries

Properly conceived and planned, such study tours offer the quickest and most effective way of demonstrating to members of Governments and to political leaders in African countries, the depth and the extent of government involvement in science and technology which is necessary in a modern State.

Project (b) : Establishment of science and technology museums

Project (c) : Promotion of science journalism

This would include the promotion of such developments as science news and features in major newspapers, science magazines, radio and TV science programmes. It will be necessary to provide courses in science journalism at a few universities or technical colleges.

Project (d) : Organization of a series of regional seminars around the general theme of science, technology and public policy

Possible subjects for such a series are:

Science and Technology and National Development  
Science and Technology and National Security  
Science and Technology and Foreign Policy  
Science and Technology and Industrial Development  
Science and Technology and Agricultural Development  
Science and Technology and Natural Resources  
Science and Technology and Environmental Conservation  
Science and Technology and Public Health  
Science and Technology and Employment  
Science and Technology and Human Rights  
Science and Technology and Religion.

Programme III - INTRODUCTION OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT  
PLANNING PARALLEL TO AND SUPPORTIVE OF SOCIAL DEVELOPMENT  
PLANNING

27. There is a need for studies directed towards developing methodology and procedures for technological planning. This will take place initially at the same time as work is undertaken on the preparation of technological development plans. An important part of the task of technological planning will be the identification and the collection of the kinds of data which will constitute the inputs to technological planning.

Project (a) : Preparation of national census (or inventory)  
of scientific and technological potential

Project (b) : Preparation of national scientific and technological development plans

Project (c) : Preparation of national plans for the transfer of commercial technology

Programme IV - ESTABLISHMENT OF FORMAL MACHINERY FOR INTERNATIONAL CO-OPERATION IN SCIENCE AND TECHNOLOGY

28. The establishment of formal machinery for international co-operation will normally be sponsored and supported by the Government. However, the creation and operation of the machinery should be done, in close collaboration with the national scientific and technological community including professional associations and universities.

29. Projects which are proposed under this programme are:

Project (a) : Organization of exchange schemes for scientists and engineers (international as well as intra-African)

Such exchange schemes should enable scientists and engineers from African countries to obtain experience in teaching, research, design and construction in foreign universities, in government scientific and technical research establishments, in large engineering corporations or on engineering projects in other countries.

Project (b) : Organization of joint research programmes in co-operation with neighbouring States and other countries having similar or related problems of research interest

Research into environmental and natural resources utilization problems are particularly suitable for this form of international co-operation.

Project (c) : Establishment of funds for financing participation of African scientists and engineers in international scientific and technical research programmes, conventions, etc.

Programme V - ESTABLISHMENT OF INSTITUTIONS FOR ADVANCED (POST-GRADUATE) TRAINING AND RESEARCH

30. The concept of centre of excellence implies an institution devoted primarily to post-graduate training and research in a subject of special relevance to the solution of development problems. As enunciated by the African States at a number of regional meetings, 4/ the idea is for the

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- 1/ (a) OAU Council of Ministers, September 1967, resolution CM/RES.116(IX).  
(b) UNESCO-OAU Conference on Education and Scientific and Technical Training in Relation to Development in Africa, 16-27 July 1968, resolution IX.  
(c) OAU Council of Ministers, September 1968, resolution CM/RES.171 (XI).

establishment of a network of institutions each specializing in a branch (or branches) of knowledge related to the exploitation of natural resources, or to the development of technology for particular industries, or to the solution of specific problems of infrastructural development. The centres may be regional or national in status depending on the field of specialization.

31. It is proposed that a limited number of institutions mission-oriented to the study and solution of development problems of scientific or technological nature be included in this sector of the WPA. The institutions proposed are the following:

- (a) Centres of excellence in applied science and technology;
- (b) Centres of excellence in earth sciences;
- (c) Centres of excellence in mineral preparation and extraction metallurgy;
- (d) Centres of excellence in machine design;
- (e) Centres of excellence in food technology;
- (f) Centres of excellence in marine science and technology.

Programme VI - ORGANIZATION AND MOBILIZATION OF THE SCIENCE AND ENGINEERING COMMUNITY

32. The projects under this programme are directed to the scientific and engineering communities in the different countries. In the main, the action that will be required from the United Nations system will be in the form of advice and technical assistance support. In some countries, the science and engineering communities already have their professional associations, in some cases very well established. For such countries Project (a) under this programme is not applicable.

33. Four projects are proposed under this programme.

Project (a) : Formation of scientific and professional engineering associations

This project is applicable at the national level only to countries having sizeable science and engineering communities. Sub-regional associations may be more appropriate in some parts of the continent. Where national associations already exist, they could be strengthened by bringing them together at the regional level for co-operative activities.

Project (b) : Establishment of national academies of science or equivalent organizations

Project (c) : Promotion of national codes for professional accreditation and practice

Project (d) : Promotion of scientific and engineering conventions, congresses, etc., at regional level

The strategies and plans for planning and implementing the projects under this programme will require the prior establishment of close personal contacts between the United Nations officials concerned and leading members of the science and engineering communities in the countries of the region.

Programme VII - THE ESTABLISHMENT OF INFORMATION AND DOCUMENTATION CENTRES

34. The need for centres for the storage and provision of information on science and technology, particularly on available technology and scientific research is well recognized. One such centre which is being planned at global level is the UNISIST project which is being developed under the aegis of the United Nations by UNESCO and ICSU. Less elaborate centres but with a similar mission require to be established at national and regional levels.

## Chapter II - NATURAL RESOURCES DEVELOPMENT

### Introduction

35. In a very broad sense "natural resources" are represented by all the elements of the material environment which influence the productive activity of man or his life in one way or another. There are many forms of natural resources, including mineral, water, land, energy, climatic, plant and animal resources. However, this Chapter, as a part of the African Regional proposals, will deal with the rational development and utilization of mineral, land, water and energy resources. Although forests and wild life, oceans and marine life represent important resources, they have not been considered in this Chapter but are included in the Chapter on Food and Agriculture.

36. The importance of natural resources, particularly land, water, mineral and energy resources for economic development of any country is generally known.

37. From early times, the general well-being of human societies has depended on natural resources - their development, conservation and utilization. It is generally admitted that natural resources are a permanent factor directly influencing the development of economic activities and that a rational use of natural resources is a prerequisite for solving the main problems of national economic development in any country. Natural resources and their derivatives constitute, very often, the main source of national income for many developing countries and practically the only source of export earnings for their economic development.

38. A characteristic of virtually all the developing countries, especially in Africa, is the existence of many undiscovered, unexplored, unexploited and underutilized natural resources. The development and optimum utilization of natural resources demands first of all, the most comprehensive knowledge of these resources and, secondly, policies to fully incorporate their exploitation into the national development plans of individual countries. A systematic approach to discovery, classification, inventory, exploitation and utilization of natural resources must be evolved in each country.

39. A major task in assisting the developing countries is to help them to determine what natural resources are available and what are the most effective methods of using them for economic development. It is generally admitted, and has been reaffirmed more than once by the General Assembly in a number of resolutions, that all countries have the right to exercise permanent sovereignty over their natural resources in the interests of their national development. They have the right to extend or to reduce the extraction and utilization of their natural resources within the framework of their development plans, in accordance with the priorities determined by the countries themselves. However, many of the developing countries do not know what should be done for more effective utilization of their natural resources.

40. National policies and institutions for natural resources research have been improved considerably in many African countries since the Lagos Conference (1964). The country surveys compiled by ECA experts during 1969/1970 show the full awareness of all Governments of the opportunities which science and technology can provide for economic development in general and for the promotion of the utilization of natural resources, in particular. In most developed countries there are government departments to deal with the questions of natural resources development and utilization. In some of these countries there are also research institutions and/or research councils functioning as the main policy-making organs. But in many African countries governmental machinery for natural resources research is as yet inadequate, or is still in the formative stage. Often there is lack of adequate co-ordination between legislative and executive bodies and between government and private agencies in the development and utilization of natural resources.

41. By and large, the mineral resources of African countries are exploited today by the simple exportation of minerals in more or less raw forms. Today, as before independence, the greater part of known mineral wealth is exported out of the continent and too little is actually used for local consumption or for intra-African trade. Even the more common deposits of raw materials for building and cement industries, for fertilizer production, etc., are not yet thoroughly evaluated, in spite of all the evidence of their importance for the development of the continent.

42. In all African countries, most of the activity in mineral resources research and exploitation was and still is oriented more to export production, to satisfy the needs of consumers in other continents, rather than of national economies. This has meant that mineral resources research has been mainly limited to the search for new deposits of known minerals to enlarge their exports, instead of the organization of investigations of general geological character. This orientation is the main obstacle to the rapid discovery of new mineral resources that are much needed for Africa's own economic development.

43. Even on the basis of existing data, there is no doubt that the ultimate mineral potentialities of the continent are so vast that Africa is sure to become one of the leading continents in mineral output in the future.

44. As far as energy resources are concerned, these are forms of natural resources or are a result of their transformation. Primary sources of energy such as mineral fuels, (crude oil, coal, natural gas, etc.), water power, vegetal fuels, wind, solar and geothermal energy and secondary sources in the form of electricity, refinery gas, petroleum products, etc., are all derived from nature.

45. The importance of different sources of energy changes with technical and economic progress. For example, the use of coke for metallurgy, the invention of the internal combustion engine, as well as the possibility to transform one form of energy into another and to transport energy over long distances either as electric power, or in the form of liquid or gaseous fuels, completely changed the main pattern of energy use in modern society.

46. The whole problem of energy development is very complicated and encompasses important technical, industrial and general economic aspects, including the necessity for full survey and evaluation of all available fuel, hydro-power and other energy resources which depend on general geological and hydro-meteorological studies.

47. The assessment of water resources of any country should take into account the whole range of water use. The major consumers of water in African countries are agriculture and livestock, but some powerful factors such as the coming industrialization, the increase in human population with the necessary development of agriculture may produce water shortages almost everywhere in the continent.

48. There is a need for multinational co-operation for the development of international river basins in Africa with a view to undertaking studies, surveys and projects related to the management of a common river basin. On the basis of integrated studies of a river basin, many problems such as the storage of water the diversion of rivers for irrigation, the creation of water falls for hydro-power stations or the prevention of floods, etc., can be combined in one project for the greatest benefit of the people.

49. It should be mentioned here that the use of land resources and their productivity in any country also depends on climatic conditions and the availability of general water resources for irrigation as well as on the availability of fertilizers. The development of land resources is closely linked with, and depends on the development and research into other natural resources, particularly water, climatic and mineral resources.

50. Research on major natural resources such as land, water, mineral and energy resources should be fitted into a programme of integrated surveys of natural wealth in general. Such surveys will be based on general geological surveys and hydrogeological and hydrometeorological investigation which for particular purposes cannot be separated from each other.

51. One of the solutions for more rapid economic development in African countries is a more systematic exploitation of the natural resources potential. Therefore systematic and thorough surveys of all actual and potential natural resources should be carried out as soon as possible, as they are the prerequisites for intelligent development, effective management and rational use of these resources.

52. It should also be kept in mind that there is the need to maintain a balance between the elements of the natural environment through integrated development and the conservation of nature and its resources. This does not mean the mere saving of natural resources, and never implies preventing their use. It only means the use of resources in such a way as to get maximum benefit from them.

### Objectives

53. The main objectives of the programmes proposed for natural resources development for the African Regional Plan are the following:

- (a) To assist African countries to determine what natural resources are available in their territories and to promote the rational planning of their utilization for more rapid economic development for the benefit of these countries;
- (b) To strengthen or create government capability to deal effectively with the economic and technological aspects of the exploration and utilization of natural resources including policy-making, planning and project implementation;
- (c) To create and develop facilities for the training of qualified personnel (e.g., skilled workers, technicians, mineral economists, engineers and scientists) for exploration, for the planning and management of exploitation, and for the conservation of natural resources;
- (d) To assist African countries to establish new, or increase the production of existing mineral extraction and processing industries;
- (e) To promote international and regional co-operation in natural resources research, particularly in the exploration and utilization of the natural resources of the continent.

Programme I - TO ESTABLISH THE BASIS FOR THE INVENTORY, PLANNING AND MANAGEMENT OF THE DEVELOPMENT OF THE NATURAL RESOURCES IN THE AFRICAN COUNTRIES

54. The development and expansion of national services, and the carrying out of systematic surveys (of natural resources) are essential for establishing the basis for the careful planning and management of natural resources.

Project (a) : To solve the existing deficiencies in mapping and surveying services by:

- Developing or expanding the national cartographic and geological services in each country; increasing the number of the field teams and providing them with the most suitable equipment; laboratories for coping with local problems, map editing units and personnel with experience;
- Establishing three or four inter-regional centres for specialized and integrated surveys, regional studies and training in the following domains, airborne geological and geophysical surveys, topographic surveys, geological mapping, photo-geological interpretation and reconnaissance prospecting, photogrammetry, ground geophysical and geochemical surveys on a regional scale.

Project (b) : To plan and carry out detailed investigations for mineral resources in selected areas in order to:

- Identify new mineral deposits;
- Establish the size, shape and the commercial value of the various mineralized zones or bodies;
- Recommend further possible development on the basis of laboratory studies and pilot experimental processes.

Project (c) : To carry out systematic surveys for water resources in order to obtain detailed knowledge on the following:

- Surface and subterranean available water sources;
- Chemical and biochemical properties of the water and external factors influencing its quality and quantity;
- River basin development;
- Possible utilization of other unconventional sources (treatment of soiled water, desalination, artificial rain).

Project (d) : To undertake at national and inter regional level surveys of potential sources and demands of energy, identifying:

- The conventional and non-conventional resources of energy available in each country and their present utilization;
- The potential hydro-electric power plants and master plans at the scale of whole river basins;
- The future demands for electric energy in the individual countries;
- Prospects for the discovery of new oil and gas fields or coal-bearing areas;
- The possibility of a supplementary supply of energy through advanced technology (such as the use of nuclear techniques in the development of other natural resources as sources of energy);
- A survey of the geothermal resources in the region, including the assessment of their possible utilization to obtain electric power, mineral resources or water.

Programme II - DEVELOPMENT AND RATIONAL UTILIZATION OF NATURAL RESOURCES

55. For the development and rational utilization of natural resources, the governmental machinery should be strengthened and a general inventory of all natural resources should be carried out.

Project (a) : To make a general inventory of the proved, probable and possible reserves of mineral resources as well as an estimation of the "inferred" (prognostical) reserves

It is recommended that:

- The general project should be divided into several sub-projects specific to the substances which form the object of the evaluation: hydrocarbons, coal and bituminous schists, metallic ores, non-metallic ores, sedimentary rocks useful in industry, etc.;
- An appropriate classification of the categories of reserves and proper methods of evaluation should be established in advance;
- An inventory of marine mineral resources should be carried out separately.

Project (b) : Strengthening and developing the existing governmental machinery or creating new bodies within governmental structures having the following objectives in the field of mineral resources

- Co-ordination of national policy and planning in respect of all mineral exploration activity carried out by public and private agencies, companies or enterprises;
- Promotion of those techniques, equipment and methods for the extraction and processing of mineral deposits discovered by exploration, that prove to be best suited to the country's planned objectives;
- Elaboration of national mining legislation, and effective control of the rational exploitation of mineral resources;
- Studies for the integrated utilization of existing mineral resources, the expansion of extraction and the introduction, of new materials.

Project (c) : Development and rational utilization of water resources

- Computation of general water balances, including all water resources and all aspects of their utilization;
- Improvement of water storage conditions in suitable areas, elimination of waste and reduction of natural losses;
- Protection against water pollution;
- Setting up of national bodies charged with water administration.

Project (d) : Development and rational utilization of energy resources

- Computation of "energy balances" for each country, and on a regional scale;
- Study of the utilization of the associated gas produced with petroleum as a source of energy;
- Small-scale hydroelectric and thermal power schemes for rural areas;
- Studies for the utilization of geothermal energy.

Programme III - DEVELOPMENT OF RESEARCH, EDUCATION AND TECHNICAL TRAINING IN THE DOMAIN OF NATURAL RESOURCES

56. The training of local personnel at all levels to perform specialized services in the field of the exploration and exploitation of natural resources is absolutely essential for each country if its natural wealth is to be utilized rationally.

Project (a) : Training of national personnel able to perform the required specialized services in the development of natural resources in African countries

The project should provide:

- Courses at medium level for field technicians or operators in: drilling wells, mineral exploitation and processing, oil production, refining and petro-chemistry, hydro-meteorological survey, energy supply;
- Specialized courses and specialized faculties in the existing universities for: engineering geology, mining and petroleum engineering, mineral economics;

- A training system at post-graduate level (courses for 3-12 months or fellowships for the scientists, engineers and economists involved in research or productive activity);
- Refresher courses, seminars and symposia at national, interregional or regional level on matters of natural resources development.

Project (b) : Establishment of documentation centres at national and regional level for collecting and disseminating the available data and information resulting from field surveys, and new methods and techniques developed in the field of natural resources

This project should provide for:

- Establishing centres with the necessary sections and units provided with the necessary equipment and personnel;
- Working out a programme and procedures for collecting literature and information concerning natural resources which may be of interest to the African countries;
- Working out the procedures for disseminating this information among the countries;
- The provision of a better and fuller collection of existing information, as well as information about new methods and techniques in the field of exploration, development and utilization of natural resources.

Project (c) : Training of personnel for the use of earth resources exploration satellites

As international organizations are going to use special satellites for earth resources exploration, all countries should be ready to use the information which can be received from these satellites in their own countries; but this can only be achieved if they have their own technical personnel trained to receive this information directly from satellites, to read and to use it;

This personnel should be able to operate the necessary instruments, computers and other equipment;

Such training can be organized initially on an international or regional basis, or in the advanced countries having the necessary facilities and equipment.

Programme IV - IMPROVEMENT OF MANAGEMENT IN THE FIELD OF EXPLORATION,  
EXPLOITATION AND DEVELOPMENT OF NATURAL RESOURCES

57. Projects under this programme are directed to the development of governmental participation in the activities of national and multinational companies. This can give the Governments greater opportunities to co-ordinate the activities of these companies with the objectives of national development.

Project (a) : Development of governmental participation in the activity  
of national companies dealing with the exploration,  
exploitation, and utilization of natural resources

If any country wants to develop its economy and enjoy higher rates of growth it should work out a realistic development plan and ensure the fulfilment of the plan. But very often the governmental bodies responsible for planning are not in a position to set up real targets for privately owned enterprises and companies since these are much more interested in the rates of growth of their own profits rather than in the country's economy as a whole.

Governmental participation in the activity of selected companies would undoubtedly make plans more realistic and facilitate their fulfilment. Furthermore direct participation of the Government in the activity of any company will give the Government an opportunity to have a share of profits and to direct these funds to the development of sectors of higher priority.

Project (b) : Creation and promotion of African multi-national companies  
and institutions with the participation of Governments for  
the exploration of mineral resources and the utilization of  
energy and water resources

Some African countries have an abundance of minerals, water or energy resources and do not need to develop minerals extraction nor to increase production of energy for their own purposes as they often have more important areas of needs and priorities. Some countries having such resources are not in a position to develop and utilize them because of the lack of financial resources. But at the same time some other neighbouring countries are suffering from acute shortages of these resources and are not in a position to obtain them from abroad, for instance electric energy production;

There is a valuable opportunity here for many African countries to undertake the development of capital intensive enterprises such as mines, hydroelectric power stations, dams for irrigation, etc., jointly by pooling their financial resources;

This can be achieved through the creation of African multinational companies with the governmental participation of the countries concerned.

Project (c) : Stimulation of private companies and enterprises to co-ordinate their activities with governmental objectives mainly with a view to:

- (i) Co-ordination of their plans of investments;
- (ii) Training of national qualified personnel for all categories and at all levels.

This project is directly connected with project (a) of this programme.

In cases where some private companies are to play an important part in the development of the national economy but direct governmental participation in the activity of these companies is not considered to be desirable, the Government should stimulate and encourage these companies to develop their activities in accordance with the national development plans by some other means, e.g., by offering them technical, and may be even financial assistance in the areas of particular concern, by provision of special import concessions, by facilitating access to state credits and loans, and so on. Such measures will help the Government induce private companies to co-ordinate their activities with the main national objectives.

Programme V - PROMOTION OF INTERNATIONAL AND REGIONAL CO-OPERATION IN THE FIELD OF EXPLORATION, DEVELOPMENT AND UTILIZATION OF NATURAL WEALTH OF THE CONTINENT

58. The co-operation of neighbouring countries in the exploration and rational utilization of natural resources, particularly those located along common borders (such as rivers and mineral deposits) will undoubtedly help these countries to pool their human and financial resources for more rapid development.

Project (a) : Encouragement of mutual co-operation of neighbouring countries in the exploitation of the potentialities of water and energy resources

Many African countries are not in a position to develop and utilize all the potentialities of their water and energy resources separately, for it is difficult for a single country to build for example, a high dam with a high capacity hydroelectric power station even if the country is in very urgent need of such a dam for irrigation;

The co-operation of neighbouring countries in the realization of large projects for the multi-purposes utilization of water and energy resources is one of the best ways for rapid development of the continent.

The necessity for rational development and utilization of water and energy resources, and for the protection of water against pollution as well as the necessity to develop the sectors which will use these resources should be kept in mind.

Project (b) : Organization of international, regional and sub-regional conferences, seminars and symposia on natural resources research, development and utilization in Africa

This project is intended to help the African countries to exchange their experience on the issues and the problems of natural resources development.

These conferences, seminars and symposia should be designed to assist policy-makers, planners, scientists and engineers to obtain better knowledge of the continent's natural resources as well as of the methods of their exploration, development and utilization;

International organizations, especially those of the United Nations family, as well as the governmental agencies concerned should bear in mind the necessity and usefulness of these undertakings.

Annex. ADDITIONAL NOTES ON THE AREAS FOR ACTION IN THE FIELD OF NATURAL RESOURCES DEVELOPMENT

Creation and/or improvement of national services

59. The Government of each developing country should review its existing structure of scientific and technical services for investigation and development of its natural resources and improve existing services where necessary. Governmental services should include:

A. A meteorological or weather services comprising

- (a) A Central office/station with
  - (i) Headquarters;
  - (ii) Workshop for routine repairs of apparatus;
  - (iii) Physics laboratory.

(b) and specialized sections:

- (i) Aerology and synoptic meteorology section;
- (ii) Climatology, hydrometeorology and agrometeorology section;
- (iii) Instrumental methods and equipment section.

B. A Surveying and mapping service, with:

- (a) A geodesy section;
- (b) A topographic survey section;
- (c) An aerial photography section;
- (d) A map printing section.

C. A Hydrology service (or water supply service) comprising

- (a) Field study and documentation sections:
  - (i) A surface water section;
  - (ii) A ground water section;
  - (iii) A data acquisition and processing section;
  - (iv) A hydrological studies and forecasting section;
  - (v) Research and training division.
- (b) Utilization sections (applied hydrology):
  - (i) A community water section;
  - (ii) An irrigation and drainage section;
  - (iii) A hydroelectric power section;
  - (iv) An inland waterways section.
- (c) Water analysis laboratory.
- (d) Sea water utilization section.

D. A Geology and mining service comprising

- (a) A geology section (to undertake all the required studies and to prepare geological maps). This should include:
  - (i) Geological survey unit;
  - (ii) Geological mapping unit;
  - (iii) Laboratory for petrography;
  - (iv) Laboratory for mineralogy;
  - (v) Geophysical unit.
- (b) A mines or mineral resources section consisting of
  - (i) Mineral ~~exploration~~ unit;
  - (ii) Mining operations unit;
  - (iii) Mining code and mining regulations unit.

E. A Energy and electric power development service comprising

- (a) Mineral fuels section;
- (b) Hydroelectric power section;
- (c) Thermal electric power section;
- (d) Non-conventional sources of energy section;
- (e) Section for integrated planning of production and distribution of energy;
- (f) Financial section (to deal with capital and foreign currency requirements for energy development schemes; with taxation and pricing in this field).

F. A Soil science service comprising

- (a) An administrative section;
- (b) A documentation centre;
- (c) A survey and cartography section;
- (d) An experimentation section for studies of the fertility characteristics of soils;

- (e) A soil analysis laboratory;
- (f) A soil conservation section.

#### Resource analysis and field surveys

60. Many types of natural resources may be involved in the development of a country and many of them can and should be studied simultaneously. The analyses of the basic resources on which the national economy may be founded are, therefore, of fundamental importance to the progress of economic development. Surveys and resource analyses should be designed, where possible, with reference to the technical as well as to economic considerations. They have to show not only the economic interest in exploiting a resource and the need for this development, but also the feasibility and the difficulties of carrying it out.

61. Surveys and resource analyses have to be closely co-ordinated with the work done or being planned by the corresponding technical and other services which will use their results. Only in such a case would they function in harmony with the general efforts of the country.

62. A regional or sub-regional approach should be kept in mind. Studies need not be limited by the boundaries of a country. They could cover a region.

63. Resource analyses should be development-oriented and based on the compilation and critical study of existing information relating to a resource, and on the geographical or other data on the basis of which the possible extension of the resource and its use can be planned. An economic study of the probable utilization of natural resources as such is also of great importance. Finally the possibility of obtaining the final product from a natural resource and its probable total cost must be investigated and evaluated.

64. Field surveys should be undertaken after it has been decided to develop one or more of the resources of the country in order to add some new details to what is known of the existence and characteristic of the resource concerned.

#### Types of field surveys

- (a) Specialized field surveys usually cover one particular subject (such as hydrology or one particular type of resource);
- (b) Ecological field surveys are easy to apply and, although narrower than the integrated method, sometimes give good results;

- (c) An integrated field survey is one in which several special aspects of a problem or a region are studied concurrently in such a way that the interactions between the parameters of the problem are elucidated.

65. In such surveys, a team of specialists in the various disciplines, after having studied and surveyed the region together, produce a series of detailed and integrated proposals that should lead to the full development of the region.

66. In many cases a survey operation also makes it possible to train young people or national counterpart professionals, (when the operation is undertaken under bilateral or international assistance) side by side with specialists of great experience.

67. The desirable coverage of surveys. Natural resources which are considered to be without value today may become very valuable in future, because of technical progress and changes in economic circumstances. And if they are not taken into account in the first inventory of an area, the process has to be repeated later. To make general surveys and thorough investigations from the beginning may, therefore, save time and money in future.

68. The development of any natural resource should not be undertaken without thorough study of the relevant economic and human conditions. Since the world economic situation and nature itself are constantly changing, the priorities are likely to change year by year and routine studies, once begun, should be carried on for several years.

69. Every operation to develop a natural resource has both short-term and long-term results. In reaching decisions, the short-term results are likely to be given more weight than the long-term results, but care should be taken to ensure that this should not lead to an irreversible deterioration of the resource that is being developed.

#### Scientific and technological research in the field of natural resources

##### A. Research

##### Specific studies and research

70. These can be undertaken in part within laboratories, but many studies have to be carried out in the field, often far away from the cities. In many cases, advanced research cannot be undertaken in the developing countries if the research calls for sophisticated apparatus which is not available in the country.

### Experimental laboratory research

71. Research with models is possible when the natural conditions are reproduced as closely as possible and to scale. It is also possible to formulate purely mathematical models based on electrical analogy. Research with models is being used in experimental hydrology, soil studies, etc.

### Technical studies

72. These are very different in character. They include physical and chemical analyses, and experiments concerning physico-chemical processes.

### On-site observations and research

73. These include:

- (a) Research on the evolution of different types of resources. Such investigations must be continued over long periods (5-10 years);
- (b) Applied research.

### Feasibility studies

74. Feasibility studies can normally be divided into three parts:

- (a) Laboratory research to make adjustments to the methods for using or processing of a natural resource;
- (b) The establishment of a kind of pilot scheme;
- (c) A careful review of the other factors that may be favourable or unfavourable for the proposed innovation.

### Institutes for research and training

#### Regional and/or multi-national research institutes

75. Several neighbouring countries may co-operate in establishing institutes for different studies which require a common solution. For a number of small States, multinational research institutions may be the only effective means of providing for their requirements.

#### National research institutes

76. National research institutes may be of two types:

- (a) Specialized institutes which may be of two very distinct types:

- (i) Dealing with a particular discipline (hydrology, geology, geophysics, etc.);
  - (ii) Dealing with particular resources (coal, metallic ores, etc.).
- (b) Multidisciplinary (or general) natural resources research institutes.

77. Such institutions could be established in a number of different ways, but in any case they should perform the following functions:

- (a) Inventory and analysis of potential land resources including integrated surveys;
- (b) Training of appropriate teams of specialists and technicians for this purpose;
- (c) Identification of research problems and specific research activity not covered by other institutions;
- (d) Collection of documents, maps, surveys;
- (e) Collection of minerals, zoological and botanical specimens.

Each institute should have an analysis and statistical section and a library. The position of the institutes in each country's structure may vary.

78. As far as specialized institutes dealing with particular disciplines are concerned, they should undoubtedly be attached to or connected with the universities or other multidisciplinary institutes. On the other hand, specialized institutes dealing with particular resources should be attached to or connected with corresponding governmental departments.

79. All these institutes should be supervised by the Government which should reserve for itself the important role of determining the programmes and the application of research. All the activities of these research institutes (both specialized and multidisciplinary) should be fully co-ordinated at three levels:

- (a) Among the institutes themselves to avoid any duplication;
- (b) At the level of national science and technology policymaking;
- (c) At the level of the country's general development policy.

#### Experimental stations

80. Co-ordination between research and application is usually maintained through experimental stations, the work of which makes it possible to determine the best way in which the methods developed by the research institutes can be applied to the utilization of a resource. These stations

should be subordinated to the principal research institute and should collaborate closely with the Government's technical services.

#### Advisory councils on natural resources development

81. The role of these councils is to advise on the preparation of programmes and to co-ordinate their execution. They should include representatives of the various technical departments and policy-making organs; of the research institutes as well as persons concerned with the practical aspects of resources (of mineral, agricultural, industrial and other sectors of the economy).

#### Training programmes

82. These should include:

- the training of different types of personnel:
  - (a) Skilled workers and experimental assistants;
  - (b) Middle level technical personnel;
  - (c) Research workers;
- the provision of seminars and courses of advanced training.
- the provision of arrangements for specialized study abroad.

In the course of the implementation of training programmes, aid may be sought from international organizations.

#### Pilot projects

83. Before the initiation of large-scale investments in the development and use of natural resources in developing countries, small-scale pilot projects should be undertaken.

### Chapter III - FOOD AND AGRICULTURE

#### Introduction

84. From surveys carried out in various African countries, it appears that agriculture is still the main activity of 70 to 80 per cent of the population. What is striking, however, is the fact that, in these very African countries there is still sometimes mention of famine and very often, of malnutrition. Efforts made during recent years to improve agriculture do not appear to have borne much fruit in this essential sector. In fact, a cursory review of the role of this sector in the African economy shows quite clearly that it does not produce enough to feed the population and that its major emphasis remains that of increasing the production of primary agricultural products in order to provide raw materials for the industries of the developed countries. In African countries, considerable attention has always been given to and emphasis placed on producing export crops which earn foreign currency. But the precarious position of agricultural raw materials is common knowledge, and it is getting worse because of the considerable development in the production of synthetic substitutes for a great number of agricultural raw materials produced in the African countries: nonetheless export crops continue to be studied and developed with a view to increasing their yield. The present situation is clearly characterized by priority given to cash crops to the detriment of food crop production.

85. Without going so far as to suggest a complete reversal of the existing trends, it is urgent that proper attention be given to African agriculture so that it will be able to provide food for the whole population which continues to increase. The present situation in agriculture in Africa whose customary vegetable foods, in particular, are deficient in protein results in an inadequate diet which takes its toll on the human resources so necessary for the economic and social development of the countries in the region.

86. It is therefore important that agronomic research should make new contributions to agricultural production in Africa by directing it towards objectives which meet local needs and result in increased agricultural production including the provision of more and better food. The inadequate development of African agriculture stems from causes that science and technology can eliminate, namely:

- Traditional cultivation practised by the peasants which contributes to the deterioration of the soil;
- The very low productivity of local varieties;
- The considerable loss of crops and harvest caused by insects and animals, disease and poor storage techniques.

87. To attain these objectives many problems must first be solved through agricultural research so that productivity in agriculture and in animal production could be increased. It will be necessary to develop the cultivable land and water resources, to study and adopt new agricultural practices suitable to the different types of soils and to the different crops, to create well-tended pasture land and introduce disease control, to exploit satisfactorily the resources of the sea and the inland waters of the continent, to develop and improve high-yielding, disease-resistant crop varieties, to promote the genetic improvement of livestock by the introduction of new strains suitable to local conditions and resistant to the major diseases, and to protect the crops against parasites and losses.

88. African agriculture with its many shortcomings offers, as can be observed, an immense area for the application of science and technology for improving and promoting its productivity, through research carried out in local institutes adapted to local conditions.

89. But the major bottlenecks to the implementation of suitable measures likely to bring about rapid change in the situation are the inadequacy of technical knowledge, the problems of full utilization of existing knowledge, and the shortage of trained staff. Therefore, for African countries the scientific problems raised by the expansion of agriculture are numerous. Of course, they cannot all be solved at the same time, some order of priority must be established.

90. The problem of increasing agricultural production in Africa may be approached in two ways. In fact, one could consider either the development of new land, or the increase in the productivity of crops particularly food crops on land already under cultivation. The increase in the area of cultivable land will require considerable capital and it is for this simple reason that increasing yield rather than land area would be an easier choice. However, in Africa, the two lines of approach may be proposed depending on the regions, but special emphasis should be given to the use of new technology to improve the yield of land already under cultivation.

91. Without a careful appraisal of the situation, one might easily be led to propose research in Africa on artificial protein. The general opinion on the continent however is that it is possible to increase the production and to raise the protein content of vegetable and other crops through conventional agriculture with the help of science and technology; furthermore, fuller exploitation of fishing and livestock can contribute at lower cost to provide the necessary supplies of protein.

92. As is well known, fishing has, up to the present time, been a traditional occupation in several African countries bordering large stretches of water. However, primitive techniques have prevented the people from taking full advantage of the fish reserves either in the sea or in inland waters. Research and modern developments (marine biology, better vessels and modern fishing techniques) in fishing offer great prospects, and their adaptation to and application in African zones should solve a great part of the problem of protein deficiency.

93. The stock-raising and animal production sector also deserves attention. Outmoded methods are still to be seen in traditional stock-raising, but Africa could have more abundant protein resources if scientific knowledge were used to improve animal feeding, reproduction and disease control.

94. One of the main potential sources of meat production, and one which has received little attention until now, could be found in the domestication and raising of wild animals such as the large antelopes and other ungulates indigenous to many regions of Africa.

95. Current field research is already showing that there are valid reasons for the interest being shown in these animals. They are, in effect, far better adapted than cattle to the ecological conditions of the vast stretches of savanna on which they graze. In these same regions, herds of cattle suffer from drought, shortage of water and grazing, extremes of temperature, trypanosomiasis, while antelope and other ungulates of the same type are resistant to all these conditions. These ecological conditions have enormous effects on the rates of reproduction and growth of cattle.

96. Comparative studies have shown that antelope grow much faster and have a far greater potential for meat production than domestic Bovidae. Considering the rather harsh conditions in which antelope exist and all their qualities of resistance and productivity, it should be cheaper to raise them. Although protecting them in vast reserves has been a wise step, it would be better to domesticate and raise them on extensive ranches where they could be bred on a commercial scale.

97. In integrated development, it is important that all agricultural resources available be properly utilized. It is within this context that mention should be made of forestry. In Africa, forests have always been considered as the gift of nature and the idea that they could be cultivated and improved just like other agricultural crops with the help of scientific knowledge, is relatively new. It will also be necessary to educate peasants on the importance of conservation of existing forests.

98. Lastly, when thinking of research for improving food production, one must not lose sight of the fact that diet is a matter which depends on social or religious habits and traditional beliefs, particularly in Africa; it would be a waste of time and money to begin research in directions which have no prospects of success under African cultural conditions.

99. Measures to be taken within the Plan should be based on objectives suitably selected so as to make it possible for agriculture in Africa to meet the needs of the people in the more or less short-term.

#### Objectives

100. The objectives to be realized for this sector of the African Regional Plan may be summarized as follows:

- (a) Research into soil characteristics and the improvement of soils already under cultivation;

- (b) The provision of a sound basis for the cultivation of new lands, using agricultural techniques which will ensure from the outset the success of and increased yields from agricultural operations;
- (c) Strengthen and improve knowledge of climatic factors in the various regions so as to make better use of water and sunlight;
- (d) The genetic improvement of the main crops and of livestock;
- (e) The protection of crops against parasites and farm animals against major diseases;
- (f) The research, development, and use of improved agricultural techniques for traditional and new crops;
- (g) The research, development, and use of suitable techniques for animal feeding and stock-raising including suitable wild animals;
- (h) The improvement of techniques of storage and conservation of agricultural products;
- (i) The development of fishing;
- (j) The development of forestry;
- (k) The strengthening of research on nutrition and food technology;
- (l) The promotion, by all available means, of the education and training of supervisory and operative manpower for agriculture.

The following programmes and projects are suggested in the agricultural sector.

Programme I - CONSERVATION, IMPROVEMENT OF LAND ALREADY UNDER CULTIVATION -  
DEVELOPMENT OF NEW LAND

101. In Africa traditional cultivation practices consist of cultivating the land until it is exhausted and then shifting to new land, in this way the care of land is restricted to letting it lie fallow in order that it may regenerate its fertility. This practice is very laborious and one of the purposes of this programme would be to encourage settled farming of land already under cultivation by improving it through research on African soils (evolution, physical features, suitability for agriculture in relation to the range of crops under consideration, fertility, erosion control and the effect of bush fires). The practice of intensive farming obviously requires considerable research to support it. For some areas of the continent, it will be necessary to develop new land for agriculture. In such cases it should be possible, through suitable technological research, to ensure success in agricultural production from the outset.

102. The following projects should be considered under this programme:

Project (a) : The establishment of bioclimatological centres

Each of the ecological sub-regions should have a centre for bioclimatology or have its existing centre strengthened, where existing data could be collected and used and where agroclimatological and experimental bioclimatological studies could be carried out.

Project (b) : The determination of crop suitability to land already under cultivation

Special studies should be undertaken or intensified by the Soil Bureaux already operating in the different regions so that large scale (1/50,000) agropedological maps could be prepared which can be used to make maximum use of land and to diversify crops on the basis of edaphic data. The physical features and the evolution of soils would be studied carefully. The necessity of fertilizing these soils should also be studied to detect deficiencies so that they may be corrected and fertility preserved.

Project (c) : Erosion control

In a large number of countries the top soil is carried away by water and wind action. Centres for erosion and soil deterioration control in the tropics should be established in the regions where the effects are most disastrous. This project should be co-ordinated with the water development programme which may have the same effect on soils.

Project (d) : Study of ecological conditions

Agricultural expansion should be based on the development and utilization of the natural resources for increased production. Knowledge of the ecological conditions in each country and the farming systems adapted to such conditions will provide the right basis for determining the crops that are most suitable for each ecological zone.

Project (e) : Development of new land

This project is only of concern to a few regions on the continent. Research should be carried out to avoid indiscriminate use of land and to ensure from the outset success and high yields in agricultural production. The problems to be solved are the following:

- Appropriate clearing techniques;

- Crops suitability of new land (studies of physical and chemical qualities of the soil, water resource assessment in the regions to be developed).

#### Programme II - WATER DEVELOPMENT FOR IRRIGATION

103. Research into water development is important in order to ensure the supply of water and the moisture retention necessary to support plant life. The problems of irrigation, drainage, control of flooding and desalination of brackish water should be studied in properly sited research centres which should be established or strengthened. Research should be geared to the use of surface and groundwater for agricultural and livestock needs.

##### Project (a) : Comparative study of various irrigation techniques

On the basis of the crops under consideration and the soils under cultivation, techniques of water supply should be studied with a view to making maximum use of available supplies (irrigation by canals, by ditches, by spraying, etc.).

##### Project (b) : Studies of water requirements of the important vegetable crops being cultivated

These studies will supply scientific data on the water requirements of the main crops. Such data will furnish the parameters for use in irrigation if necessary. The water retention and hydrodynamic qualities of the soils in their relation to the needs of the plants to be cultivated should also be studied.

#### Programme III - GENETIC IMPROVEMENT OF MAIN CROPS AND ANIMALS

104. This programme is one of the most important for improving productivity in agriculture and in livestock. As far as agriculture is concerned, research should be geared to the development of new quick-maturing, high-yielding varieties, suitable to varied ecological conditions, possessing high protein content, resistant to the major diseases and having improved processing qualities.

105. Genetic improvement is a long-term process and, if the required quality is to be realized, it will be necessary to choose a small number of essential crops for in-depth research. As far as farm animals are concerned, many African countries have enormous herds of cattle, which paradoxically are a burden instead of being an important source of protein since productivity is very low. The reasons for such a state of affairs are numerous. In the first place by tradition, African herdsmen keep the largest number of animals possible. The result is that the excess numbers destroy the grazing lands which are often subject to excessive grass burning in the semi-arid regions. In addition, the shortage of water, the presence of the tsetse fly and numerous diseases render the environment hostile to productive stock raising. Lastly, there is a shortage of beef and milk. The strains of the animals should therefore be improved by overcoming cattle diseases and ensuring better

feeding in order to increase unit production. Because of this hostile environment, consideration could be given to the domestication and raising of species of wild antelope which are already adapted to all these adverse conditions.

106. Improvement in poultry and pig production should also be considered under this programme.

107. The following special projects could be proposed.

Project (a) : Improvement in the productivity of the principal cereals

- (i) Establishment or strengthening of rice research centres. Many studies on improving rice cultivation have been undertaken in Africa and elsewhere. These studies should be continued with a view to adapting improved varieties to local conditions;
- (ii) Establishment or strengthening of research centres for maize and related hybrids. The studies in this respect would also deal with the increase in protein content (lysine and tryptophane);
- (iii) Establishment or strengthening of research centres for developing genetic strains of sorghum and millet suitable to varied geographic conditions;
- (iv) Research in the genetic improvement of wheat.

Project (b) : Improvement in the productivity of vegetables and protein-rich crops  
Protein content

It will be necessary to intensify research into grain legumes like soya and haricot beans (*vigna unguiculata*).

These two crops are very important because of their high protein content. Research should be aimed at producing varieties of these crops which are suitable for different ecological conditions so as to extend the area of production of the improved varieties. Genetic improvement should also make it possible to improve the nutritional quality of these crops by perfecting toxin-free varieties (antitryptasis).

Project (c) : Improvement of tropical tubers and roots (cassava, yams, sweet potatoes)

Unlike cereals, research on tropical roots and tubers has so far been limited in scope although they constitute the staple food for the population in the forest regions. Research centres should therefore be established to study ways of improving productivity and increasing the protein content of cassava, yams and sweet potatoes.

Project (d) : Improving the quality and expanding the cultivation of plantains

This crop is of considerable importance over a large geographical area in tropical Africa and deserves to be the subject of a research project.

Project (e) : The establishment of centres for producing quality seed

Centres for producing and distributing quality seeds should play a major role in the process of agricultural extension thus facilitating the replacement of local varieties by new seeds which give increased yields.

Project (f) : The establishment of centres for research into the adaptation and genetic improvement of livestock

The studies to be undertaken should cover the following objectives:

- (i) Beef production;
- (ii) Milk production;
- (iii) Increased work capacity of the animals.

Project (g) : Programme of agricultural extension of knowledge on the improvement of poultry and pigs

Although the improvement of poultry and pigs must be considered, it is no longer a question of research but one of the application of existing knowledge. Poultry and pigs are easy to raise and grow quickly. Improved strains already exist and scientific and technical knowledge is available with regard to their feeding and the control of prevalent diseases. Therefore, what is necessary in this case is an agricultural extension programme.

Programme IV - PROTECTION OF CROPS AND ANIMAL HEALTH

108. Modern intensive agriculture of high-yielding varieties brings in its train the problem of wastage caused by disease and parasites. In order to avoid considerable losses to crops, a system of protection should be installed so as to make it possible to preserve the high yields resulting from genetic improvement and from the rational use of fertilizers to improve the soil. Phytopathological and entomological research should be strengthened as well as research into the methods of protection of high quality crop varieties.

109. In the case of animal health, research should concentrate on those diseases which cause the greatest damage.

Project (a) : Establishment or improvement of centres for research into cereal diseases

The most serious disease in the case of rice is piriculariosis. Existing studies, which must be continued, are oriented towards research into resistant varieties and chemical treatments. However, improvement of crop conditions (soil, water and drainage) appears to help in eliminating the disease.

In the case of maize, millet and sorghum, research must be conducted into the control of the major cryptogamic diseases (smut rust). The treatment of sowings and the development of resistant varieties are probably solutions to the problem.

Project (b) : Research for the control of cassava and yam mosaic

Research into developing resistant clones seems to represent the most promising approach and consequently collaboration with the genetic improvement programme is essential. Very little work has been done in respect of tropical tubers, this makes necessary the establishment or improvement of a research and extension centre in the African forest belt. In the case of cassava, it should be noted that research work has resulted in the development of mosaic-resistant clones. However, the results of this research have not yet been diffused widely through appropriate extension programmes.

Project (c) : Establishment or improvement of insect pest control centres

Cereal crops (rice, maize, sorghum and graminaceous fodder crops) are subject to parasitism from the larvae of insects which attack the stems. It is this type of parasitism which causes by far the greatest amount of damage. Entomological research must be conducted into the biology of these parasites in order to develop chemical, or better still, biological control methods.

In the case of rice, the effects of parasitism caused by nematodes are becoming increasingly noticeable. Research should be conducted into ways of controlling these attacks.

The "niébe" bean acts as host to numerous insect parasites, which impair yield. Research is required to safeguard the cultivation of this important legume.

Coleoptera (heteroligus meles and prinoryctes sp.) attack tubers (yam and cassava). Studies of the biology of these coleoptera will also be of assistance in developing control measures.

Project (d) : Establishment of centres or programmes for the control of the major livestock diseases

Diseases constitute a factor which limits animal productivity and little improvement can be realized in animal production unless the state of health of livestock is fully controlled. Many research centres are already involved in carrying out the basic research into the control of the major diseases. These centres, however, require to be provided with more staff and equipment. Nevertheless, a number of control programmes in the field need to be conducted in many countries in order to prevent or eliminate diseases such as:

- Contagious bovine pleuro-pneumonia;
- Tick-borne infections;
- Trypanosomiasis;
- Foot and mouth disease.

All these diseases reduce animal productivity and impede progress in this very essential sector. Centres are required which specialize in disease detection, in the preparation of vaccines and serums and in treatment. Such application centres need to collaborate with the research centres in selecting disease-resistant strains. Control programmes must be directed at the eradication of these diseases over extensive areas, through a co-ordinated campaign.

Project (e) : Establishment of tsetse fly eradication programmes

The tsetse fly is the most widely distributed vector causing extensive damage to livestock in Africa. Research centres are required to carry out extensive investigations into the eradication of the tsetse fly, principally through the technique of sterilization of the male and through studies into other possible biological controls. The major technical problem at present delaying the immediate eradication of the tsetse through the sterile male technique is that of the large-scale breeding of males.

Project (f) : Establishment of centres or programmes for the control of parasitic gastro-intestinal sheep diseases

The sheep is a hardy and ubiquitous animal which provides for a substantial proportion of man's food and clothing requirements. It is, however, subject to parasitic infestation which limit its potentialities. Control measures already exist, but the absence of precise, epidemiological knowledge considerably reduces the effects of any action. Research efforts must therefore be concentrated on obtaining more precise local epidemiological knowledge.

Programme V - RESEARCH, DEVELOPMENT AND UTILIZATION OF IMPROVED AGRICULTURAL TECHNIQUES FOR BOTH TRADITIONAL AND NEW CROPS

110. The aim of this programme is to study and adopt new and improved farming techniques for the dual purpose of increasing crop yields and reducing production costs. The rational working of tropical soils must be directed at preventing erosion while improving permeability, porosity and water conservation. Techniques for the use of animal and motorized traction should be determined for each type of soil and for each type of crop, to avoid any action which might reduce yields. It would be worthwhile incorporating into this programme measures for the control of parasitic plants harmful to crops. The problem of harmful plants has not yet been solved in Africa and is closely connected with farming techniques.

111. The following projects could be considered as part of this programme.

Project (a) : Programmes for introduction of intermediate technology in farming

Farming techniques currently employed by peasant farmers are crude and result in very low productivity. A straightforward advance to full mechanization of farming may be difficult in view of limited technical skill and organizational ability of peasant farmers as well as the heavy capital costs per worker and the restriction of employment opportunities that such mechanization would entail. However, improved techniques of production that can be adopted on peasant farms are very desirable. These could consist of simple equipment like animal-drawn ploughs or small power-traction equipment as well as improved cultural practices. There is considerable scope for the introduction of intermediate technology devices and practices on existing farms in the rural areas.

Project (b) : Centres for the application of mechanization

Research into adequate mechanization and tests on various types of soils could lead to fuller and improved soil use and would contribute to the control of harmful plants. The adaptation of tractors to African soil conditions would also permit the working of larger surface areas in the minimum time. Research into the effects of mechanized sowing on yields, systematic studies of root growth to ascertain the effects of ploughing, research into mechanized crop husbandry are other fields which must be exploited as part of the application of mechanization to farming. But the problem of mechanization is a delicate one. Consideration should be given primarily to costs, including the social costs which must be kept low, and the need to create additional employment opportunities. The mechanization of harvesting to prevent excessive loss will also be an important aspect of this project. The establishment of centres for

adapting equipment and for conducting regional research should also be contemplated with a view to better adaptation to local farming practices, since poorly-planned mechanization could produce disastrous results.

Project (c) : Study and research programmes into the use of chemical fertilizers

The possibilities for increasing agricultural yields by the use of fertilizers of all types is now well known. It is necessary to develop, through research, the best methods of application, the economic effects of increased use of fertilizers and how to organize and promote the large-scale use of fertilizers by farmers. Research should also be conducted into the effects of mineral fertilizers on production in tropical regions. Fertilizer trials should be carried out, together with analyses of the correlation between soils and the reaction of the crops to be planted (traditional and new) to fertilizers on different types of soils and under various climatic conditions. Research into crop rotation will also be part of this programme.

Project (d) : Programme for the control of harmful plants (weeds)

The programme for the control of harmful plants is of importance because of the competition which they present to crops in general, and the parasitism of certain weeds in particular. Research should be directed towards the development of farming techniques which ensure effective control of parasitic weeds such as sorghum striga. Researchers should give consideration to control by the application of small doses of effective herbicides.

Project (e) : Development of improved farming practices

The very low crop yields on many African farms are, to a large extent, due to bad farming practices: the soil is not properly prepared, the seeds are not sown at the right time and are not properly sown, weeding is not done at all or done late, etc. It has been found that good farming practices could raise yields by 20 per cent to 40 per cent. Studies in this respect should include study of rotational pattern and study of cultural methods for retaining moisture in the soil.

Programme VI - RESEARCH, DEVELOPMENT AND APPLICATION OF STOCK-FARMING AND ANIMAL NUTRITION TECHNIQUES

112. When the state of health of livestock has been brought effectively under control, the improvement of nutrition and stock-farming must logically increase productivity. Research and study based on the application of animal-breeding techniques to the large antelopes in the hunting reserves can open up unsuspected prospects for the production of cheap meat.

113. The following projects could be considered:

Project (a) : Programmes for the application of artificial insemination techniques

These centres must concentrate on increasing the numbers of livestock through using existing modern techniques, such as artificial insemination and semen storage, which have the two-fold advantage of shortening the process of natural multiplication and of improving strains through selection for adaptation to tropical conditions.

Project (b) : Programme for setting up water and feed storage points for extensive stock-farming

In Africa, most herds are found in semi-arid areas where there is the problem of shortage of water and pastureland, which explains the tradition of nomadic grazing and movement of herds. It would not be feasible to try to introduce sedentary livestock production in respect of all these herds, since this would create other insoluble problems. A first stage improvement programme would be to solve the problem of water supply and of reserves of feed. This would also be much less costly than trying to eradicate nomadism.

Project (c) : Establishment of intensive stock-farming centres

Ranches should be set up to promote the production and spread of selected breeding stock adapted to a specific environment, thereby improving strains.

Project (d) : Domestication and stock-farming of the large antelopes

The only obstacles to establishing antelope ranches would be domestication and intensive breeding of these wild animals, the productivity of which has been demonstrated. Experiments at present being conducted, particularly in East Africa, have shown conclusively that by capturing very young animals, it is possible to build up breeding herds.

Project (e) : Animal nutrition and production centres

Centres of this type exist at the national level in Africa. Two or three of these should be set up as regional centres comparable to the regional animal health research centres, by improving their facilities and their means of action. Agrozoological and zootechnical research should be intensified as part of this project. The centres should concentrate their research on the use of natural and artificial pastures, on fodder crop experiments, range management, the prevention of encroachment by the bush, the creation of permanent pastures with combinations

of grass and legumes, and the production of hay and various types of fodder under different climatic conditions.

The centres will conduct research into the major elements and oligo-elements of species of fodder plants, the pharmacology of toxic plants and the effects on animal health of chemical substances in the toxic plants found in natural pastureland. Research will be carried out into the digestibility and the energy value of various types of feed, into the effects of water deficiency, and will also involve testing the effects of animal/land area ratio on meat and milk production, and fattening techniques using local products.

This project should be associated with the project directed towards the genetic improvement of livestock.

Project (f) : Research into sociological problems of introducing new animal production techniques

The introduction of changes into rural society in Africa often involves changes, more or less profound, in the very pattern of living of the peasant. Changes which may be considered simply as technical changes have sometimes very far-reaching implications on the life of the people which could institute serious obstacles to their introduction. Sociological research should be able to identify in advance all these implications and eventual difficulties which can then be taken into consideration during the process of introducing technological changes into rural agricultural production, particularly animal production.

Programme VII - STORAGE AND PRESERVATION OF AGRICULTURAL PRODUCTS

114. The use of new techniques in agricultural production will have the effect of placing large harvests on the market. This situation will call for crop preservation in order to reduce, if not completely eliminate, wastage at all levels. The preservation of stocks of agricultural produce will provide farmers with a fair price for their produce and eliminate periods of scarcity.

115. Consideration could be given to the following project:

Project : Research into the storage of agricultural produce

The programmes to be established should intensify research into traditional methods of storage in farming areas, with a view to improving them. Important work is already under way in this field but it needs to be inventoried, co-ordinated and made the subject of extension programmes. This project should, on the basis of the results of the research, modernize storage through the use of modern but economical techniques (silos, plastic sacks, use of insecticides, drying, etc.). Rodent control should not be neglected.

Programme VIII - DEVELOPMENT OF FISHERIES

116. Considerable progress has been made in the development of the fishing industry in the technologically advanced countries through the study of the biology of fish, and of catching and breeding techniques. Further research directed specifically at studying conditions in tropical seas, rivers and lakes, should be undertaken. The purpose of this programme is to increase the size of catches without depleting the numbers of fish in the sea or in inland waters.

117. A number of projects can be considered:

Project (a) : Marine biology research centres

Such centres already exist and need greater support. Research into the biology of the main economically viable species, the distribution and availability of food in the sea, and the study of fish migration could all be conducted as part of this project.

Project (b) : Study, research and application of modern fishing techniques and equipment

Activities under this project would be directed towards motorizing fishing boats, development of improved fishing gear, etc.

Project (c) : Research directed towards improving the productivity of inland waters

The biology of the main species of fish must be studied, together with feeding conditions in inland waters. Experiments in cross-breeding of species of fish suitable for fish farming, such as heterotis and tilapia, which grow rapidly and are highly adaptable, should also be undertaken in order to stock water-courses and artificial lakes. Research should also be carried out for the development of equipment and improved methods of fishing in inland waters.

Project (d) : Preservation of fishery products

The preservation of fishery products presents a problem in many African countries. Research should be undertaken to adapt the techniques already developed in this field. More complete knowledge of drying and smoking processes would permit the improvement and standardization of these techniques.

Programme IX - DEVELOPMENT OF FORESTRY

118. The intensive exploitation of tropical forests is already presenting serious problems. The disappearance of vegetation exposes soil to erosion and depletion, and can induce climatic changes. Research must therefore be undertaken for the purpose of reafforestation with economically profitable species. The projects included in this programme should demonstrate to farmers that forest resources can be cultivated in the same way as agricultural crops, and that cultivation of trees can assist in holding down soil erosion.

Project (a) : Research centres for the genetic improvement of the main species

Research into the improvement of the economically profitable tree species must be stepped up (selection, crossbreeding, artificial pollination) with a view to obtaining trees with rapid growth and improved technological characteristics.

Project (b) : Programme for the exploitation of forest plantations

Forest plantations are often not in natural balance with their environment. Research should therefore be carried out into forestry techniques (spacing, trimming, thinning, etc.), which permit the balanced and profitable growth of the plantations and make it possible to safeguard them from possible diseases. Such techniques should be disseminated among companies engaged in forest exploitation.

Project (c) : Education for farmers on forest conservation and on development of forests

In forested areas, trees are often indiscriminately cut for firewood by the farmers, and forest fires destroy some very useful trees. Farmers need to be educated on the better care of forests, especially on the preservation of useful woods. They need to be taught also that they could convert the less productive land into small forests and plant useful species of trees on slopes as a means for combating erosion.

Project (d) : Exploitation of forest products

Research should be promoted on the lesser known tree species and forest plants with a view to finding appropriate uses for them and developing the treatments which can be given to them to make them useful. Also research should be promoted on discovering new end-uses for various types of timber and wood waste.

Programme X - NUTRITION AND FOOD TECHNOLOGY RESEARCH

119. Institutions must be established to specialize in research into traditional food practices with a view to improving them.

Project (a) : Establishment or strengthening of food technology institutions

This project must be carried out in conjunction with the centre for advanced training and research recommended in Programme V (e) in Chapter I on general science development. By employing all existing modern techniques, including those newly developed and those adapted from existing ones, this project will concentrate on the processing and preservation of the products of local agriculture, animal production and fisheries. Such institutions are already in existence in a number of countries, for example, in the Ivory Coast (ITIPAT), and in Ghana (Food Research Institute).

Project (b) : Development of new processed foods from existing agricultural products

In order to take advantage of the food materials deriving from a number of traditional crops, it will be necessary to develop new varieties of processed foods. This might include such new products as proteins extracted from oilseeds and legumes, and bread based on cassava flour. The "superamine" produced in Algeria from wheat, legumes and powdered milk, the "faffa" produced from teff, soyabean and other legumes which was developed in Ethiopia, are a few examples of the creation of new foodstuffs out of existing agricultural materials.

Programme XI - EDUCATION AND TRAINING OF SUPERVISORY AND OTHER WORKERS FOR AGRICULTURE

120. The implementation of all these programmes and all the various projects at different stages of preparation is only possible if qualified staff for research centres and institutes, specialists in agriculture, livestock farming, fisheries, forestry, extension workers and officials for the agriculture services are available in sufficient numbers. The most urgent problem to be dealt with is the training of such supervisory staff, the lack of which could delay any progress and even compromise any social and economic development hitherto achieved.

121. It is therefore clear that special attention must be given to the development of human resources. Many proposals were put forward during the first United Nations Development Decade, all of which were equally well-thought out for dealing with this most serious of all problems. It now only remains to implement concrete action, with the emphasis on the most simple and effective proposals.

122. The various types of personnel to be trained can be classified as follows:

- Research workers: agronomists, veterinarians, pedologists, biochemists, geneticists, entomologists, phytopathologists;
- Middle- and senior-level specialists; technicians, extension workers.

Scientific and technical training is unfortunately a long and demanding undertaking. The need for the solution of the manpower problem in this sector is however urgent.

123. It is quite clear that all the research centres and institutes mentioned above, will require considerable expertise to plan and create. International teams made up of experts who are already familiar with these problems must be called upon to establish as quickly as possible an inventory of all the existing material and human resources within each area.

124. The establishment of new institutes would only be necessary in certain cases. Once these research centres and institutes are established, they should be used to train future technicians - on the job so to speak, for it is these technicians who will lighten the burden of the senior supervisory staff and research workers whose training is more prolonged. Trainee technicians must be recruited from among high school graduates with junior or senior secondary school leaving certificates. Their training will be mainly practical and will emphasize contact with the actual conditions of the area with a modicum of theory. Such training would probably be of two or three years duration according to whether it was directed towards the creation of middle- or senior-level technicians.

125. Senior supervisory staff and research workers will be trained in universities and in the advanced training and research centres recommended in Programme V of the Chapter on scientific programmes.

## Chapter IV - INDUSTRIAL DESIGN , RESEARCH AND DEVELOPMENT

### Introduction

126. As we enter into the decade of the seventies, the need for industrialization in the African countries shows itself not only as imperative but also as getting more and more urgent. Much has been said about the deterioration in the terms of trade, the fall in the relative prices of the agricultural raw materials exported by the developing countries vis-à-vis the prices of the machinery and the manufactured products which they import from the developed countries. This deterioration in the terms of trade involving agricultural exports shows no signs of abating in the future as it is aggravated by two trends. The first one is the production of increased surpluses in agricultural raw materials for export as many developing countries improve their agricultural methods and raise their production. The marked fall in the prices of agricultural exports during the last twenty years has jolted most developing countries into the realization that more stable income might be obtained through the joint control of production by the formation of producers associations and the allocation of maximum production quotas.

127. However, this may not be such a beneficial policy in the long run unless the same countries take steps to create locally the industries for processing their own agricultural raw materials into the finished products they would later import. Otherwise, the higher prices they are able to obtain through control of raw materials output will merely be passed on to the finished products they import which are processed from their original exports.

128. The problem of deterioration in prices due to over-production is further aggravated by the considerable investment being put into the development of synthetic substitutes for agricultural raw materials by the industrial nations. The last two decades have seen synthetic fibres replace cotton in the bulk of the textiles produced in the industrial countries and synthetic rubber is gradually replacing natural rubber; so it is also with vegetable oils and leather. Plastics started out as interesting new materials some thirty years ago. Today, modern industrial research has developed plastics to such an extent that, in addition to their own uses in areas where they are supreme, plastics are beginning to be used as substitutes for metals and for wood; this has implications for the prospects of maintaining timber exports. An analytical look into the future shows that any African country planning to base its long-term development on the export of agricultural raw materials is heading for disillusionment.

129. Of course, there is still the growing trade in minerals: but the shortage of minerals which has conferred some natural production advantages on the developing countries no longer seems an immutable situation. The decade of the seventies confronts the African countries with the prospect

of a similar development of surpluses in minerals for export, as the advances made in technology within the advanced countries begin to trace the outlines of the future.

130. With the improvement in techniques of prospecting and production, oil and natural gas are being found in many of the large consumer countries. Furthermore, the results of recent marine research shows that the occurrence of oil under the sea is widespread along the coasts of most continents. It is therefore certain that the world is moving towards a petroleum surplus for export and a competition in the world markets that could have adverse effects on prices within the next decade.

131. The future for many other minerals shows similar trends. A factor in the present international wrangle over a regime for the exploitation of the resources of the sea, is the abundance of many mineral ores which are there for the taking by any country that has mastered the technology of deep sea mining. If the future sees large international companies based in the advanced countries able to mine from the sea bed all the minerals required to provide the major raw materials they need to feed their own industries, the comparative advantage of those African countries whose economies are now based on the export of minerals or raw materials of mineral origin will disappear. We shall witness, within the lifetimes of some of us here, the same situation develop in the international export trade in minerals that we are already living with in the exports of agricultural commodities.

132. Time is running out for most African countries in terms of their traditional patterns of trade. If well-planned and effective steps are not taken to industrialize, many countries may yet sit, ten years from now, in the middle of mineral resources that they do not know how to use, but cannot sell to those who do.

133. Industrialization for the African countries is, therefore, not an option, but an imperative. The question is not whether to industrialize, but how soon, how to start, where to start. Of course, no country will end up being self-sufficient, but the African countries taken as a whole must be able in the foreseeable future to produce and provide themselves with the major portion of the manufactured consumer and eventually capital goods that they need for the development of their societies. A major policy objective whilst there is still time should be to make use of their temporary comparative advantage in the production of raw materials to create and expand the necessary investments in technology and capital goods so as to develop their own industries rapidly, on a planned and necessarily co-ordinated basis. Regional co-operation is going to be necessary for successful industrialization in Africa.

134. The foundations of industry are to be found in technology: technology based on empirical knowledge or derived from science. Technology is incorporated in the design of industrial products, in the process by which these products are made in the procedures for utilizing them. Within the African region, the technological foundations for industry are still largely non-existent. The whole range of structures required to plan the acquisition of

technology and to direct the utilization of such technology still has to be created in many countries.

### Industrial design

135. One of the early stages of any industrialization programme should be the preparation of industrialization plans and the location of industries. Industrialization plans will be based on economic market studies and a review of technologies already available. Such studies must take into consideration the demand for a particular product, the availability and the cost of raw materials, the kind of technology involved in production operation and the actual machinery and plant which will be required.

136. The preparation of industrialization plans is a team activity since so many disciplines enter into it, but the leading member of this team is the industrial engineer who will design the scheme and provide the technological inputs for the decisions on choice of industries and choice of locations.

137. After an industrialization plan has been prepared and a number of industries have been selected, the next stage is the preparation of feasibility studies for each one of the proposed industrial units. Once the feasibility study for any industrial plant has been completed and the recommendations in it accepted, the following stage is that of project design.

138. The project design will be based on the technology already selected in the feasibility report and will usually start with a choice of production plant available from regular manufacturers, or specifications for the design of a new plant. At the same time, the design of the plant layout and installation will be undertaken. The design or specification of ancillary equipment for the factory such as materials handling equipment and specialized workshops has to be carried out as well as the planning of factory facilities such as power supply, water supply, compressed air supply, waste disposal and so forth. Finally the project design will include the planning of the factory building layout and the design of the factory buildings.

139. The design of a manufacturing unit is a team activity and usually requires special expertise in the particular technology of production involved. The task of planning and designing manufacturing plants is usually carried out by engineering consulting firms or organizations specializing in the particular fields of production.

140. Of course, no factory is built before the products it is going to make are decided upon. So at some stage in the industrial plan, either before or during the project design stage, another group of designers or design engineers will be concerned with product design. Product design is probably the biggest field for the activity of local engineers in the African countries. At the moment, many industrial products are imported as designed for different environments and different communities with different characteristics. The fact that imported products are designed for different types of environments and for different societies is a common problem in respect of consumer goods and domestic appliances. It means that many developing

countries import products designed for the tastes and habits of another culture and they then have to change their own patterns of living in order to suit the products that are imported.

141. A great deal of work is therefore waiting to be done in product design of goods for local use. Consumer goods and agricultural implements should be designed to suit local conditions and requirements and should take into consideration the existing modes of life. Such goods will be easier to use in the home and in work places because they will suit more closely the needs for which the consumer bought them.

#### Industrial research and development

142. Much of the technology which is already available in the developed countries can be utilized in the creation of new industries and in the expansion or reconstruction of existing industries within the African region. However, in many cases, it will be necessary to adapt this technology before its utilization primarily because of differences in the natural resources base of the African countries and, in some cases, because of differences in the factors which determine the directions of industrialization.

143. There are also many industrial products which will be peculiar to the African countries; so the technology for their production will require to be developed through research in these particular countries.

144. The usual purpose of research and experimental development which is carried out for the manufacturing industry is to secure and maintain increased productivity and product quality through technical innovations. This can usually be achieved by creating new technologies appropriate to the products peculiar to the branch of industry concerned, by the acquisition and adaptation of existing technology, and by providing better knowledge of raw materials, processes and operations for a particular branch of industry.

145. Industrial research to derive technologies for production purposes utilizes usually the discoveries of fundamental research. Industrial research may be carried out to seek an improvement of an existing process, or to derive an entirely new one, or to develop an entirely new product. Industrial research may also be concerned with the study of industrial operations and the organization of manpower within the factory so as to obtain a higher level of production through better utilization of materials and skills.

146. Most industrial research is applied research, but that is not to say that some basic research is not carried out in industry. Sometimes during the implementation of an industrial research programme, some basic research problems arise which have not yet been solved up to that time. However, most industrial research is based on the large stock of fundamental knowledge already available and the majority of industrial research problems within African countries can usually be solved on the basis of applied research.

147. Often one can hear decision-makers in African countries making statements that there is already enough technology in the developed countries to borrow from, and that research is not really necessary. This is an overstatement. It is rare that any type of technology can be completely copied without any modifications. Many of the technologies available which have been developed in the countries of the temperate zones cannot be transferred in their original form directly to tropical conditions.

148. Furthermore, most technology in the industrialized countries is based on labour-saving and capital-intensive processes and techniques, but the developing countries with abundance of inexpensive but unskilled labour and scarcity of capital and foreign exchange, require, initially, techniques and processes which use comparatively large amounts of labour and smaller quantities of capital.

149. The differences in resource availability and in environmental circumstances therefore necessitate some form or degree of adaptation of the technology developed in the advanced countries, if they are to be suitable for use in developing countries. Hence the promotion of industrial research and the accompanying experimental development must be part of the infrastructure for any self-sustaining industrialization.

#### Objectives

150. The main objectives of the industry programmes for the WPA in the region should be the following:

- (a) To create the conditions for the systematic development of local processing of surface, underground, and marine natural resources;
- (b) To enable the government technical ministries and industrial agencies to deal more effectively with the technological aspects of industrialization including policy-making, planning and project definition;
- (c) To increase the capacity of each country to generate or import appropriate technologies for industrial production;
- (d) To develop institutional infrastructure for the collection and dissemination of information about industrial technology, industrial design and research;
- (e) To promote the development of technical manpower for production and managerial functions in industry;
- (f) To improve productivity and product quality in existing industries.

The following programmes and projects are suggested in the industrial sector.

Programme I - STRENGTHENING OF THE POLICY-MAKING, PLANNING AND ADMINISTRATIVE MACHINERY FOR INDUSTRIAL PROMOTION WITH TECHNOLOGICAL UNITS

151. Many ministries or government departments responsible for the preparation and promotion of plans for industrial development within the region are staffed and directed largely by non-technical administrators and are composed largely of units concerned with industrial economics. The machinery for industrial development must include units which deal with industrial technology if it is to be fully effective.

Project (a) : Development or expansion of units within ministries of industry which will be responsible for technological policy and forecasting to promote industrial development

Project (b) : Provision of multi-disciplinary units within ministries of industry for industrial project evaluation and technical advice to decision-making organs

The project evaluation unit is not expected to produce feasibility or project reports. Owing to the wide range of expertise that would be required for such a purpose, project preparation should still be carried out by the use of consultants or consulting firms. However, the unit should be able to analyse and appraise project and feasibility reports submitted to it.

Project (c) : Creation of units or institutional facilities for the collection and dissemination of information about industrial technology and industrial research and design

Project (d) : Studies of the socio-economic impact of alternative technologies in selected industries

Programme II - INDUSTRIAL RESEARCH AND DEVELOPMENT

152. The involvement of Government in industrial research is still relatively limited in most African countries. Greater emphasis will require to be placed on investment in this sector in order to promote the increased utilization of local raw materials in existing and in new industries.

Project (a) : Creation of new, strengthening and expansion of existing government institutes for industrial research

Industrial research programmes should encompass the following subjects, in different institutes if necessary:

- (i) Industrial processing of local food materials (including plant and animal);

- (ii) Industrial processing of local vegetable fibres (raw material preparation, spinning, weaving, dyeing, etc.);
- (iii) Beneficiation and extraction processes for local mineral ores;
- (iv) Industrial processing of local ceramic materials and manufacture of ceramic products;
- (v) Processing of forest products;
- (vi) Manufacture of building materials from local natural resources;
- (vii) Design of farm machinery and irrigation equipment.

Project (b) : Pilot plant design and development for industrial utilization of research results

Project (c) : Development of capacity for evaluation of technology generated through research

Programme III - STANDARDIZATION FOR INDUSTRY

153. It is envisaged that the development of industrial standardization will be accompanied by a conversion to the metric system (S.I.) of the basic units of measurement in those countries where this system is not yet in common usage. Apart from metricization of basic measurements, the major need at the moment is for the creation of the necessary national structures for the development of standards.

Project (a) : Metricization of the system of basic measurements

This applies to a number of anglophone countries which are still operating on the Imperial (F.P.S.) System of Measurements.

Project (b) : Creation of self-sustaining national standards organizations

Project (c) : Establishment of standards for a number of products and services

It is recommended that these should be on a multinational basis right from the start. This project is now urgent to prevent any further technological atomization of existing markets.

Programme IV - IMPROVEMENT OF TECHNOLOGY FOR INDUSTRIAL PRODUCTION

154. Much still needs to be done to obtain the maximum benefits from existing industrial enterprises, particularly those devoted to the manufacture of indigenous consumer products. Action in this field will include both the importation of new technology from other countries as well as the improvement of existing ones through local R. & D.

Project (a) : Improvement of production technologies presently utilized in existing cottage, small- and medium-scale industries

Many existing small- and medium-scale industries in African countries produce consumer goods intended to substitute imports. Often the locally produced goods find considerable difficulty in competing against imported versions, even when these are much higher priced because of the low quality in function and in finish of the local production. This results in stagnant conditions for local industries, particularly those owned and operated by indigenous proprietors.

The project envisaged will be directed to the improvement of the technologies in use in these small- and medium-size industries so that their products will be able to hold their own in the local markets and eventually enter into the export trade.

Project (b) : Creation of legislation and organization for patent administration and industrial licensing

It will be necessary for Governments to formulate policies and legislation for patent administration and industrial licensing. This should be associated in the same project plan with the setting up of a bureau or agency for the processing of patented technology, and the granting and administration of patents and protective licences.

Programme V - DEVELOPMENT OF INDIGENOUS CONSULTING ORGANIZATIONS AND INDUSTRIAL SERVICE LABORATORIES

155. The projects proposed in this section are intended for those African countries, the large majority, which have a mixed economy, and where it is government policy to stimulate private initiative to play a major role in the planning and promotion of industry. The projects selected are of high priority not only because of the large amounts of foreign exchange which are being spent in these areas by all African Governments, but also because without the developments which the projects are intended to produce, there will be no effective implantation of technology for future self-generating industrial expansion in the African countries concerned.

Project (a) : Development of local consulting organizations to provide engineering and technical services in the following areas:

- (i) Project studies and feasibility reports;
- (ii) Project design;
- (iii) Product design;
- (iv) Plant design.

Project (b) : Development of local industrial service laboratories to provide the following services to industry:

- (i) Chemical and metallurgical analyses;
- (ii) Material testing;
- (iii) Mineral analysis and identification;
- (iv) Operational trouble-shooting and ad hoc investigation, and solution of technical problems in industrial plants and machinery.

## Chapter V - TRANSPORT AND TELECOMMUNICATIONS

### Part One : TRANSPORT

#### Introduction

156. The surveys of needs and priorities of most developing African countries show that Africa in the twentieth century is in a sad state of neglect as far as services and facilities for transport and telecommunications are concerned. This situation has seriously handicapped the development of her economic potential and unless effective measures are taken to strengthen these sectors of the infrastructure of the countries in the region, African countries will be seriously handicapped in meeting pressing national demands for economic and social progress and the challenges of world competition in international trade.

157. In almost every country in the region there are serious deficiencies in the transport and telecommunications infrastructures. The action required must be based upon sound technical and economic analysis, upon progressive and locally orientated research and training, upon careful planning and upon well-reasoned and realistic judgement.

#### The role of transportation

158. Transport plays a proportionately larger role in the development process in Africa than it does in more highly industrialized areas of the world, in view of Africa's greater dependence upon agriculture and mineral resources for her economic well-being, and the relatively greater importance of goods in relation to services in the pattern of the economic life of the countries in the region. Transport is important to ensure that these countries get as much of their agricultural land as possible into production and to facilitate the marketing of their products. It is needed to facilitate access to forest and mineral wealth, to effect the distribution of imported and locally produced industrial goods and to stimulate and expand trade with the outside world. At another level, transport is vital for conducting health and education programmes and for promoting national integration.

159. Lack of mobility has hampered Africa's development in the past and the present situation gives no indication of satisfactory progress in this sector. In many countries, there still exist isolated pockets of agricultural producing regions which have not been linked by means of transport to the main marketing centre or ports. Produce therefore rots on the ground because it cannot be moved to areas where the hungry and needy are, or to centres where the country can make use of it for international trade. Similarly, much of the region's forest and mineral resources lie untouched because no access to it exists, or because no one can move it to where it could be processed for the good of the nation. Land-locked countries are particularly handicapped by poor access to ports in neighbouring countries. Their economic

activity is thus slowed down considerably. Even where a country can boast of a port of its own, there are too few lines of penetration from the port to vital economic centres in the hinterland.

160. Poor transportation has limited the scope of Africa's industrial activity. Since the establishment of regional branches of industry is not yet common, unreliable transport can lead to erratic supply schedules for industrial products which are marketed in the hinterland. In the same way, the running and maintenance of installations in the hinterland can suffer serious setbacks because poor transport facilities cause delays in vital supplies of fuel and spare parts.

161. The solution of transport problems in Africa requires the implementation of policies which are relevant in the African context. For example, not all routes which, from considerations of say, nearness to existing trunk routes, require development, can have high economic justification. In many cases, roads will have to be constructed before the traffic density on them can be assessed or before their economic value can be realized. In the African situation therefore, it will often be the experience that it is the establishment of transportation links between certain areas which will transform their dormant lives into lives of full vitality and bring them within the economic communities of their respective countries. Any meaningful transport policy for African countries should take account of this situation in addition to the usual planning concepts in transportation. Transport policy should be conceived as an integral part of other policy decisions since transportation links all sectors of the economy, it should not be considered as a separate sector of policy as has been the case in the past. Transport policy should also consider all methods of transportation collectively and planning must reflect the interrelation between them. Goals should be established in all policies which recognize the needs of agriculture, of industrialization and of the passenger population. It will be necessary to organize the detailed study of those factors which will have a direct bearing on these goals. Such studies should include:

- (a) A thorough survey of the country's resources;
- (b) An assessment of the development potentials of the country; and
- (c) The effectiveness of any existing transport plan.

#### Transport planning

162. The major objective of transportation planning in Africa is to effect transport progress through all stages as quickly as possible. This must be done in such a way that all areas of the country will be serviced to present-day standards to yield a high rate of economic return for the country. Present-day mobility implies aerial, highway, pipeline and railroad mobility. Careful planning must ensure therefore that the best use is made of these modes of transport to provide the most efficient and economic service, since developing Africa at the present time cannot afford the luxury of having all these forms of transport operating in competition with each other.

163. The first step in planning is the assessment of transport needs in all areas. This will require studies to be undertaken which will lead to the accurate mapping of existing transport routes, existing as well as projected agricultural and mineral producing centres, existing and proposed rural marketing centres, population distribution and the topography of the region. Next should follow proposed new transport lines under the following categories:

- (a) "Penetration lines" which will connect each country with the outside world and provide an access from ports to areas of economic activity in the hinterland;
- (b) "Axes of integration" which will link a country with her neighbours and so encourage economic co-operation among neighbouring African countries;
- (c) "National networks" which will provide access to areas of a country remote from the "penetration lines". These will be the supply routes or feeder routes without which the full development of any African country is impossible.

164. Although rigid rules cannot be laid down in the African situation, the criteria for choice of routes should primarily be based on the consideration of their capacity to serve simultaneously, national and international requirements, tourist attraction and development goals. "Penetration lines" and "national networks" are, of course, of immediate national concern, but recent interest in intra-African trade should direct attention to the development of "axes of integration". Preference for development should also be given to routes which seem to be loaded by traffic in both directions against those which carry single-direction traffic. Furthermore, routes, which have more impact upon the economic and social life of an area should be developed in preference to those with less impact.

165. The choice of mode of transport for a given purpose should be made after the most rigorous analysis of the data relating to the problem that has to be solved. Again, local conditions may affect the final judgement, but, in general, road transport in the form of trucks are advantageous for short hauls and small shipments. In addition, where the population is sparse, road transport appears the most suitable for moving people. Railways are suitable for the movement of low-value bulky commodities.

166. Air transportation lends itself quite readily to the flexibility required in the long-distance movement of people. Quite apart from this, where the terrain is rough and difficult to cross, even the movement of cargo can be found to be relatively economical by air transport. However, for the transportation of oil and gas, pipeline transport has the distinct advantage of being able to traverse the most difficult terrain, of being capable of remaining almost unaffected by the weather, of requiring only simple maintenance and of being capable of operation at low unit cost.

167. Land and air transport systems are by no means the only systems available for utilization in Africa. There is, of course, inland water transport whose potential has remained unexamined and whose possibilities have been left unassessed. Yet, many African countries are blessed with naturally occurring navigable rivers and lakes or have come to acquire them in the course of constructing a high dam for an irrigation or hydroelectric power scheme. Water transport is a cheap means of transport for short and long hauls of bulk commodities of low value. In the absence of a railway, this is the most economic way of carrying bulk material.

168. In recent years, the combination of road and railway investment has absorbed most of the transport resources in developing countries, with road transport attracting the most attention. This is because road transport service can be faster and more flexible than rail operations with their complicated schedules, fixed routes and loading problems. Besides, roads provide access to land and resources throughout their length and accommodate all kinds of traffic from primitive to mechanized vehicles.

169. Proper selection among transport modes must not be hampered by hesitancy to adopt innovations and to change traditional attitudes. The delicate task of evaluating cost effectiveness and service characteristics must be carried out without the risk of denying the African population the transport revolution required for development.

170. It should not only be in the selection of transport modes that innovations are required. In the design of the transport systems chosen, new approaches are required which will take into account relevant environmental conditions such as climate, character of the terrain and soil types. Designs should be simple, economical and capable of being modified for increased traffic capacity. Similarly, materials and methods of construction, particularly for roads and railways should be selected in a way which reflects creative thinking. Of course, new ideas in these fields ought to be tested by adequate research methods. The traditional use of crushed gabbro as ballast and of steel for sleepers should be examined, and possible substitute materials like laterite for ballast and timber for sleepers should be investigated. Local roadmaking materials should also be investigated so that their correct use under local conditions can be determined and specifications and codes of practices developed. Studies should also be made of a variety of soil types; this should lead to the cataloguing of suitable soils for road, airfield and rail track construction.

171. The construction methods presently used for roads, railways and airfields, for example, may need modifying in many instances to improve the efficiency of manual labour, as well as rationalize the use of certain machinery. In this respect, the place of heavy machinery, for example, earthmoving equipment and compacting rollers, in the construction process should be investigated. Research is required into the comparison in terms of cost, time and efficiency, between mechanized earth moving and construction operations and those carried out by manual labour, so that direction could be given in the organized use of manual labour for a wide range of construction works. Where machinery may be necessary, it is important that

the type employed be labour-intensive. Research and development work is required in the area of construction machinery design to produce machinery at low cost for use under conditions where it will supplement rather than replace human labour.

#### Maintenance of transport networks

172. It is easily noticeable in most African countries that existing roads, railways and airlines, initially constructed or developed at considerable cost, have not received the desired attention in respect of maintenance. This gives a gloomy picture of an unnecessary waste of national resources. Deterioration of existing facilities in this sector jeopardizes the natural development of other sectors of the economy, namely, agriculture, commerce and industry.

173. Lack of proper maintenance is traceable to two main factors. Firstly, the attitude of some heads of ministries or corporations concerned, who often consider maintenance costs an unnecessary burden on their budgets; this attitude results in a reduction of financial provision for maintenance. Secondly, there exists in African countries a shortage of competent maintenance personnel. This shortage has led quite often to the situation where responsible people are willing to accept lower standards of workmanship and to live happily with engineering defects. At the other end of the scale, craftsmen often do shoddy work because of their poor social and educational background and because there is little competition among them. Because competition at this level is virtually non-existent, they are able to get away with poor quality work without penalty. The discipline to devote more time and a little more effort to do a better job is sadly lacking. It is of the utmost importance therefore that means be sought to increase the number of people with maintenance skills, as well as develop amongst users and workers alike the right attitude towards the careful use and maintenance of engineering equipment and services.

174. The organization of maintenance work on transport networks should be accomplished in a manner which will keep them always in a state of good repair and so lengthen their useful lives. This should involve regular inspection by maintenance teams in specialized areas such as roads, bridges, railways tracks, airfields, pipelines and inland waterways, each team following a well-defined programme of activity. Defects when discovered should be speedily remedied, and in addition routine maintenance operations, including the protective painting of steel bridges, regrading and rolling of earth roads, conservancy work on rivers and the clearing of the permanent way and the cleaning and renewal of ballast between rails, should be carried out according to a regular programme. Because of shortage of good maintenance services, any plan for future transport development should emphasize the importance of instituting measures which will reduce maintenance in several areas of the transport network. For example, any improvement in road construction methods which will result in roads withstanding, more successfully than at present, tropical weather conditions, will reduce maintenance costs immensely. Also, processes of track laying and upkeep can be reduced in the railway system if the techniques of long welded rail were extended and suitably adapted for use in the tropics.

### Terminal facilities

175. Most modes of transport lack the advantage of door to door delivery. Road transport perhaps is one system with the flexibility of affording some measure of this facility. Nevertheless, for road transport as well as for all other forms of transport, terminal facilities must be provided for passengers, for the handling of freight, for storage and for transshipment in certain circumstances. Existing facilities are far from being adequate. Trucks, long distance coaches and "mammy wagons" ply busy African routes whose terminal points are recognizable only by a collection of roadside market stalls. Railway stations in many provincial towns are built with platforms too short for the average train, with inadequate signalling facilities and with no freight handling equipment of any kind. Water transport is handicapped by poor terminal port facilities if they exist at all, and to no less extent at seaports, where serious bottlenecks in cargo flow reduce seaport activities to a low economic level. Facilities at airports, especially those located in the hinterland are insufficient in most cases, in respect of passenger and freight handling and landing aids.

176. The entire field needs careful examination so that improvements can be made in the management of and the services at transport terminal points which will be compatible with today's pattern of trade and travel.

177. For land transport, lorry parks, bus stops and railway stations should be upgraded to provide decent storage and packing facilities for merchandise and perishable produce which must await collection by agents or transshipment to another destination. Train movements should be made easier and faster by improved signalling and train control installations, so that the common experience today of long waiting at stations for rail shipment of produce, even with advance space reservations will be avoided in future. The state of train landing platforms should be reviewed with the object of introducing modifications which will permit the use of mechanical handling equipment, including fork lift trucks, conveyor belts, pipelines, etc., especially at port terminals. Pipeline transport in the port setting ought to be investigated for its suitability for use in moving some kinds of solids in addition to gases and liquids.

178. Existing international and national airports need re-examination with regard to the adequacy of their runways for modern airplanes and their passenger facilities and lengths of routes served from particular airports. While for the moment one runway may be sufficient for most of the countries in the region, it will be desirable to investigate cross-winds at these airports to find out whether circumstances exist anywhere to justify the construction of cross-wind runways.

179. At this period of Africa's history where inter-continental tourism is having a great impact upon the economy of some countries, it is essential that all necessary action be taken to maintain the flow of tourists into these countries. The problem of handling the large numbers of passengers

brought in by the larger jet planes commissioned by tourist organizations has to be solved by many countries. Airport buildings should be examined with a view to increasing their capacity where necessary and in particular, to improving amenities for tourists, instituting fast and efficient passage through customs and immigration barriers and providing an attractive portage service, whether mechanized or manual. Air traffic control should also be improved through the development of services such as telecommunications and meteorological services.

180. The provision of improved terminal facilities for water transport needs even greater attention. Many inland ports need to be rebuilt and others provided with improved equipment to service night traffic as well as reduce waiting time at ports. Improvements in inland ports should follow investigations into the suitability of the route served for large vessel traffic and into the level of economic activity possible, so that the returns for any improvement will justify the expenditure involved. The data upon which inland port design and development should be based ought to be carefully collected and analysed. Seaports fall into a different category. The problems in this area involve the improvement of transport connections into the hinterland and the development of local capacity to carry out modern designs of storage and port handling facilities. Study and testing of modern technological innovations is required if the effort to improve all round conditions is to be in line with modern practice in this field. In particular, systems of handling such as containerisation and palletization should be investigated for use under the special conditions of African trade and labour.

#### Transport equipment

181. The achievement of greater transport efficiency is bound up to a great extent with the provision of improved transport equipment. The last decade saw the introduction of mass-produced diesel engines into medium and light commercial vehicles. With this type of vehicle having low fuel consumption, operators have been able to give cheaper service while at the same time reducing the costs of keeping their fleets roadworthy. A desirable development at this time would be the further reduction of maintenance costs through the designing of vehicles specially adapted for African conditions of service. Although some attempt has been made by foreign exporters in recent years to introduce improved features in certain vehicles, such as heavy duty tyres, special springs and shock absorbers, etc., there has been no way in which African countries have themselves been involved in setting standards to meet the demands of their country's climate and terrain. Such issues need close study.

182. Another area of action offering great advantages is the restriction of the number of types of transport equipment imported into African countries, particularly trucks and cars. Before restriction is recommended, an examination should be made of selected types of vehicles so as to assess their suitability under local conditions, the ready availability of spare parts and the cost of the equipment. Testing facilities will be required to carry out such studies. When a number of types of vehicles have been

recommended, it will then be necessary to carry out further investigations for the purpose of specifying service standards for each type. Such standards could then be used in legislation governing the importation of vehicles. The same need for the examination of existing transport equipment with a view to introducing improvements applies to other transport systems. For example, in the field of railways, the relative advantages of diesel, electric and steam motive power should be studied with regard to fuel economy, fuelling processes, modifications demanded on tracks and wagons, speed of movement and efficiency of operation, and the most advantageous system selected for more common use. Standardization of rolling stock should be pursued as keenly as possible so that repair and inspection times will be shortened and the availability of materials and spares will be increased.

#### Standardization of transport networks

183. Apart from standardization of equipment so as to promote efficiency in the transport sector, standardization of network design and carrying capacity ought to be pursued in the interest of smooth traffic movement within national boundaries and easy movement across national frontiers. At present the width of carriageways varies in anglophone Africa from an average of 24 feet in urban areas to 18 feet in rural areas, while many interstate roads could barely admit two-way traffic. Most bridges in the hinterland can only take single-lane traffic, some, just barely. Railway gauges vary from somewhere below 1.000 metre to 1.440 metres in the region, with no correlation between track gauge standard and the pre-independence European influence in the countries. Each railway also has a different coupling and braking system.

184. While it is vital to effect standardization in this area of transportation, it is important that plans for such standardization should anticipate future traffic. Standards of road, bridge and rail construction should be developed for adoption by all countries in the region, and these should be such as will permit greater safety and speed in operation. For roads, a minimum lane and formation width should be specified, which will allow for the ultimate provision of a double carriageway with adequate central reservation. It should then be left to traffic densities in particular areas to dictate the number of lanes for which pavement construction is to be carried out. Standardization is also required for bridge designs, geometrical and engineering specifications for roads and harmonization must be achieved for road traffic signs and signals and for rules of driving.

185. Standardization of rail track on the continent however, poses financial problems of great magnitude. Existing tracks can be modified to comply with new agreed standards, but the cost involved may be prohibitive. The alternative approach to the problem, namely that of developing systems which will facilitate the linking of railway systems of different specifications at points of change may prove more economically attractive and should be investigated.

### Maintenance of transport equipment

186. More widespread and more competent maintenance service is required to keep equipment in good working condition during their life span. Poor maintenance results in high operating costs. This situation should be avoided by the provision of increased numbers of trained maintenance engineers and technicians, as well as by the establishment of high quality workshops throughout each country, and particularly at transport terminal points. The quality of maintenance service will depend not only upon the quality of engineers and technicians but also upon the availability of spare parts and the organization of maintenance services.

187. It has been difficult in many countries to keep a decent level of stocks of certain vital spare parts. A variety of problems are associated with orders and shipment of machine parts and these affect maintenance services adversely. Different solutions to these problems are possible. One method is to overstock special items and introduce at the same time a stock-control system which will reduce off-the-shelf service. Some countries have established assembly plants for a wide range of vehicles and light machinery. By far the most progressive step is to encourage research activity which will lead to the successful design and development of spare parts production not only for well-tried equipment but also for those with poor performance under local conditions.

188. Maintenance service itself ought to be better organized. It will be an advantage to investigate existing maintenance establishments to discover areas in which co-operation is possible, both in the national context and in the wider field of interterritorial service. In this respect, the establishment of sub-regional engineering bases for aircraft maintenance should be investigated; so also should the provision of sub-regional facilities for the repair and servicing of sea and river craft.

### Operation of transport networks

189. Irregularity in the operation of transport networks makes it difficult to provide efficient transport service in the region or to maintain an economical transport system. Inefficiency slowly stifles economic development as vital economic routes become congested through poor traffic management and administration or become impassable for long periods through poor control and planning of maintenance services. In addition, inefficient operation of networks tends to increase operating costs and leads to the subsidizing of services and the resultant overburdening of national economies with service costs. Attention should therefore be paid to the promotion of technical and administrative efficiency in the operation of networks. This should include the training of personnel at all levels as well as the provision of suitable equipment for the management of airways, railways, roads and waterways.

190. Studies of existing systems of operation of all networks should be made to discover areas requiring improvement. A few transport sections need highlighting. In the road transport sector, for example, methods of operation should consider the rising standards of living in the region which tend to demand faster delivery of goods ordered and greater comfort, more safety and less delays in their journeys for passengers. Studies of traffic patterns should reveal the best spacing along routes of such facilities as servicing, filling stations and road repair bases. In the operation of railways, signalling and train control installations should be improved to cope with the expected increase of the volume of rail traffic in a number of countries. It will be an advantage in this sector if advances made elsewhere to increase railway efficiency were examined for adaptations to suit local requirements. In particular, attention should be given to devices which would make door to door delivery possible without incurring undue transshipment costs, delays and breakages. For river transport operation, speed, safety and economy can be suitably planned to achieve meaningful efficiency through studies of craft sizes and methods of towing barges. It seems, however, that at the present stage of development in the region, emphasis should be placed on economy, i.e., among other things, greater carrying capacity and safety, rather than on speed.

191. In general, regular scheduling of commercial transport services should be carried out and strictly adhered to, so that departure and arrival times will be known well in advance by clients who must make advance preparations for discharging and loading of goods and cargoes.

## Part Two : TELECOMMUNICATIONS

### The state of telecommunications services in developing Africa

192. The demand for national, inter-territorial and inter-continental telecommunications services is steadily growing in African countries, but services in this field have been slow to develop because African nations have not, before now, given it the priority it deserves. Many national telecommunications networks are of poor quality and some of them are frequently out of commission. Such a situation is bound to affect the efficiency of many undertakings in the country, particularly in commerce and industry, and will hinder any progress planned in the development of inter-territorial and inter-continental telecommunications.

### Telecommunications planning and development

193. Telecommunications in the region should be planned firstly to give efficient and uniform national services; secondly to provide cheap and reliable inter-African networks, and thirdly to strengthen and improve inter-continental networks. Great improvements are required in all areas of the national services, so that more of the population will benefit from the advantages of telecommunications. In the area of telephone services,

for example, the utilization factor <sup>5/</sup> was 0.8 in 1969 for the developing African region while the figure in Sweden was 22.7. Telephone density, i.e., the number of telephones per 100 of the population was 0.9 for the African region while the world average was 7.1 and that of North America 48.8. The problems of availability and utilization are intricately bound together and their close examination in planning improvements in telephone services is necessary. This is equally true for the planning of other services such as telegraphic, telex and broadcasting services. For all these services, more availability in terms of increased facilities is no guarantee of increased utilization. Services should be reliable, giving little or no loss in scheduled connection, transmission or viewing time. Evenly scheduled services or operating timetables should be planned to cover the larger part of each day.

194. The choice of a suitable communications system should be based on studies determining the degree of operational efficiency desirable for particular links, as well as upon the cost of the system. Many developing countries have shown great interest recently in the use of microwaves for national networks although this system is more expensive than a VHF system. It will be desirable to study this trend to find out how it should be directed towards the proper provision in each country of a high grade internal circuit which will eventually be incorporated into the proposed Pan-African telecommunications network.

195. In this area of inter-African telecommunications links, studies of the possibilities of space communication already begun should continue and should examine the prospects for satellite broadcasting in addition to communications by telegraphy and telephony. The advantages of the use of a simple satellite for Africa as against the provision of sub-regional satellites should be investigated. In any case enormous advantages could be gained through co-operative action in this field. The cost per capita of such installations will be reduced, and for Africa with her yearning for cultural and economic interaction and political understanding between States, the achievement of regional or sub-regional satellite communication services will take her a long way towards the attainment of these goals.

196. Apart from the application of space technology to telecommunications in general, there is an urgent need for the application of science and technology for the more widespread and more purposeful use of national broadcasting. The scope of broadcasting services ought to be expanded so that the remotest villages will benefit from sound and television programmes which should be biased heavily in favour of education rather than of entertainment. Techniques should be developed for African requirements in the area of education by radio and television and studies ought to be carried out on the cost/effectiveness

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<sup>5/</sup> Utilization factor =  $N \text{ divided by } 10^{-5}G$ . Where N = no. of telephones.  
G = GDP in US dollars.

and cost per student of proposed methods for different countries. Africa at the moment has the least facilities for disseminating information amongst her peoples, and for conducting adult education classes on a large scale. It is of utmost importance, therefore, to find ways of improving these facilities, particularly through the development of high performance broadcasting and transmitting stations, and the design and production of low-cost television and radio sets, for private as well as for commercial viewing and listening.

#### Maintenance of telecommunications networks and equipment

197. Maintenance of telecommunications networks is handicapped firstly by the shortage of spares, mostly resulting from the shortage of foreign exchange, and secondly by the limited number of trained maintenance personnel available.

198. The shortage of spares can be partly overcome through the development of skills locally for the design and manufacture of a limited range of spare parts, especially those parts which require frequent replacement. Locally produced parts should be able to resist more successfully than foreign imported parts, these weather conditions peculiar to African countries which are given scant regard by foreign designers.

199. The shortage of trained personnel of the right calibre can be overcome through the improvement of training facilities in telecommunications. Training should include such fields as telecommunications systems and equipment design and maintenance. Emphasis should be placed on continuous training of personnel at all levels who must keep in step with the rapid advancement of knowledge in this field.

#### Objectives

200. In the light of the foregoing, the objectives of the programmes proposed on transport and telecommunications for the African Regional Plan are as follows:

- (a) The development of machinery for the assessment of transport needs and the planning of national transport systems. Planning should consider, among other things, such matters as co-ordination of national systems, including inland waterways, and the development of intra-African transport links;
- (b) The improvement of maintenance services for networks and equipment in all areas of activity in the transport and communications sectors. It will be necessary to emphasize in this process the need for each country to establish a tradition of quality standards amongst their craftsmen and a motivation for excellence in the performance of their tasks;

- (c) The establishment of research programmes by which knowledge of local engineering materials would be acquired and disseminated for increased use by planners, designers and builders;
- (d) The provision of improved facilities at terminal points on transport routes. Facilities for land transport should be considered in addition to port and harbour facilities;
- (e) The development of facilities for investigating and improving the serviceability of transport equipment under special environmental conditions in Africa.
- (f) The institution of programmes for standardizing transport equipment and transportation networks;
- (g) The development of technological and managerial know-how for the operation of transport networks;
- (h) The development and improvement of national, sub-regional and regional telecommunications networks and services.

Programme I - IMPROVEMENT AND EXTENSION OF ROAD TRANSPORT AND SERVICES

201. Most of the problems associated with the improvement of road transport services in the African countries are technological problems deriving often from inadequate technical data on materials and methods or absence of technological services. The projects proposed under this programme are directed at filling the gaps in know-how and in essential services.

Project (a) : Establishment of national road research institutes

Although a few countries have established Road Research Institutes, progress in the field of road research is very slow, and little impact so far has been made on the road construction industry.

It is desirable for road research programmes to cover soil investigation, road-making materials, structural and geometric designs for roads and road construction methods, as well as research into the use of construction machinery. In view of the large expenditure that will inevitably have to be incurred on road construction, research institutes should be created which should be devoted to achieving maximum economy in road building.

Project (b) : Cataloguing at the national level, materials suitable for road and airfield construction

The preparation of a catalogue of soils and other materials suitable for road, rail and airfield construction will make the result of researches carried out by the Road Research Institutes more meaningful and more readily available for use. It will also improve and quicken the processes of preliminary investigations for roads, railway and airfield projects.

Project (c) : Creation of research and development institutions for the establishment of specifications and of performance criteria for the design and construction of highway and railway bridges

The functions of such institutions will include advising on minimum standards for national and international roads and bridges and the drawing up of specifications and codes of practice for the design and construction of road and railway bridges in the sub-region, having regard to local climatic conditions. They should investigate standardization of designs for economic construction of bridges as well as the possibilities of using precast and prefabricated bridge structures.

Project (d) : Establishment of national and regional centres for road planning and design

Such centres will work towards the improvement of techniques of road planning and design. They will also evolve, through careful studies, sound bases upon which interregional roads would be developed. These centres should advise on problems of maintenance organization, and promote the introduction of measures to make travel by road easier, safer, and quicker.

Project (e) : Improvement of road transport services

Expertise should be developed in the planning and management of road transport services. Mass transportation by road for long journeys should be made more comfortable, to be compatible with rising standards of living in most countries. The standard of transportation of goods by road should also be raised to reduce losses through damage or delay. The customary types of transport vehicles should be examined with the aim of introducing modifications in their design and construction which will raise the standards of comfort and safety for the passenger and reduce risk of losses for the trader.

Project (f) : Improvement of the organization of road maintenance

The maintenance of road networks should be pursued with greater efficiency than at present to keep traffic in continuous flow and reduce road hazards. The project envisages the creation of maintenance units consisting of inspection and repair teams. Units of this kind would be responsible for the drawing up of schedules of routine inspection and maintenance. Routine inspection would mean the early discovery of defects or damages and consequently, the early execution of repair work.

Programme II - STRENGTHENING OF RAILWAY TRANSPORT

202. After a period characterized by a fall in demand for railway transport in African countries, the importance of adequate and efficient railway services is coming once more to the fore as industry and mineral exploitation begin to expand. The most urgent problems in relation to railways are more intensive exploitation of existing networks coupled with greater reliability and improved overall performance in maintaining service schedules. Both technology as well as additional capital investment are involved.

Project (a) : Improvement in the operational efficiency of existing rail routes

This would involve improving, for example, the rail track for better riding comfort and for the reduction of wear and tear. Studies are required in this connection, into the efficient use of long welded rails, laterite ballasts and timber sleepers. The successful introduction of dieselization into the railways in some countries should be studied and ways found to increase its application. In addition, signalling and train control installations should be re-examined and improvements introduced for safer and faster train movements.

Project (b) : Development of methods to achieve the linking of railway systems of different technical specifications

Technical studies are envisaged under this project to solve the problems of linking railway systems with different track gauges and axle loads, as well as different coupling systems and height of buffers for the rolling stock. There is further need also for technical studies which will lead to the standardization of track loading gauges. If an inter-regional railway network is to grow out of existing national networks, a solution to this problem must be found.

Project (c) : Development of improved handling facilities at railway terminal points

Railway stations should be developed to give better handling services for goods. The use of mechanical handling equipment should be examined against the background of the availability of cheap labour in Africa. The solution to the problem of improving handling facilities may be found in the combination of a limited number of machines and a well-trained team of manual workers.

Project (d) : Improvement of maintenance services for railway networks and equipment

The problem of maintenance in this area is traceable to poor organization, and the limitation of maintenance facilities to a few urban areas. The railways in many African countries have a tradition of possessing high quality workshops and technicians. It is only necessary for this acquired tradition to be upheld throughout each country by providing the skills and equipment at more centres suitably located along the railway routes.

Programme III - DEVELOPMENT OF INLAND WATERWAYS, MARITIME SHIPPING (INCLUDING COASTAL) AND MULTINATIONAL SHIPPING LINES

203. Except at the main sea ports, both the technology and the equipment of inland and coastal ports are very rudimentary. Inland waterways, in particular, require special attention. At all ports, improved management is essential to obtain the full benefits from the investment in installations and equipment.

Project (a) : Study of the application of new technologies in maritime transport to the African situation

This study is necessary in the area of goods handling so that the advantages of the new technology in developing sea-borne trade will not be lost to Africa. Studies must include the organizational character as well as the technical character of the new systems, namely those of utilization.

Project (b) : Improvement of efficiency and operation of ports

This project is expected to include the continuous study of inland and sea port operations with a view to simplifying them and bringing about reduction in shipping costs and freight rates.

Project (c) : Provision of efficient zonal dockyards

Dockyards of high efficiency should be developed to serve a group of countries in a sub-region. There will then be available repair and servicing facilities for sea and river vessels which will enhance the development of water transport in the region.

Project (d) : Institution of zonal centres for the study of navigation problems in inland waterways

Such studies should include bridge clearance on navigable rivers, silting rate, pollution levels, and safety measures, problems of dredging and related hydraulic studies.

Programme IV - IMPROVEMENT AND DEVELOPMENT OF AIR TRANSPORT FACILITIES

204. Air transport has developed very rapidly in African countries and is the one domain in transportation where modern technology and systems have been installed as a matter of intrinsic necessity in all countries. The main technological requirements in air transport in the region are improved services for navigation and maintenance.

Project (a) : Improvement of air transport services and equipment

Various improvements in such areas as air traffic control, meteorological services and terminal facilities should be undertaken in a way which will serve the requirements of the budding tourist industries in many African countries. Studies are required to give information on the minimum requirements in these areas which will ensure the development of an economic, safe and regular air transport, not only for the conveyance of passengers, but also for the transport of freight and mail within and outside the borders of Africa.

Project (b) : Establishment of sub-regional engineering bases for aircraft maintenance

Such bases will undertake maintenance, overhauling and checking of aircraft and aero-engines. Aircraft maintenance to international levels of proficiency is very expensive for individual countries to undertake on their own. It is important for the future development of air transport to provide high-level maintenance facilities on a sub-regional basis. Co-operation at this level will bring immense benefits to all countries.

Project (c) : Establishment of a sub-regional technical services centre for air transport

The responsibility of a technical services centre for air transport will include the provision of services to test for airworthiness of aircrafts, the provision of facilities for the licensing of personnel, the maintenance of flight standards and the investigation of accidents.

Programme V - DEVELOPMENT OF AND IMPROVEMENT TO TELECOMMUNICATIONS NETWORKS AND SERVICES

205. In this programme, emphasis has been placed on the need for improved and more comprehensive planning of telecommunication systems. A pressing priority in planning should be the need for interconnections between the African countries. Further improvement in maintenance services will be required as systems become bigger and more complex.

Project (a) : Development of technical criteria for the planning of national telecommunications networks and services

Studies and analyses of various systems must be carried out to lay down criteria for planning, and for the improvement and extension of telephone, telegraph, telex and broadcasting networks and services within the various countries of the region.

Project (b) : Improvement of telecommunications links with neighbouring African countries

The standard of existing services between adjacent African countries is far from being satisfactory. Apart from this, few neighbouring countries have direct connections. The establishment of reliable links between neighbouring states is vital in the whole programme for a proposed Pan-African telecommunications network. Without quick and trouble-free links to the main centres, the Pan-African service will become unusable.

Project (c) : Investigation into the possibilities of the use of space technology for communications

Studies are required into the general impact upon the region of satellite communication services. Such studies must cover the economies of installation and use, as well as the advantages or otherwise of sub-regional satellites, of a single satellite for Africa, and of multipurpose satellites.

Project (d) : Maintenance of telecommunications networks and equipment

Emphasis in this project is expected to be placed on the development of:

- (i) skills in planning maintenance operations;
- (ii) skills in the early diagnosis of faults in networks and equipment;
- (iii) facilities for producing a selected range of spare parts locally.

Programme VI - TRAINING OF PERSONNEL IN ALL AREAS OF TRANSPORT AND TELECOMMUNICATIONS

206. The whole success of any development programmes in transport and telecommunications depends in the most crucial way on the availability of competent personnel in a wide spectrum of professional and operative skills. Hence this programme which provides for the training of personnel of all types should be considered as having the highest priority in this sector.

Project (a) : Training of personnel in transportation planning

The training required should be in the following fields: highways development, traffic engineering, aviation and navigation, and should be oriented towards the special needs of a developing environment.

Project (b) : Training of maintenance engineers and technicians

Maintenance engineers and technicians are required in the following fields:

- (i) Highway engineering;
- (ii) Automobile engineering;
- (iii) Railway engineering;
- (iv) Mechanical plant engineering;
- (v) Marine engineering;
- (vi) Aeronautical engineering;
- (vii) Electronics and telecommunications engineering.

Project (c) : Establishment of regional facilities for the training of personnel in port operations and management

The need for personnel in these fields is quite serious in most countries. In view of the modern developments in port operations (shipping), training should be directed towards the production of workers who will be capable of operating and managing modern systems efficiently.

Project (d) : Training of qualified operating personnel for small and medium-sized vessels

The rapid development of inland waterway transport will make heavy demands upon the few trained operators now available. Training must therefore be carried out bearing in mind the circumstances under which operators will have to work and the level of local demand for operators from time to time.

Project (e) : Training of qualified operating personnel for seagoing vessels

The need for **indigencus** operating personnel for Africa seagoing vessels, as well as for the whole maritime industry, will go hand in hand with the development of maritime shipping in African countries. Training can be organized on sub-regional or regional bases or initially in the institutes of advanced countries, but it should include the preparation of indigenous personnel in every field needed for the marine industry.

Programme VII - INSTITUTING PROGRAMMES FOR STANDARDIZING TRANSPORT EQUIPMENT AND NETWORKS

207. The objective of using transport and telecommunication networks as a means for promoting regional economic integration, particularly in terms of intra-Africa trade, will only be fully achieved when there is improved co-ordination in the planning of networks and greater harmonization in the standards adopted for the design and utilization of these networks. Standards relating to the capacity, the quality and the performance of systems especially need to be jointly laid down by the African countries. Standardization in transportation equipment especially requires attention so as to reduce variety and facilitate maintenance.

Project (a) : Standardization of roads

This development is necessary to promote international co-operation through the construction of international road networks. Standardization should be studied and pursued in the areas of structural and geometric designs for roads, road planning, construction and maintenance.

Project (b) : Standardization of road transport equipment

While it will be a great advantage to work towards this goal in the regional context, immediate interest should be focussed at the national level where such standardization will lead to the simplification of transport equipment maintenance.

Project (c) : Development of performance standards for road transport equipment

For this project, planned and effective research will be required into the behaviour of transport equipment under local weather conditions and local road conditions. There have been difficulties in the past in getting high performance and satisfactory durability from certain vehicles because certain components such as tyres, springs, shock absorbers, brakes, engine exhaust units, their mountings as well as certain joints and couplings, were not designed to withstand the service conditions imposed upon them in the African environment. Recently, however, some foreign manufacturers have introduced improvements in their vehicles to enable them to perform better in the African region. This project will make it possible for the African countries themselves to set performance standards for equipment imported into or produced within their countries. Such standards should then be incorporated in legislation governing the importation of vehicles.

Project (d) : Standardization of air transport equipment

It is important to institute studies for the standardization of air transport equipment in the African region. Such standardization will help in the pooling of resources, especially in the area of maintenance and other technical services.

Programme VIII - DEVELOPMENT OF INTERNATIONAL CO-OPERATION IN  
THE FIELD OF TRANSPORT AND TELECOMMUNICATIONS INCLUDING  
RESEARCH AND DEVELOPMENT

208. This programme proposes some subject areas and modes for formal co-operation between African countries in the field of transportation and telecommunications. Whilst emphasis has been put on mutual co-operation in technological matters, such co-operation can also be extended to commercial activities where joint acquisition and usage of technological facilities can confer considerable benefits in commercial exploitation.

Project (a) : Encouragement of mutual co-operation of neighbouring  
African countries in research and development of  
means of transport

It is very difficult for many African countries to undertake research and development of means of transport, particularly air and sea transport, because of the lack of qualified personnel and financial resources as well as research facilities.

Such co-operation can give them an opportunity to pool their human and financial resources to develop research in the areas of mutual interests.

Project (b) : Encouragement of mutual co-operation of African  
countries in research and development of tele-  
communications

This project is to help the governmental agencies responsible for the development of telecommunications to undertake studies and research in the area of multinational co-operation which in turn can offer greater opportunities for the rapid development of all means of telecommunications throughout the continent.

Project (c) : Organization of international, regional or sub-  
regional conferences, seminars and symposia on  
matters of transport and telecommunications  
development and research

This project should include conferences, seminars and symposia on the matters of research and development of all means of transport; air and sea transport, railways, roads and inland waterways as well as all means of telecommunications.

This undertaking will help African countries to co-ordinate their activities in these fields and enable them to achieve more rapid progress in their development.

Project (d) : Encouragement of the development of multinational shipping lines

It is impossible for many African countries to establish shipping lines of their own because of very high cost of seagoing vessels. One of the best ways to develop maritime shipping by African countries is through the establishment and development of multinational shipping lines, including coastal shipping lines.

It will enable them to pool their financial and human resources and give them the opportunity to reduce expenses for freight and, consequently, to save foreign exchange needed for the development of their own sea transport.

Project (e) : Encouragement of mutual co-operation of African countries in joint operation and maintenance of airlines

It is very difficult, if at all possible, for many small African countries to develop air transport operations independently of each other, because of the high cost of airlines themselves and maintenance services.

In general co-operation in joint operation and maintenance is mainly a commercial problem and not technological. However, the promotion of such co-operation should be encouraged by international organizations particularly in the field of maintenance services, as it can help the developing countries to develop their air transport more rapidly on the basis of new technology.

## Chapter VI - HOUSING AND URBAN DEVELOPMENT

### Introduction

209. The rapid growth in urban populations in developing African countries has resulted in a big demand for all classes of domestic and commercial buildings. Consequently, activity in the building construction industry has been of a magnitude which this continent has never before experienced. Already, the industry absorbs a substantially high percentage (58.8%) of the total investments in the region and accounts for the employment of a large proportion of non-agricultural labour. Its position, therefore, in the social and economic framework of countries in the region is quite dominant and accords it the advantage of a significant measure of control over the pattern of national development. All indications at present are that the industry's dominant position will be maintained during the Second Development Decade and that its influence in the field of social and economic development will increase as it is forced to expand under pressure from an increasing urban population and a growing commercial sector. Yet, in this key industry, there has been very little innovation through science and technology for promoting its planned and progressive development.

210. Despite the marked effort in many countries to provide more and better housing for their people, so far only a small dent has been made in the housing demand. Furthermore, the housing situation is bound to worsen as the growth rates of urban populations increase with the daily flow of rural dwellers into cities and towns. The pull of the urban areas remains a formidable force to overcome in the presence of such motivating factors as the demands of industrialization for more skilled and unskilled labour, and the natural attractions of city life to rural youths. Some of these eventually drift into the towns, and those who fail to find work feel ashamed to return to the rural areas. They therefore set up make-shift and insanitary settlements in the urban areas, thus accelerating the growth of slums and undermining to a serious degree the social infrastructure of the urban communities.

211. To meet the present needs and to avert serious disruption of the social framework of indigenous African communities, immediate action is required to increase the production of houses, to keep in good repair the existing housing stock, and to evolve satisfactory plans for urbanization. The production of more and better houses requires to be speeded up and at the lowest possible cost. The urban population must also be settled in a manner which makes for efficient use of available land while providing, at the same time, a comfortable, healthy and happy environment for all.

### Housing design

212. Everywhere in Africa, urban dwellings are in general overcrowded and lack the most elementary amenities. The immediate concern, therefore, of many countries in the region is the production of more and better houses at low cost. The initiative for conceiving low cost schemes must come primarily from the designers whose responsibility it is to choose such forms and features of design that will be compatible with local climatic conditions and cultural components and the application of simple and inexpensive construction methods. Savings in materials and methods of construction should be complementary to savings in the operating costs of buildings. Designs should, therefore, be conceived which will provide for proper sanitary and other household facilities taking account of cultural factors, good orientation to ensure adequate natural illumination and ventilation, so that the use of electric lights during daylight hours and the need for air-conditioning will be reduced to a minimum.

213. Most of Africa inherited at independence a building materials industry that produced very few materials of great importance in building construction. Most of the materials for constructing urban dwellings came from Europe. Iron, steel, electrical and sanitary fittings and installations, sheet glass, paints, cement, varnishes and often even timber was imported. The traditional wooden poles and compacted soil for walls, and bamboo and straw for roofing were left undeveloped. Consequently, designs for urban houses were conceived with imported materials in mind. These were expensive and out of reach of the vast majority of people.

214. New thinking must be infused into housing design so that comfort and good taste may not be sacrificed for quantity. New adventures into the world of tropical architecture should be made which should include the examination of the necessity for maintaining existing conventional features in their present form. For example, if light and fresh air could be let into a building by some judicious method of staggering wall panels, there may be no need for conventional windows at all. Furthermore, if partition walls were not taken to ceiling height in every case, "through ventilation" will be achieved quite cheaply without loss of floor space in corridors. Designs ought to be directed more towards the use of modular co-ordinated structural and non-structural components, which will result in standardization and in the eventual smooth management and organization of construction sites. Designers should therefore approach the problems of the provision of inexpensive urban housing through the integrated use of standard building materials and components, through more widespread use of local building materials and through the introduction of suitable basic modules in housing design and adaptation for multistorey buildings.

## Materials of construction

215. The cost of building materials forms a substantial part of the overall cost of buildings in Africa. Cheaper houses will, therefore, ultimately depend upon how low the prices of materials required for construction can be kept. Great savings are possible through the substitution of indigenous building materials for some of those being currently imported. Savings in time and money can also be effected through the local manufacture of products which are in quite common demand and which are equally short of supply in some countries. Products like screws, faucets, hinges, tiles, door knobs and sanitary fittings fall into this category. As far as the increased use of indigenous building materials is concerned, a tremendous amount of research is required to establish the scope of use in their present form and to improve their strength and durability. In the research and development effort to produce new materials and improve techniques the role of building regulations and specifications as the means of establishing the use of new materials and techniques must not be lost sight of.

216. Building materials research must be developed in all countries of the region to a level at which it can competently investigate problems of direct relevance to the development of the building industry - problems, for example, that limit the use of timber as a major building material. The industry has been and is still indifferent to the use of timber to any extent beyond the category of an interior finishing material. Yet Africa abounds with forests and produces high quality timber. However, ignorance of the techniques of preventing it from fungal and insect attacks, and the uncertainty of its behaviour under the influence of high radiation and heavy rainfall have made it unreliable for use as a major material in buildings for which the aspect of durability is a vital consideration. Other problems relating to known and widely used indigenous materials include the poor performance and tensile strengths of sandcrete blocks, used extensively in West Africa for load bearing walls in buildings. The material which is made from a mixture of sand and cement in varying proportion is a cheap building material, but investigations are required to improve its quality with respect to strength, shrinkage and stability. Investigations are also required which will give guidance to the specification of minimum standards so that the material will become more capable of resisting normal roof and floor loads without showing those signs of distress which reduce splendidly conceived architectural designs to shabby spectacles of crack-riddled partitions and outer walls. Similar problems exist with stabilized and non-stabilized soil or earth blocks which need to be solved.

217. In addition, ways should be found to produce locally, at lower costs, such materials as are at present being imported at high cost but which cannot be readily replaced by indigenous building materials. Much as it is desirable to localize, as much as possible, the activities connected with the building industry in Africa, it must be accepted that certain new materials will continue to be imported from advanced countries for certain categories of buildings. Vast new strides are being made in those countries in the production of a wide range of aesthetically attractive and technically revolutionary

products. Nevertheless, it will be unwise to import these new products without subjecting them to technical and socio-economic evaluation under local conditions. Indeed, even the use under local conditions of the old materials borrowed from advanced countries has not been properly mastered. Concrete behaviour and durability in the tropics, for example, still remain an enigma and steel components in buildings sited on the sea coast have never successfully been protected against corrosion. The corrugated iron sheeting which is now so popular in many tropical African countries as a cheap roofing material was introduced into building practice in Africa without considerations of its high heat absorption, radiation and conductivity properties, its poor fire resistant properties, its poor acoustic properties and its unaesthetic quality. It is now time to assess the roofing situation in the light of past experiences and endeavour to develop safe and durable roofing materials for low cost housing. Furthermore, it should be the task of researchers to effect a gradual increase in the variety of products derived from indigenous materials and to make them suitable for sophisticated use in a wide area of the building industry. Local clay and lime, for example, could be processed into more durable and better looking bricks and tiles. The potential of local silicious materials for the manufacture of glass and ceramics (as crushed laterite) as well as that of local igneous or sedimentary rocks for use as concrete aggregates should also be investigated.

#### Methods of construction

218. The present housing shortage in the urban areas calls for a method of construction which will combine speed of execution with a minimum demand for skilled labour. The solution appears to lie in the mass production of housing units. This will inescapably mean the development of local and pre-fabricated components for the building industry. It will also mean the introduction of some form of mechanization into building construction methods. The implications of mechanized building have to be studied for each national situation. The successful introduction of mechanized building will depend on:

- (a) The willingness and ability of a nation to plan housing schemes well ahead of implementation dates;
- (b) The readiness of public authorities to acquire land where necessary;
- (c.) The availability of adequately developed sites in terms of the provision of pipe-borne water supply, drainage and modern sewage disposal services;
- (d) The existence of enforceable national specifications and codes of building practice;
- (e) The existence of trained personnel in the field of mechanized building construction; and
- (f) A ready source of supply of a wide range of building materials.

219. The technology required for mechanization to the extent envisaged must break new grounds in areas of knowledge about which the scientific world has been for far too long disinterested. The level of resources in the developing African region makes it necessary to demand not only speed of construction of homes but also a new kind of mechanized operational efficiency which will significantly reduce costs while at the same time generate a high level of employment of unskilled labour. Concerted research efforts are needed in this direction. Also, in vital stages of the mechanized process, for example, in the development of the techniques of prefabrication, the possibilities for innovation are very wide. Intensive research is required to give direction to the assembly of interchangeable structural and non-structural components for buildings. Studies will also be necessary to evolve economic methods of earthmoving by a judicious combination of manpower and machine intensive methods. Studies are also required into the optimization of building height for domestic housing complexes, having regard to the parameters of cost, employment potential and construction time.

220. Mechanization can and should, where possible be supported by existing traditional methods. It will be to the great benefit of countries concerned if traditional methods of construction were closely studied to discover what lessons of value could be learnt for adoption into a modern technology, and which areas of traditional practice could be retained and improved.

#### Consequences of urban population explosion

221. With the continuously rising urban population, the threat to orderly growth in urban areas has assumed quite serious proportions. Usually, the problems of urbanization are reflected in the problems of housing. As migration of people takes place from rural areas into economically attractive centres, certain localities in these centres soon become the favourite settlement centres because of the ready availability of worker inexpensive accommodation. Such localities eventually become overcrowded and slummy. The implications of this kind of development are that housing problems will become more acute and that considerations of the economic integration of the migrant population will constitute an important factor in planning any programme of meaningful urbanization.

#### Urban settlement planning and development

222. The problems of settlement planning and development must be viewed not only from the standpoint of the urban situation as it exists, but also from that of the rural situation from which most of the problems arise. The solution to these problems therefore must be at two levels, and calls for studies from which objectives and concepts of planning will evolve which will take account of the rural-urban interaction. Research is also required into methods of decentralization of industrial and related urban activities and into the design of rural settlements in such a way as to reduce the intensity of the push for migration presently exerted by the rural areas.

223. The specific task of settlement planning and development, however, is to use the limited land available in providing healthy and comfortable accommodation and in creating facilities for the easy and smooth mobility of the population. In planning urban settlements in Africa, the objective of low cost has in many instances in the past been given too high a priority, so that little or no provision was made for essential service such as access roads, water supply, sewerage and drainage including their maintenance or for amenities. Districts sprang up with no recognizable road systems or municipal services. While planning must aim at achieving savings, such savings must be rational. Investigations must be carried out into such aspects of planning which will yield realistic savings. For example, the optimum population density of a settlement which will meet at a reasonable per capita cost, the provision of essential service and amenities should be determined. These, nevertheless, should be designed with the element of cost in mind. Services such as the provision of domestic water supply should be designed so that advantage could be taken of the cheapest and most convenient sources of supply from which distribution to settlements could be carried out so that the greatest number of inhabitants would benefit. The same kind of consideration should be given to the planning of sewage and waste disposal systems and electricity services for urban communities. It is important that the right kind of service be provided at minimum cost. Other important factors need careful study. Although most of these are sociological rather than technical, their influence upon the technical aspects of settlement planning is quite significant. Such factors include the following:

- (a) Studies to determine the influence certain types of settlements might have on the behaviour of their inhabitants and the quality of their relationships with each other;
- (b) Studies of the accepted patterns of social behaviour of population groups to determine the design of layout of settlements for particular groups;
- (c) Determination of the variety of standard sizes and types of housing units desired in any particular settlement;
- (d) Determination of the minimum number and quality of social amenities essential to the normal functioning of a settlement;
- (e) Determination of the most desirable siting of settlements in relation to industrial centres and other places of work, having regard to transportation and other problems;
- (f) Studies for the design and location of market centres, shopping precincts and office blocks.

### Urban transportation

224. One of the most difficult problems in planning for successful urbanization is the provision of adequate transportation. Urban planning must satisfy two important requirements, namely, the need for a satisfactory system of urban mass transportation and the need for a good network of urban roads.

225. The achievement of adequate mobility for the population in urban areas is a special responsibility of the urban planners. The utilization of mass-transit systems is unavoidable and the special requirements of this form of urban transportation puts it outside the scope of action desired for a broad based transport modernization programme for an entire country. Much higher standards of convenience are required, and rapidity of transit must be provided. The effect of these developments will ultimately be the reduction of the dependence of the population upon the private car for mobility.

226. At present, many urban roads are overcrowded with private cars and long-distance commercial vehicles, and have no waiting or parking facilities. Many of these roads are narrow and sometimes constitute the only access through the cities. In some cases traffic congestions can be so serious as to cause enormous delays in travelling short distances through city centres. With the large volume of workers needed to be moved from their homes to various places of work, urban roads must be re-designed to segregate "through" traffic from local urban traffic. Urban traffic must be made to flow smoothly and safely, without undue interference with the movement of pedestrians. The development of urban road networks must be in the direction of maximum separation of pedestrians and traffic, with provision of shopping areas that are barred from motor traffic of any kind. In addition, studies must be made of the African setting to determine the most economic and appropriate methods of separating pedestrians from vehicular traffic. In this respect, the possibilities of underground rail, elevated roads and monorail systems should be seriously investigated.

227. The planning of urban transportation must be a deliberate policy to be pursued in every case where a town or district seems destined to grow into an urban area or urban complex. It will be wrong always to wait until the problems of urbanization are upon us and the urban areas develop chronic immobility before attempts are made to remedy the situation. Progressive action in urban planning should involve a reasoned process of selection of centres for urbanization through sound economic, social and technical analyses of, and the gradual application of the process of urban planning to the areas. In this way, the faster and more rational development of an entire nation will be achieved.

### Preservation of the urban environment

228. The advent of industrialization has meant the introduction of new types of polluting agents into the urban environment. Factory wastes are discharged into the atmosphere, into rivers and coastal waters with little or no treatment. If this practice continues unchecked, irreparable damage will be done to the urban landscape, to lake and river fishing, to the natural

vegetation in the outskirts of the city and to beach resorts. The effect of these on Africa's budding tourist industry will be shattering. Urban planning must therefore take account of the dangers of uncontrolled disposal of factory wastes and devise ways of reducing the pollution of the urban environment. It will be found an advantage, in this connection, to establish research and standards organizations for the control of industrial pollution.

229. Urban settlements in Africa must be made to blossom out with distinct traditional freshness despite the growth of industrial activity in her territories. Apart from breathing pollution-free atmosphere, urban life itself must be made more pleasant and more relaxed. For example, more and better balanced recreational facilities need to be provided and open spaces and attractive parks should be created in subtle relief against cloisters of brick and block structures and against endless dark rings of tarmac and motorways.

#### Objectives of proposals for development in the sector

230. The following objectives have therefore been proposed for this sector of the African Regional Plan:

- (a) The development of better adapted designs of dwellings. The provision of more and better housing in urban areas to meet the rising demands for homes from a rapidly growing population, requires that methods of designing houses be evolved which will increase the output of homes while at the same time providing features relevant to local conditions. Climatic factors and cultural patterns in the African region should influence house designs. For example, considerations of heat transfer, acoustics, ventilation and illumination should feature predominantly in the design process; so also should aspects of the African way of life relating to the separation of adults and children in the house, play interests and kitchen requirements for local cooking methods;
- (b) The development of low-cost methods of housing construction. The orientation of building technology to serve the needs of the region in the areas of low-cost housing, concrete practice and the protection of metals in tropical areas. Building methods are required which will not adversely affect employment prospects in the building industry;
- (c) The development of methods to increase the use of indigenous building materials, so as to reduce the region's dependence upon imported materials which at present use up valuable foreign exchange and do not always perform satisfactorily under local conditions;

- (d) The improvement in the environmental conditions of urban settlements through the application of the results of sound technical studies. Such studies should be directed towards the improvement and maintenance of the quality of the environment and against deterioration through pollution;
- (e) The improvement and extension of water supply services in urban areas;
- (f) The provision of mass transportation services in urban areas;
- (g) The development of facilities for the removal and disposal of wastes in the cities and towns of the region and the improvement and extension of existing sewage disposal systems.

Programme I - PROVISION OF TECHNOLOGICAL KNOW-HOW FOR PRODUCING LOW-COST HOUSING

231. The activities envisaged under this programme are primarily R. & D. involving the undertaking of research projects in existing research establishments or the creation of new ones.

Project (a) : Development of better adapted designs

It is intended to develop designs of standard types of inexpensive urban housing. Such designs ought to consider and develop the integrated use of standardized building materials and components and the use of suitable basic modules. Designs should be forwardlooking taking account of climatic and cultural requirements and should incorporate as much as possible the use of known and proven indigenous materials.

In addition, the development of appropriate designs will be aided by research into topics which should include the following:

- (i) Investigations into the siting of urban housing;
- (ii) Socio-economic implications of the physical characteristics of rural and urban settlements including the interaction between rural and neighbouring urban settlements;
- (iii) Investigation into the nature of accommodation most compatible with the African environment.

Project (b) : Development of the use of local materials

Research institutes in the region should pursue research in this area of extreme relevance to the development of the building industry. If local materials are to be widely used, research is required, to improve their quality as well as to give guidance to the formulation of codes for the design and construction of buildings for which such materials are specified. The following are considered vital areas in the field of materials science in which research should be undertaken.

(i) Development of safe and durable roofing materials for low-cost housing

Interest should be focussed on such aspects as thermal properties, sound insulation characteristics, water-proof qualities and durability etc.;

(ii) Investigation into the efficient use of local clay, sand and lime for making low-priced structural and non-structural building components

Products to be investigated should include, clay bricks and tiles for which improved methods are required in moulding and firing using simple equipment;

(iii) Investigations into the utilization of local siliceous materials for the manufacture of glass and ceramics

The ready availability of siliceous materials in most places makes it an attractive economic proposition to produce glass and ceramic products locally. It may be necessary in certain cases to improve furnace designs for the mass treatment of certain types of sand in Africa. There is in addition enough demand for glass in the building construction industry to stimulate further interest in local production of this material. Glass is needed for example, in sheet form for doors and windows, as glass blocks for partitioning and facing panels, and recently for telephone and high voltage insulators. The demand for ceramics on the other hand is not great, but nevertheless warrants consideration for development and production locally. The quantity of ceramic tiles used in Africa is growing steadily and with its non-slip properties, may offer serious competition to terrazzo tiles. In addition, ceramics are now used for facing walls, and in protecting the surface of steel sheets used as cladding for outer walls of buildings;

- (iv) Development of lightweight materials from local sources for the making of housing components

Development of materials of this kind will reduce transportation costs as well as erection time at building sites. In this area of research, a wide range of waste materials, e.g., discarded rice and groundnut husks, coconut husks, cocoa pulp and some vegetable fibres containing cellulose should be examined, both from the point of view of availability of adequate quantities and of suitability for use with binders for the production of good quality building components;

- (v) Research into the effects of tropical temperatures and rains on the strength and durability properties of cement-bound materials

Most cement-bound materials used in low-cost housing construction, e.g., sand-cement blocks and stabilized earth blocks, are employed without knowledge of their properties and behaviour under tropical weather conditions. Because of this, many homes made from these materials suffer deterioration as blocks undergo shrinkage during the dry weather, and become poor loadbearers during the wet seasons because of their poor "wet strength" characteristics. It is necessary to have available, enough information about these materials to guide manufacturers in the production of more dependable blocks and designers and builders in the safe use of these products;

- (vi) Research into the effects of solar radiation, heavy rains, fungal and insect attack on timber and timber structures

This research project is intended to encourage the more widespread use of timber in African buildings. Although quite old timber structures exist in Africa today, the present trend of builders and designers alike is to move away from using timber, except in a very limited way for interior decoration. Lack of proper curing of local timber and the present indifference towards treatment of the right kind has made the material unreliable. Planned research in the areas specified will help to solve the problems preventing the popular use of Africa's most commonly occurring and aesthetically appealing building material;

- (vii) Investigations into the suitability of crushed laterite rock as coarse aggregates for the making of high-quality concrete

Laterite rocks are common in most parts of Africa, but because of its low impact value it has not been found suitable for the making of high-quality concrete. On the other hand, the material is far cheaper than the conventional crushed gabbro or quartz gravel aggregate (nearly a third cheaper). There are indications that if suitably treated, the strength of the material will be improved. Various methods ought to be investigated: the economic hardening of lateritic aggregates, including accelerated weathering and treatment with lime;

- (viii) Investigation into fungal attack on plastered and paint-coated walls

Fungal attack on plastered and paint-coated walls leads to unsightly discolouring of buildings. Research is required to reduce the incidence of fungal attack to a minimum and thereby reduce the frequency of maintenance and consequently maintenance costs.

Project (c) : Development of more appropriate methods of construction

This project is intended to bring about transformation of the building industry from one using mostly traditional methods, into one using modern technology. It is expected that investigations will be carried out with the aim of developing methods for fast and economic construction. At the same time some balance ought to be struck between speed of construction and a high employment of labour. Investigations will be needed into mechanization methods and these should be introduced only after studies of pilot construction projects.

Project (d) : Establishment of National Buildings Standards Bureaux

Such bureaux could be established as separate new institutions or as divisions of existing government departments. The duties of bureaux of this kind should include the testing of imported and locally manufactured building materials and components, the certification of quality, the enforcement of building codes, dimensions and methods of construction of buildings, and the sponsoring of research in these fields.

Programme II - URBAN PLANNING AND SETTLEMENT DESIGN

232. Town planning and rural settlement studies are long-term activities which take several years to yield results for application. Action within this field should therefore be given high priority for an early start in implementation plans.

Project (a) : Town planning

This project is designed to cover the investigation and planning of the use of available land for accommodating industries and for siting settlements for the expanding urban populations, and the re-structuring of outmoded central districts. Provision should be made in the planning for modern market schemes and for shopping precincts. Concepts and standards should be developed for the more effective design and layout of public buildings, open spaces, parks and gardens to relieve the feeling of congestion. It is important, however, that planning must take place long before urbanization becomes very rapid, and towns that are to become industrial centres must be carefully studied for their suitability for the industrial activity proposed.

Project (b) : Rural settlement design

As more than 80 per cent of the population of Africa is living in rural areas, the improvement of urban areas must be accompanied by the improvement of the conditions of living in the rural areas themselves. Rural settlements should be designed with the objectives of:

- (i) Introducing industrialization and creating job opportunities in rural areas;
- (ii) Effecting housing development and the supply of essential services in order to encourage the population to remain in rural areas;
- (iii) Providing central markets for buying and selling agricultural products;
- (iv) Creating adequate transportation services between the rural areas and towns;
- (v) Rural electrification.

Rural areas could be made centres of great attraction through the resourcefulness of capable designers. It should be possible to find ways of improving traditional village architecture while maintaining the concept of the "compound" as the central unit of design. Apart from economic and social attractions, man's love for the intrinsic beauty of traditional life can pull him back to the rural areas.

Programme III - PROVISION OF ADEQUATE SEWAGE AND WASTE DISPOSAL SYSTEMS

233. This is a sector of urban services which has been most noticeable for its neglect. A few of the more prosperous cities have invested in modern refuse collection equipment and incinerators, but nowhere is an effective and adequate system to be seen within the region. Design concepts and operational systems need to be worked out first before investment in installations and equipment is made.

Project (a) : Design of improved garbage and refuse disposal systems

This is a project which will serve two purposes, if designed with foresight. It will, on the one hand, relieve the terrible squalor in several neighbourhoods of major cities and towns by the organization of regular and efficient garbage collection. On the other hand, some of the collected garbage can be used as raw materials for fertilizer production which will meet an important need in agriculture.

Project (b) : Design of improved sewerage and drainage systems

A determined effort is required to correct years of bad planning of the drainage systems in most African cities. The immediate improvement envisaged will take account of the channelling of the often neglected domestic sewage, and the redesigning of road drains and sewers to reduce the incidence of flooding of urban roads, especially in areas of heavy rainfall.

Project (c) : Establishing research and standards organizations for the control of industrial pollution

Pollution of the environment in urban areas has been accentuated by rapid industrialization. The immediate problem needing consideration is the indiscriminate disposal of factory wastes. This results in the pollution of the air, water bodies, riversides and sea coasts. It will be necessary under this project to conduct studies aimed at:

- (i) Developing and applying methods of detecting and monitoring pollution in the urban centres;
- (ii) Developing adequate standards for the quality of pollution-receiving media;
- (iii) Advising industry on suitable methods of treatment of wastes from existing and future industries;
- (iv) Advising industry on the modification of those industrial processes which generate wastes of high toxicity.

Programme IV - IMPROVEMENT OF DOMESTIC WATER SUPPLY

234. Many countries within the region have placed considerable emphasis on the provision of pipe-borne water supply to rural areas. Commendable effort is already being put into rural water supply projects. However, it is important to develop the necessary capability to enable the existing domestic water supply systems in both urban and rural areas to keep pace with population growth and economic expansion. Cities are particularly vulnerable to the incidence of creeping water shortages which after some years suddenly assume crisis proportions. Such crises can only be avoided if there is permanent organization to monitor the growth in demand for domestic water supply and to put in hand long-term programmes of studies and design, so that early action can be taken to expand the water supply in step or in advance of increases in demand. In appropriate areas, the domestic water supply systems can be improved to include hot water supply by taking advantage of solar heat.

Project (a) : Organization for the design of water supply systems

Designs of water supply systems should be adapted to existing conditions and needs of areas where the supply is required. Storage and supply systems should always be proportioned to the needs of the users in the interest of economy and maximum coverage of the area with facilities for obtaining drinking water. The need in certain settlements of an urban area may be modest and designs should aim in such cases at providing shared or communal facilities. Data collection and analysis will be required to guide designers in the establishment of design criteria for water supply systems.

Project (b) : Development of solar water heating systems

The supply of hot water for domestic use has been achieved over the years by methods which varied from boiling water in pots heated by firewood to heating in electric boilers. The method used depended on the financial status of the householder. Even today very little change has occurred in this pattern of activity. Despite the existence in Africa of limitless energy from the sun's radiation, little advantage if any has been taken in Africa of this source of energy to heat water for domestic use. Elsewhere, solar energy has been tapped successfully for water heating. What is required in African countries is the implementation of a programme of research and development to adapt existing solar hot water systems to suit local conditions such as variations in length of daylight and intensity of sunshine. Standard designs will be required for particular localities and for different capacities of water heaters.

Programme V - PROVISION OF ADEQUATE URBAN MASS TRANSPORTATION SERVICES

235. The urban traffic paralysis has already arrived in a number of African cities. The development of urban transportation networks should now be undertaken utilizing the modern concepts which have been introduced into this field in recent years. It is important that the development of urban transportation be treated as a special subject of its own, related but separate from the general problem of providing national highways and feeder roads.

Project (a) : Development of specifications and standards for urban road networks

The project is expected to aim at the development of original ideas in design which will lead to the drawing up of suitable specifications and standards. The objectives should be the following:

- (i) Separation of people from urban traffic;
- (ii) Creation of shopping areas barred from vehicular traffic of any kind;
- (iii) Easy bypass of city centres for long distance traffic;
- (iv) Easy entry into and exit from town centres.

Project (b) : Provision of design concepts for an integrated system of urban mass transportation

A system of urban mass transportation which will involve the efficient and integrated use of the railway, public and private buses, and taxis should be designed for each city. A design for such a system should be formulated which takes account of the parameters of low cost, rapid mobility, high standard of cleanliness and comfortable seating accommodation. Emphasis should also be put on the laying down of conditions under which one type of transport service will be preferable to another, having in mind the disposition in the urban areas of the centres of concentration of the working population.

Programme VI - TRAINING OF MANPOWER FOR HOUSING AND FOR URBAN DEVELOPMENT

236. The training of personnel in these fields should meet the need for African professional and sub-professional workers, who are at present in too short supply, to undertake the urgent design, planning and development work that has to be done. Such training should be devised to have relevance to national

needs. The number of personnel required in the professional fields will have to be related to the development plans in this sector. The projects proposed under this programme are as follows:

Project (a) : Training of personnel in tropical architecture

This training should be directed towards the production of architects trained in a way which will enable them to perceive the needs in tropical Africa and who will be sensitive at the same time to the traditions of the people in respect of their social and domestic lives, as well as of their heritage in architecture and building. In addition, supporting personnel, such as draughtsmen, should be produced.

Project (b) : Training of urban planners

The basic training for personnel in this field should be in town planning.

Project (c) : Training of building research engineers and technicians

The following personnel should be trained:

- (i) Engineers specializing in materials science;
- (ii) Physicists and chemists;
- (iii) Structural engineers;
- (iv) Experimental officers to assist personnel in categories (i) to (ii);
- (v) Laboratory technicians to assist personnel in categories (i) to (iv);
- (vi) Machine workshop technicians;
- (vii) Instrument technicians;
- (viii) Electronics technicians.

Project (d) : Training of personnel for water supply and sewage disposal services

Training is required for the production of manpower in the following categories:

- (i) Hydrologists;
- (ii) Hydrogeologists;

- (iii) Hydrometeorologists;
- (iv) Water supply engineers;
- (v) Sewerage engineers;
- (vi) Chemists;
- (vii) Bacteriologists.

In the technical grades, the following workers will be required:

- (i) Treatment works technicians;
- (ii) Pump operators;
- (iii) Treatment plant operators;
- (iv) Plumbers;
- (v) Mechanics.

Project (e) : Training of personnel in construction engineering

In addition to instituting formal courses in this field which should be locally orientated, training is required for specialized personnel with knowledge of mechanized building techniques, as well as for the workers, team leaders, site agents and mechanical plant operators and technicians.

## Chapter VII - HEALTH AND SANITATION

### Introduction

237. The health of the population is one of the primary requirements for economic and social development, particularly in Africa where the level of hygiene in rural areas leaves much to be desired, where numerous debilitating diseases continue to take their toll on the labour force and consequently on productivity.

238. Much has already been said elsewhere on the importance of health in overall development and there is no need to labour this point here. But it is at present essential to make a thorough inventory of all scientific and technological resources available in the health field and to draw up plans for the implementation of health projects which aim at improving the provision and availability of health services adapted to the specific needs and conditions of the African countries.

239. The present situation in African countries with regard to diseases transmissible by water and food is still causing concern. Attention is particularly drawn to the increasing incidence of schistosomiasis, ankylostomiasis and onchocerciasis associated with river valley development, man-made lakes and other water development projects.

240. Special attention should also be given to cerebro-spinal meningitis, the incidence of which is particularly high in the regions bordering the Sahara.

241. The solution to the major health problems in Africa requires an all-out effort in the following fields : improvement of environmental hygiene, particularly in rural areas; supply of safe drinking water; prevention and control of endemic and epidemic diseases; control of vectors such as tsetse flies, mosquitoes, and sand flies through improvement of environmental conditions; extension and improvement of health services in rural areas. It will be essential to develop a health infrastructure adapted to the specific needs and conditions of each country through a network of increasingly complex structure, consisting of health posts, health sub-centres and health centres and hospitals. Special attention should be given to the rural health delivery system which should be easily accessible and adequately staffed in order to improve the health status of the population. The emphasis on the team approach in which auxiliaries take a substantial share of the work under professional supervision should lead to a more economical use of the relatively small professional cadre. Medical assistants and rural medical aids can play a very important role, particularly in rural areas. Where appropriate, further study should be given to the improved use of the communities own traditional health personnel.

242. Advances in mechanization, the increased use of chemicals in agriculture, and in the rapid expansion of industrialization and means of transport in the African countries are already presenting problems with regard to the safety and health of workers, problems which, although by no means neglected, are not always taken into consideration. The overriding importance of the human element in all areas of development calls for adequate measures and resources to solve the problems connected with working environments. Steps must be taken as soon as possible to protect the health of the worker against the serious hazards from contact with toxic chemical compounds, harmful dust, noise, machine tools, harmful radiation, luminous substances, heat and cold, working in confined spaces, etc.

243. Studies and research into possible sources and agents of poisoning, sickness and accidents would unquestionably provide an essential basis for immediate and positive action.

#### Objectives

244. The main objectives to be achieved in the health field are already included in a great many national plans. National efforts and bilateral and international assistance for the implementation of these objectives should be co-ordinated and strengthened.

These objectives may be outlined as follows:

- (a) Improvement of national health planning;
- (b) Education and training including in-service training of health personnel;
- (c) Development of comprehensive health services, with special attention to rural health services, integrating maternal and child health, including family planning, effective nutrition and health education;
- (d) Control of communicable and infectious diseases, including water-borne and vector-borne diseases;
- (e) Environmental health, including the improvement of environmental hygiene, the provision of adequate supplies of safe water and the development of food quality control services;
- (f) Establishment, or strengthening of systems for safety and hygiene in places of employment.

Programme I - PROVISION OF CLEAN WATER FOR HUMAN CONSUMPTION AND CONTROL  
OF DISEASES TRANSMITTED BY WATER AND FOOD

245. Many projects contributing to the full realization of this programme fall within other sectors of the regional plan. (See section on housing and urban development). A co-ordination of all related projects is necessary in order to obtain the best results.

In the field of community water supply two important aspects need to be considered: the organizational, administrative and managerial aspects of community water systems on the one hand, and the potability of water on the other hand.

Project (a) : Technical aspects of water supply

Technology in this field is sufficiently advanced to meet most requirements. This project will be confined to the main objectives of collecting and diffusing the most rational techniques and preparing studies of the technical and financial aspects of water distribution and sewage systems. Co-operation with hydrological research and co-ordination with other projects such as those dealing with the manufacture of distribution material (e.g., plastic pipes) is indispensable. It may be desirable to establish three or four international centres responsible for this kind of work. Projects of this type will benefit from collaboration with hydrological research centres.

Project (b) : Health aspects of supplying drinking water

All countries have a water analysis service for checking water supplies to the towns. Nevertheless, water-borne diseases are still a great concern because the programmes for distributing clean water often do not extend to rural areas. In support of plans being prepared for extending the distribution networks to rural areas, the services for analysis and control of water quality should be strengthened so as to eradicate epidemics of cholera, and amebic and bacillic dysentery.

Project (c) : The establishment or strengthening of services for  
ensuring food hygiene

The role of food in the transmission of communicable diseases is very well established. There is, therefore, a pressing need to monitor and control the standards of hygiene of institutions engaged in the manipulation, preparation and sale of foodstuffs. Guidelines, as well as standards, need to be prepared by the health authorities in order to encourage and implement the practice of hygiene and sanitation in respect of foodstuffs.

Programme II - CONTROL OF TRANSMISSIBLE DISEASES (MALARIA, TRYPANOSOMIASIS, SMALLPOX AND VIRUS DISEASES, TUBERCULOSIS, SCHISTOSOMIASIS, ONCHOCERCIASIS, LEPROSY AND VECTOR CONTROL)

246. Considerable progress has been made in this field, but additional effort is required to overcome and eradicate transmissible diseases which limit social and economic development. National centres operate in all the States but need additional staff and financial resources.

247. Vaccination campaigns and improvements in techniques of prevention should make it possible to eradicate smallpox in the near future.

248. Increased attention and resources are required to strengthen leprosy control centres in endemic regions and to initiate or intensify measures against tuberculosis.

249. Although remarkable progress has been made in the elimination of malaria from North Africa, the disease persists south of the Sahara, and special efforts must be made to protect the large population in the growing cities of the continent. Outbreaks of yellow fever still occur, particularly in the more remote areas. Human trypanosomiasis has been considerably reduced, especially due to the attainment of tsetse-free zones.

250. Schistosomiasis is still spreading, due to the introduction of the schistosome and of the carrier snails into the lakes and irrigation systems created by the new water impoundments in Africa. With onchocerciasis, there is still promise that the insecticides and application techniques now available to treat the rivers and streams where the vector breeds could result in the success of large-scale programmes against the disease.

Project (a) : Vector control

Vector-borne disease is still one of the most important obstacles to the health of the working population of Africa and vector control still offers the most efficient, but contributory, means of combatting the situation. The needs in research and development are surveillance, environmental improvement, chemical control, and biological control including in some cases genetical manipulation. To meet these needs, research programmes could be established and provided with adequate resources.

With yellow fever and other arbovirus diseases, the need is for surveillance of the vector and the development of rapid means of controlling outbreaks by means of appropriate insecticides. With malaria, there is a need to develop the use of substitute insecticides of the organophosphorus and carbamate group, to replace DDT in the savanna area where certain factors tend to make it less effective. For both types of mosquito-borne disease, biological control agents

such as larvivorous fish must be developed as elements in the integrated control of the vectors. For combatting trypanosomiasis, the main needs are the recognition and mapping of focal areas of transmission, and the discovery and evaluation of residual insecticides which control the tsetse fly but do not produce the environmental contamination, however slight, involved with the organochlorine insecticides hitherto employed. Development of genetical control by means of the sterile-male technique is well advanced for one species of tsetse fly and has been commenced for one species of malaria mosquito.

The control of schistosomiasis is a more complicated problem. To eliminate the snail carriers, existing molluscicides must be tested fully in the field and new ones must be developed. But the use of chemical, and possible biological and environmental control must be supported by an intensified ecological study of the snail host, and by measures designed to prevent human populations from contaminating the water-bodies with the schistosome pathogen. For control of onchocerciasis, the watercourses in which the blackfly vector breeds must be mapped, at least for all regions where this insect is known to bite man; for the rest, it remains to work out the logistics of carrying out treatments of the watershed systems with already-known insecticides, applied from the ground or the air, and to establish where such operations are feasible and on a sound economic basis. For the future, methods of biological and genetical control should be investigated.

Project (b) : Diagnosis and treatment of diseases

Programmes should be prepared for the detection of major communicable diseases in populations, so as to define and direct the specific action to be taken in affected areas.

In the case of malaria, control measures have already had considerable success in certain areas. Further progress in the control of the disease will require new, more sophisticated methods of diagnosis in order to detect cases which in their majority can only be diagnosed at present by microscopical examination. When malaria eradication is nearing completion, however, its incidence becomes so low that microscopy entails the examination of thousands of blood samples. This procedure is expensive, time consuming and frustrating. A new method of detection is being developed, the fluorescent antibody technique (FAT). This method, which detects raised antibody titres, offers a supplementary means of malaria diagnosis, which hopefully could be applied to large numbers of people. It is, however, necessary to study the feasibility of using it either to supplement or to replace microscopic diagnosis, especially under field conditions.

With respect to trypanosomiasis, vector control constitutes the major means of control through reduction of the tsetse fly population. However, treatment of the disease will remain important for some considerable time, especially as the incidence of sleeping sickness seems to be on the increase again in some parts of Africa. A considerable number of residual foci remain and it will be necessary to eliminate them and to strengthen epidemiological surveillance. Further research is needed on the epidemiology of the disease, on the biology of its vector and of the parasite, in order to acquire precise knowledge of its effects on the human body during the development of the disease. This will hopefully lead to the development of new and effective drugs, and ultimately to the preparation of a vaccine for the control of trypanosomiasis.

As an effective prophylactic method against trypanosomiasis does not exist yet, the development of diagnostic techniques which can be used in the field, is of particular importance. Several serological methods for the diagnosis of trypanosomiasis are available, but these tests remain to be investigated to ascertain their value as a tool which could be used under field conditions.

Schistosomiasis continues to be a major public health problem in large parts of Africa. Although it has declined in importance in a few places, it is uncontrolled in most endemic areas, and it has increased in importance in some areas due to migration of people or the development of water resource schemes. The creation of new reservoirs and irrigation systems can be expected to cause further increases in its distribution and importance, unless preventive and control measures are taken. There exist well defined and effective methods for the control of schistosomiasis which have been tried in the field under specific circumstances. It should be borne in mind, however, that these methods are not universal in their applicability, and that they require careful adaptation to varying ecological conditions on the basis of detailed epidemiological investigations. Research on new drugs for the treatment of schistosomiasis has also made progress, and their use under medical supervision should be encouraged, together with the application of control methods for the reduction of the vector snail population.

Onchocerciasis constitutes one of the foremost public health problems in parts of Africa. Although the pathogenesis of its most important complication, ocular onchocerciasis, has remained obscure, considerable advances have been made in our knowledge of epidemiological and entomological aspects of the disease. As a result, new ways have emerged for a systematic attack of the problem through vector control methods,

so that large-scale control projects in the original endemic areas of Africa can now be envisaged with reasonable optimism. Chemotherapy has also an important role to play in the fight against onchocerciasis. Interest in further research in this field should be stimulated. For the solution of this problem, as for many others, multinational co-operation is essential.

Project (c) : Programmes for systematic vaccination

This project is designed to assist countries to improve both equipment and personnel for systematic vaccination campaigns against smallpox, tuberculosis, etc.

Project (d) : Programme for the control of cerebro-spinal meningitis

A long-term programme for the control of this disease based on the collection of data and epidemiological surveillance is necessary in regions bordering on the Sahara. There still remains much to be done in the field of bacteriological research, diagnosis, vaccine testing, anti-meningitis immunology and statistical information about disease-carriers (who may sometimes not show symptoms themselves).

Project (e) : Diagnosis and treatment of leprosy

Leprosy is a serious public health problem in many African countries. Because of the social stigma attached to the disease, leprosy patients do not come forward and tend to avoid treatment until the disease has reached an advanced stage.

Successful leprosy control must be primarily directed towards early diagnosis and treatment of cases. It is important to secure efficacy and regularity of treatment for the greatest possible number of patients. The drug treatment of leprosy demands a concerted effort on the part of medical and allied health workers, social workers, agricultural extension workers and others. The length of treatment calls for the continuing health education of the patients and their relatives, so as to enlist their confidence and obtain their co-operation. Health education is also needed for the communities in which the patients live, to remove the stigma attached to leprosy and to obtain the participation of the communities in the care of the patients.

Research is being carried out towards the development of a vaccine for leprosy but so far the results have been inconclusive. More efforts are required in this direction as in principle it should be possible to develop a vaccine for leprosy, particularly as a vaccine has been found for tuberculosis which is another mycobacterial infection.

Programme III - NATIONAL HEALTH PLANNING

251. The responsibilities for health planning are quite heavy; rationalizing the activities of the health services, planning the necessary resources for future activities and making optimum use of existing resources. This activity has therefore been assigned a high priority. The approach lends itself to an appropriate long-term view of health problems.

Project (a) : Collection and analysis of health statistics

In view of the continual changes in morbidity and mortality patterns the growing need for health services in the region and for comprehensive planning, evaluation and the introduction of management principles in everyday health administration, health statistics of increasing variety and complexity are required. Statistic units are therefore essential for all aspects of planning and programming including evaluation of projects in the health services. Assistance is required in the establishment of training centres for training middle-grade and clerical personnel and the strengthening and improvement of existing centres.

Project (b) : Improvement of health planning and plan evaluation

The formulation, implementation and evaluation of national health plans should be reviewed and improved in association with economic and other planners, as they have to be an integral part of the overall development plans. It is important that plans for the health sector are definite, itemized, quantified and comprehensive plans. For this purpose an increasing number of health personnel with knowledge of modern planning and evaluation technique is required.

Programme IV - IMPROVEMENT OF PUBLIC HEALTH

252. Preventive measures must play an important part in the control of disease. The following projects could be considered:

Project (a) : Health education of the public

The active participation of the population in the promotion of its health and in the best use of available health services is essential for the solution of health problems in Africa. For this purpose, the development of the use of mass media and of educational methods and techniques adapted to the local conditions is an important factor. Particularly in preventive health programmes special emphasis should be placed on educational activities to foster public interest and participation.

Project (b) : Improving the health infrastructure

In most African countries the problems of distribution and coverage of health services arise generally from the concentration of medical and health personnel and health facilities in the urban areas with a resulting deprivation of the rural areas. It is therefore essential to develop an efficient health infrastructure in rural communities, providing accessible, permanent, comprehensive and integrated services. The provision of such basic health services which is an articulated system wherein medical and health care of all kinds is given through a progressive series of health service units, namely health posts, health sub-centres, health centres and hospitals, will ultimately ensure adequate coverage and easy accessibility.

These services must be staffed by competent professional and auxiliary personnel, capable of performing effectively a selected group of functions essential to the health of the people living in the rural areas. Properly trained and supervised auxiliary health workers which will be a permanent feature of the expanding health services in rural areas, can bring an acceptable standard of health care to the community.

Research is required to develop innovative approaches of the most economic and efficient methods for the delivery of health services. There is also a need to bring all those who traditionally provide health care within a community into the total health delivery system. At the national level, identification, retraining and deployment of such personnel deserves priority attention.

Project (c) : Improvement of nutritional status, maternal and child care

Although there are no precise figures on the nutritional status of the African population, either on a regional or national basis, it is estimated that at least half of the population is malnourished. Because of the lack of both medical and non-medical nutritionists and the fact that nutrition activities have not yet been developed as an integral part of the basic health services, the African population has not benefitted from the increased knowledge of the causes, treatment and rehabilitation of protein-calorie deficiency in early childhood or from the progress made in the diagnosis and treatment of other nutritional diseases. Departments of nutrition in most African countries need to be established or strengthened and regional institutes need to be set up where research and training can be carried on simultaneously and provide scientific support to government departments.

In addition, a number of institutes are required with objectives and aims similar to those of the Institute of Nutrition of Central America and Panama, namely:

- (i) assistance to countries in carrying out epidemiological studies on nutrition problems;
- (ii) research on food and nutrition problems and in particular weaning food mixtures and on low-cost protein-rich foods made from local products;
- (iii) the training of personnel in food and nutrition at all levels;
- iv) service of reference centres for governments.

Project (d) : Research in drug safety and drug dependence

The danger of drug dependence and misuse of drugs is increasingly apparent in developing countries. The aim of the project is to investigate the problem with a view to assisting governments in organizing research, establishing clinical pharmacology centres, training the necessary personnel and developing methods of control and treatment. A clinical pharmacology institute is needed that will exercise quality control over locally manufactured or imported drugs and carry out research for the promotion of the quality, efficacy and safety of drugs.

Programme V - TRAINING OF HEALTH PERSONNEL

253. The necessity for giving-adequate training to health personnel at all levels is apparent in every country of the Region. The acute shortage of trained health personnel continues to stifle health programmes, and every effort must therefore be made to provide the necessary trained personnel at the appropriate levels for the implementation of health programmes. The curricula of health training institutes would need to be more realistic and related to the health needs of the respective countries in which the schools are located.

The following projects could be considered for ameliorating the situation:

Project (a) : Establishment and improvement of training centres for doctors, specialists, research officers and medical assistants

Most of the African medical schools' curricula have, in the past, been traditional in type and unrelated to the country's health problems which are those of public or community health - communicable diseases, nutritional deficiencies and environmental sanitation. Efforts are now being made and should be given impetus for more effective reorientation to give due priority and emphasis to community health and preventive health measures.

The teaching faculties would require reinforcement mainly through orientation in educational technology in better established training centres with similar health problems. Medical research, both basic and applied should be encouraged and undertaken locally to give opportunities for training in research methods and also to ameliorate the so-called "brain-drain". A number of centres should be supported for the training of specialities in public health.

The training of medical assistants is more efficacious in several countries and the admission requirements are more easily met. This cadre is able to undertake much clinical and other responsibilities, particularly in rural communities. Suitable training programmes should therefore be evolved for this category in view of their wider application.

Project (b) : Training of nurses, midwives, laboratory technicians, sanitary inspectors, and auxiliaries

The training of these health workers is of paramount importance since they are usually responsible for primary health care of the majority of population. Their training needs to be task-oriented so that greater responsibility can be accepted through delegation from the doctors.

Such health personnel should also be multipurpose in order to be truly effective, particularly in isolated rural health posts. The training should be more practical and obsolete theoretical material should be eliminated to make room for training in community health practices.

This category should receive special instruction in the supervision and in-service training of health auxiliaries.

Project (c) : Improvement of the curriculum and teaching methods of the health personnel

In many African schools the curriculum needs to be changed to produce health workers fully acquainted with local diseases, nutritional habits and social conditions. Teachers at the schools for health sciences, for medical or other allied health personnel as well as supervisory staff of the health services should receive proper information on teaching methods. A small number of institutes could be selected for this project and assisted technically and financially in studies and experiments that could be of far-reaching value throughout the region.

Project (d) : Training of teachers in the health sciences

A large proportion of the teaching staff in African schools is still provided through bilateral aid programmes and other forms of international assistance. The need for teaching staff will be increasing with the establishment of new schools. This justifies the expansion of a number of training institutes, with international assistance, to take over the responsibility of training teachers at regional and national level.

Programme VI - HEALTH AND SAFETY OF WORKERS

254. The risks incurred at workplaces often have serious consequences sometimes resulting in the disablement of the worker. Modern techniques must be geared to the prevention or reduction of such hazards to the minimum.

255. Studies and research should be undertaken constantly to determine the common causes of these hazards in order to find appropriate solutions and to verify the proper functioning of safety systems.

Project (a) : Study and research into possible agents and sources of hazards

The aim of this project is to conduct comprehensive research into desirable safety systems. This will require inspection of workplaces, minute observation of the working machinery already installed, and study of the materials used and the atmospheric conditions of these workplaces, to facilitate the design of safety systems. In order to eliminate risks which could have been foreseen, statistics of occupational accidents and diseases in specific sectors should be studied so that appropriate measures may be taken.

Project (b) : Safety education

Workers must be instructed in the dangers inherent in their particular type of work in order to associate them with preventive measures. Teaching programmes using every effective means can produce satisfactory results and must consequently be put into effect. Audio-visual methods are particularly effective in this situation.

Project (c) : Inspection of industrial and similar establishments

A body of inspectors of labour and industrial and similar establishments must be organized to be responsible for ensuring observance of the legal standards in force regarding safety and hygiene in workplaces.

Project (d) : Medical examination of workers

Systematic medical checks of at least certain categories of workers must be made compulsory. This constitutes a preventive measure against possible dangers to the health of workers and permits early diagnosis and treatment of occupational diseases.

Project (e) : Training of industrial hygiene officers, of doctors for medical examination of workers, and of mechanical, electrical and chemical experts as inspectors of industrial and similar establishments

The training of all these categories of officials can be undertaken at the post-graduate level.

## Chapter VIII - SCIENCE AND TECHNOLOGY EDUCATION

### Introduction

256. Although the subject of science and technology education is dealt with exclusively in this chapter, it should be borne in mind that this branch of education is only a part of the general subject of education. The objective of treating science and technology education separately within the regional plan is to highlight the special requirements of this branch of education and to enable special emphasis to be given to its reinforcement.

### Science in primary education

257. The importance of science education at all levels in the educational system is already well recognized in all African countries. However, a great deal still requires to be done in order to achieve the effective development of this branch of education. In primary education, for example, whilst there has been an African Primary Science Programme under the aegis of the Association of African Institutes and Schools of Education since 1967, suitable texts and simple laboratory equipment to enable the objectives of this programme to be widely realized are still wanting.

258. Furthermore, there is a general feeling among leaders in many African countries that the avowed objectives of existing primary science programmes should be much more than simply cultural. Many countries have been investigating ways and means of introducing into general primary education some training in the technology of production, especially in agriculture.

### Science in secondary education

259. More effort has been put into the expansion of science teaching at the secondary level. Even here, however, there are still many issues undecided and many problems still to be resolved. One major area of debate is the question of the objectives to be adopted for science education at secondary level. Hitherto science has been provided in secondary schools, primarily as an option for those students who require science subjects as a foundation for the study of scientific and technological subjects at university or other third level technological institutions. However, the consensus which is gradually being created among educational policy-makers is that, the secondary school being the last opportunity for many students to obtain education in science as a cultural foundation for modern living, a comprehensive general education in science and scientific method should be provided eventually for all students during secondary schooling. Those who will continue with science-based studies at third level institutions will be given additional material of a more specialized nature.

260. In a similar way as for primary education, the realization of many of the accepted ideas for the expansion and improvement of science education at secondary level is held back by the failure to resolve a number of problems attendant on implementation. These include the need to train more science teachers, to provide revised texts and course material more suitable (or relevant) to the circumstances and the background of pupils and the very big question of providing school laboratory equipment at low cost.

261. A parallel trend of thought in secondary education to that existing in primary education is that advantage should be taken of the increased depth in science teaching provided to students at the secondary level to continue their introduction to production technology and to extend it to include the processes of metalworking and the use of metalworking tools. This would ensure that any pupil who has at least completed formal secondary education will have some general knowledge of the technology of production which provides the basis for a modern economy and for the technological culture of modern living.

#### Technical vocational education

262. Although the actual pattern varies from country to country, vocational training is generally provided at post-primary or post-secondary institutions for those students who do not proceed to third level studies in universities, technological colleges or professional training institutions. The teaching of science and technological subjects is central in all technical vocational courses. However, there is still a great deal to be done to improve vocational schools and colleges to ensure that they are functionally effective, that is, that they produce skilled craftsmen who are relevant to the occupational requirements of the economy and expert technicians who can discharge the roles for which technicians are required in industry and other occupations.

263. Two problems can be identified as central to the improvement of vocational technical education in the African countries. One is the need to review the objectives and the orientation of the programmes for vocational training. The wastage caused by inappropriate programmes copied from developed former metropolitan countries leading to the production of locally unemployable craftsmen and technicians is already a major issue in many countries. Secondly, there is a need to improve the standards and the quality of technological instruction in the vocational schools through upgrading the standards required for lecturers and instructors and the improvement of the equipment in teaching laboratories and especially workshops.

#### Science and technology education at third level

264. Science departments and faculties have always constituted one of three major sectors of emphasis in African universities from their earliest days, with few exceptions. The other two major sectors of learning with which these universities concern themselves are the humanities (arts) and social studies (sociology, economics, etc.). In their striving for instant recognition, many of these universities have been created as carbon copies of

existing university institutions in the developed countries and have copied such important aspects as structure, administration, programmes, syllabuses and standards of achievement from their parent organizations. This has had very successful results in the humanities and the sciences although it has led to some misgivings in the orientation and the objectives of social studies. This latter area is already receiving attention for a review in objectives, methodology and values.

265. The entry of African universities into the field of technological teaching and research came much later. However, the same pattern of copying programmes and syllabuses from existing universities in developed European countries has not yielded the best results. In engineering, graduates have been produced who are suitable for entry into the developed industrial economies of Europe but are unprepared for the pioneering tasks of professional engineering in their own countries. In universities which have put emphasis on training in engineering sciences and the development of analytical skills, many of their graduates have sought refuge from the creative tasks of practical engineering problem-solving in university departments where they teach engineering from textbooks and engage in basic or applied scientific research, but not in engineering.

266. Up till now the majority of medical education systems operating in African Medical Schools have been close copies of European or American ones. These systems have been found wanting in the solution of the changing health problems of the areas in which they originated or totally unsuited for the health needs of Africa. The recognition of this has led recently to major re-examination and reviews of the objectives of medical education and the initiation of programmes aimed at producing health workers more immediately able to tackle the prevailing health problems of their environment. In spite of these efforts encouraged and ably assisted by WHO, bilateral agencies and the Association of African Medical Schools, there is still need for considerable original thinking in medical education and training in Africa. Such rethinking cannot be done in a vacuum and the objectives, planning and health delivery systems themselves should be a component. It is only in this way that the tendency to produce specialists, who are useful only over a small range of health problems, and practitioners who can only practise satisfactorily, provided an expensive supporting organization of scientists, laboratories, and special equipment are available, can be avoided.

267. Without sacrificing educational quality, by the selection of more relevant basic science and social science content for the medical curricula, and by more aggressive training programmes in community and managerial medicine, it should be possible to turn out practitioners more in tune with the needs of Africa, and more immediately confident of their own role. This might assist to correct the present "urban practice mentality" of the doctors produced in today's medical schools.

268. The medical clinician produced by African medical school is, therefore, still being trained and oriented to practise in a system of health services largely unavailable outside the urban areas. This has been confirmed by the reluctance of medical graduates from existing medical schools to agree to settle in the rural areas where the majority of the population is to be found but where there is none of the supporting organization for medical services available in the urban areas.

269. It appears that there is, therefore, a need to develop a less elaborate concept and organization of medical services that can be installed in rural areas and to train a new cadre of clinicians who will probably be less specialized than the current cadre of professional clinicians, but who can be produced in large numbers within a shorter time for service in rural medical services. This system will not replace the existing organization but will complement it. Such an addition to the network of medical services will remove the majority of the population from the invidious alternatives of either the best medical attention or none at all.

270. A third field of technological studies which is well-represented in African universities is agriculture. The general impression is that agricultural faculties and schools are fairly well attuned to the needs of their service areas because of the considerable attention given to this field of technology from the earliest days of university development. However, there are still some doubts as to the effectiveness of the contribution of university-trained agricultural experts to the improvement of non-export agriculture. Hence this is an area of technology where university involvement still requires continued review and improvement.

#### Special technological institutes

271. The reluctance and in many cases the dilettantism with which African universities have entered into the field of technology have led many educationists and professional technologists to suggest that perhaps African universities, as at present conceived, may not offer the best milieu for pursuing and fostering technological education and research. There are frequent proposals for the creation of special institutions devoted to the application of science and technology for industrial purposes, and to the development of new technologies for special types of production that may be demanded by the natural resources endowments of individual or groups of African countries. Action is already being taken by many authorities in the region motivated by this line of thinking, and the programmes which they might lead to can be considered suitable for inclusion within the W.P.A.

### Objectives

272. The objectives proposed for this sector of the regional Plan are the following:

- (a) Expansion and improvement of science education at primary level;
- (b) Improvement of science education at secondary level;
- (c) Introduction of technology concepts into education at first and second levels;
- (d) Improvement of technological training in vocational education;
- (e) Review and re-orientation of technological education and training in universities and other third level technological institutions;
- (f) Development of educational matériel for science and technology teaching;
- (g) The provision of scientific and technological manpower in answer to national requirements;
- (h) The promotion of international co-operation in the training of high level scientific and technological manpower.

### Programme I - IMPROVEMENT OF SCIENCE TEACHING IN PRIMARY SCHOOLS

273. The movement for introducing science into primary education is well under way in the African countries. What is now required is not so much exhortation about the importance of science teaching in primary schools, but action on a number of specific issues and problems whose solution would promote the expansion of science teaching in primary schools and the improvement of its quality.

#### Project (a) : Review of objectives and methods

Under this project, policy studies would be undertaken to review the purposes to be aimed at in science education in primary schools. The studies should also include an examination of the approaches which would be most effective for science teaching at this level in different social environments.

#### Project (b) : Development of course material

This project should cover the development of textbooks, visual aids and other course material suitable for science teaching in primary schools.

Project (c) : Development of inexpensive laboratories and equipment

The cost of establishing laboratories and providing scientific equipment will be one of the major obstacles to the rapid expansion of science education at primary levels. It will be necessary to design and develop simple and inexpensive laboratory equipment which can be locally manufactured. Some attention will also be necessary towards the development of low-budget laboratory designs.

Project (d) : Training of science teachers for primary school teaching

This is not as simple a task as might appear at first sight. It is necessary firstly to develop the professional specifications for science teachers at this level in the African countries. Courses will then have to be designed to produce such science teachers and incorporated into the programmes of existing or new teacher training colleges.

Programme II - IMPROVEMENT OF SCIENCE TEACHING IN SECONDARY EDUCATION

274. In addition to strengthening existing science teaching in secondary schools, it is necessary under this programme to consider the issue of extending the scope of science education at secondary level to provide for additional objectives other than those of preparation of students for higher education in science and technology at third level.

Project (a) : Review of objectives and approaches to science teaching at secondary level

Science teaching at secondary level is now being called upon to provide for three categories of students. Those who need a foundation in science subjects for further studies at the university, those who require a foundation of applied science for post-secondary vocational training and those who require a science education for cultural development but do not expect to enter further science-based studies.

Project (b) : Development of course material for the teaching of science at secondary schools

The largest task under this project will be the preparation of new textbooks. However, the development of visual aids and demonstration films should be included.

Project (c) : Development of inexpensive laboratory equipment

The main objective here should be the design of simple laboratory equipment, which can to a large extent be manufactured locally in addition to being inexpensive.

Project (d) : Training of science teachers for secondary schools

In addition to increasing the production of science teachers which should be the central objective here, attention should be given to the improvement of specifications for training and of standards of performance.

Programme III - INTRODUCTION OF TECHNOLOGICAL EDUCATION AT PRIMARY AND SECONDARY LEVELS

275. The need for technological education among the general school population is an objective which is now being expressed by an increasing number of the leadership in African countries. In some countries, this desire is based on the need for improving the standards of work in traditional occupational pursuits such as farming; in other countries it arises out of new social philosophies of participation of the young people in production activities of the nation.

Project (a) : Development of objectives and policies

Although needs are strongly expressed, there is still no clear consensus in many countries as to the objectives and the orientation of technological education in primary and secondary schools. This is a question to which early attention should be given.

Project (b) : Development of course material for technological education

The development of programmes and texts for general technological education at these two levels is expected to constitute a major pioneering task.

Project (c) : Establishment of school workshops for the teaching of technology

Project (d) : Training of teachers for general technological education

Programme IV - IMPROVEMENT OF TECHNOLOGICAL TRAINING IN VOCATIONAL EDUCATION

276. The quality of craftsmen and technicians produced by existing vocational schools and colleges has been a subject of considerable discussion in recent times owing to the failure to meet the skill requirements of expanding industries. Both a re-thinking of the objectives as well as a re-design of existing programmes will be necessary to obtain the improvements required.

Project (a) : Review and re-design of programmes for the training of craftsmen

Project (b) : Review and re-design of programmes for the training of technicians

Programmes should have their derivative base in the requirements of industry in the service area of each technical college.

Project (c) : Development of course material

New texts and other course material are required for the training of craftsmen on the one hand and of technicians on the other.

Project (d) : Training of instructors for craftsmen training schools

A few of these should be designed as centres of excellence for developing new methods of instruction.

Project (e) : Training of lecturers and instructors for technician training colleges

Programme V - TECHNOLOGY IN UNIVERSITY EDUCATION

277. Greater involvement is required from African universities for teaching and research in technological subjects. The difficulties of re-orienting universities originally created for liberal arts studies may be avoided in some cases by creating new universities with essentially technological orientations.

Project (a) : Review and re-design of university courses in engineering

The two central issues to be tackled in this project are the orientation of training towards the production of creative design engineers and the provision of adequate opportunities for meaningful practical experience. Existing engineering courses in African universities place little emphasis on design and concentrate on the teaching of analytical skills in the engineering sciences. This orientation will need to be changed in order to produce engineers better prepared for the solution of engineering problems in real life. It will be necessary to recruit larger numbers of university professors and lecturers from amongst professional engineers in consultancy or industrial practice in order to effect and to support the new orientation.

The problem of providing relevant and adequate practical experience in engineering for students has still not been satisfactorily solved in many countries of the region. The usual method of providing such practical training in developed countries has been through apprenticeship or internee programmes in industry, either during the undergraduate course

or at its completion before professional accreditation. Greater co-operation between universities and industry and much new thinking will be required to deal with this problem within the African context.

Project (b) : Review and re-design of university courses in medicine

The review and possible re-design of university courses in medicine should take place preferably in conjunction with a revision of the concepts and the re-organization of national systems of health services. This will ensure that medical attention is provided for a wider sector of the rural population.

Project (c) : Reinforcement of applied science programmes in existing universities

Courses in earth sciences, applied chemistry and applied physics require special attention.

Project (d) : Establishment of technological universities

Technological universities are required which will be oriented towards teaching and research in industrial technologies and the development of prototype designs of equipment and machinery.

Project (e) : Review of objectives and policies for university-based research

There has been a feeling at government levels that too much of the research undertaken in African universities is entirely unrelated to national realities. Most university research in these universities seems to be motivated by the desire to acquire international recognition as early as possible by university professors and lecturers: consequently many research projects are extensions of research programmes already in progress at universities in developed countries.

There are demands that university research, even when basic, might be oriented towards the unsolved problems of the African environment.

Programme VI -- DEVELOPMENT OF EDUCATIONAL MATERIEL FOR SCIENCE AND TECHNOLOGY

278. Under this programme are included the projects for the development of educational literature and teaching aids which deal with problems not associated necessarily with a particular level of formal education.

Project (a) : Development of scientific texts and literature  
in local vernaculars

There is an increasing demand for scientific literature in the local language for those segments of the population that are only literate in their own languages. It is also felt among educational policy-makers in African countries that the learning of science at primary level would proceed much more effectively, if teaching could be carried out in the mother-tongue of the pupils of this age range.

Project (b) : Development of literature for science popularization  
in adult education programmes

Project (c) : Development of films for science popularization

Programme VII - PLANNING FOR NATIONAL INVESTMENT IN SCIENCE AND TECHNOLOGY  
EDUCATION

279. Because of the high level of investment required in education and particularly in science and technology education, it is necessary to establish priorities and make plans to guide national investment in this sector. Insofar as science and technology education is concerned, there are two general priorities. One is the provision of education for cultural development and the second is the production of technological and scientific manpower.

280. Under the present circumstances of the African countries, greater emphasis has to be placed on the second priority, namely, the production of technological and scientific manpower. The projects under this programme relate primarily to the studies which are required to establish the minimum needs and the budget requirements for the production of technological and scientific manpower.

Project (a) : Determination of technological manpower needs  
for agricultural development

This study will be directed towards determining the high-level manpower needs for the agricultural development envisaged in the national development plan.

Project (b) : Determination of technological manpower needs for  
industrial development

This study should be directed at determining manpower needs for industrial development covering the range from skilled craftsmen, engineering technicians to professional engineers. Whilst the basis of such estimation of needs will be the national development plan, it should be borne in mind that in many countries a significant proportion of the manpower needs will be defined by the plans of private sector organizations in the majority of countries. These must be taken into account in such a study.

Project (c) : Determination of research manpower needs for national development research programmes

Project (d) : Preparation of targets and plans for the training of technicians

The shortage of technicians is now a major bottleneck for countries in the full course of industrialization. Special attention therefore needs to be given to investment in the expansion of technical colleges and programmes for training of technicians.

Project (e) : Preparation of targets and plans for the expansion of engineering training facilities

Project (f) : Continuing technological education

Programme VIII - INTERNATIONAL CO-OPERATION IN SCIENCE AND TECHNOLOGY EDUCATION

281. International co-operation has been a major factor in the growth of science and technology. It remains just as important a factor in science and technology education. One main area of co-operation will be the exchange of ideas as to new ways of looking at old problems, approaches to new problems and the evolution of quality criteria. In addition to this, co-operation is important in the sharing of educational facilities, particularly by better endowed countries with less developed ones, and the exchange of technological and scientific personnel. The projects listed here are only a very abbreviated selection to illustrate the types of action envisaged.

Project (a) : Exchange programmes for students of science and technology

This is relevant primarily to students at third level institutions. Ideally, projects will give more emphasis to regional exchanges between African countries, but should not be limited to these only.

Project (b) : Exchange programmes for university teachers and research workers

Project (c) : International consultations and exchange of ideas and information

In this project, "international" is meant to include "regional". Consultations and exchange of ideas take all forms from individual visits to seminars, conferences and symposia. Sometimes consultations are institutionalized through professional associations and intergovernmental study groups.

## Chapter IX - POPULATION

### Introduction

282. Africa with an estimated population density of eleven persons per square kilometre in 1966 is considered to be the most sparsely populated of all the regions of the world. Even when the population density is calculated for the arable land this comes to 133 per square kilometre against the world average of 231. These crude density figures, however, do not always reveal the very many existing variations between the sub-regions of Africa, nor do they reveal the startling facts about the very densely populated cities where there are obvious signs of overcrowding and other ills brought about by the large populations concentrated in limited areas. In terms of individual States the population problems differ in kind, from over-population and high growth rates to nomadism and a few African countries have already taken serious steps to deal with the population problems applicable to their own situation.

283. One of the interesting observations which came out of the ECA surveys of needs and priorities in the application of science and technology which were carried out throughout Africa in 1969, was that very few countries expressed specific needs in connection with population. However, population problems should be seen in a much wider perspective and should not merely be limited to the food problems and availability of land for settlement. They should include under-population, mal-distribution of the population and the quality of the population. When all these factors are considered, it is difficult to maintain that there are no population problems or potential problems in the region. Hence one of the important tasks facing the United Nations and other organizations interested in population matters will be to bring about in African countries an awareness of the existing and potential population problems, and to assist individual countries to evolve suitable policies and action programmes to deal with them.

284. On the basis of existing information, it is possible to outline the main characteristics of the African population and in so doing reveal many of the population problems, some of which are already matters of considerable concern in a number of African States.

285. In general terms the African population is characterized by a high and constant fertility together with a decline in mortality. This has greatly influenced the rapid rate of growth of the African population estimated to be second only to that of Latin America. There is a high proportion of children under fifteen years of age comprising about 43 per cent of the total population. Similarly the population of the working age groups 15-59 years constitutes about 53 per cent of the total population, leaving approximately 4 per cent as the population in the group of 60 years and over. One of the consequences of such a population composition is a high dependency ratio which places a heavy burden on the working age population and is often a hindrance to the improvement of living standards

286. The heavy burden of children dependency imposes a constant pressure at personal and national levels to provide additional facilities such as education, public health services, housing, etc. These services consume a large amount of the available national investment resources. Thus a considerable proportion of the resources may be used up in the effort to maintain the living standards at the present low level, leaving only a small balance available to promote economic and social development and to absorb the growing labour force into productive employment.

287. Regarding the youthfulness of the African population, the situation is expected to persist for a long while in the future. The number of young people entering the working age group will increase and this will necessitate the creation of more employment opportunities to absorb new entrants. Although land appears to be relatively abundant, capital for investment is very scarce and the present rapid population growth appears, at least in the short run for most African countries, to be faster than the rate of expansion of opportunities for productive employment.

288. The African population is also characterized by rapid urbanization. Although in terms of urbanization Africa is the least urbanized region of the world with about 13 per cent or 37 million of its population living in towns of 20,000 or more inhabitants in 1960, the rate of growth of its urban population estimated at 5 per cent between 1940-1960 is one of the highest in the world, and it is projected that by 1980 one out of every five Africans would be living in towns of 20,000 or more inhabitants. One of the problems regarding urban population is the tendency to be highly concentrated in one town, the principal city, which for most African countries happens to be also the political and administrative capital of the countries.

289. Against this background, it must be borne in mind that African countries lack basic demographic information and do not always have reliable knowledge of the existing demographic situation nor of the components of future population change which are essential for the planning of social and economic development, especially in the area of needs affecting health, education, production targets, employment, etc. Assistance will be needed in this area so as to enable them to collect, process and analyse their demographic data and improve upon their vital registration system.

290. African countries should become increasingly aware of the factors influencing rapid population growth and the various forms of population maldistribution and the possible measures that can be applied to arrest this trend. At the same time they should establish machinery within the government structure to deal with population matters and to assist in the formulation of their population policies based on proper demographic analysis and a study of the relationship between population trends, and social and economic development.

291. The African regional proposals for the World Plan of Action are directed primarily towards the contribution that science and technology can make in the acquisition of more complete information about population within Africa and in the implementation of the population policies evolved and adopted by each individual country within the region.

292. Regional and national facilities for training, research and information in the field of population need to be further developed and strengthened. This must go hand in hand with the task of creating an awareness of the population situation in Africa.

#### Objectives

293. Although the ECA surveys of needs and priorities of the African countries in the field of science and technology indicated that only a few countries recognized specific needs in the area of population, this was felt to be due to the general assumption at country level that the UN system is only interested in population limitation. However, in view of the population problems inherent in the situation prevailing in most of the African countries, the following objectives are proposed for this sector of the regional plan:

- (a) The provision of institutional facilities including manpower for an increased collection and supply of demographic data and for the analysis, interpretation and evaluation of such data;
- (b) The support of methodological studies for the improvement and standardization of biological, social and statistical measurements in the field of population;
- (c) The promotion of studies of human fertility in the different communities within the region and of the psychological, social and environmental factors affecting fertility;
- (d) The provision of assistance to countries within the region in the formulation of population policies and programmes;
- (e) The promotion of family planning programmes including institutional facilities for such programmes;
- (f) The training of personnel for demographic work and for population programmes generally.

The following programmes are proposed towards achieving the listed objectives:

Programme I -- PROVISION OF DEMOGRAPHIC DATA FOR SOCIAL AND ECONOMIC PLANNING

294. The basic need in practically every country within the region is for adequate and reliable demographic data. Some countries already possess some organization in this respect but this has to be reinforced. In the majority of countries, however, adequate structures are still to be created for this purpose.

Project (a) : Establishment or improvement of national machinery for the collection and analysis of demographic data

There are still many African countries which, up till now, have not been able to carry out a population census owing to lack of organization, trained personnel and the supporting technical services. Probably the highest priority projects in the population sector will be those directed towards creating or strengthening national capacity for carrying out full and reliable national censuses.

In addition to the creation of organization, projects under this heading should also provide for training of census workers and officials as well as providing the technical services for data processing and the preparation of population maps.

Project (b) : Establishment or improvement of national machinery for the collection of vital statistics

This will involve the establishment or expansion of organization for the registration of births, deaths and other vital events in both the urban and rural areas.

Project (c) : Development or strengthening of national manpower and institutions for demographic analysis

This will include projects providing for the training of specialists in demographic analysis (demographers, statisticians, sociologists, etc.), projects for development and verification of survey methods including research into the correlation of demographic coefficients, ratios and other measures employed in population analysis with socially significant phenomena.

Programme II - RESEARCH INTO POPULATION INTER-RELATIONSHIPS WITH ECONOMIC AND SOCIAL CHANGE

295. Next in importance to the collection of reliable demographic data is the understanding of the nature and the significance of population phenomena which play a role in economic and social change. This programme is intended to provide for research projects which will promote the acquisition of such understanding.

Project (a) : Studies of the role and influence of population as a parameter in development

Under this project, research studies will be undertaken to understand the inter-relationships between population composition, population dynamics and development strategy.

Project (b) : Comparative studies of fertility

Comparative studies of fertility levels and trends in African communities, both rural and urban should be undertaken. The studies should also be directed at correlating fertility characteristics with socio-economic factors.

Project (c) : Studies of the population phenomena associated with urbanization

Urbanization is proceeding at an accelerating pace in most African countries. This process is usually accompanied by considerable population movements which create many social problems for national and city authorities. The studies envisaged would provide some basic information to guide policy-making and planning in relation to this subject.

Project (d) : Studies to determine the effects of rural development on population distribution

Programme III - DEVELOPMENT OF POPULATION POLICIES AND PROGRAMMES

296. What happens to the population is a major factor in development since essentially development is about people and for people. It is necessary that objectives be formulated in this domain, even if only as a background to social and economic policies.

Project (a) : Development of national population policies

Few African countries have defined policies in relation to population. The population factor is, in effect, simply ignored in deciding on development strategy. Since population changes may impede or even negate development objectives, it is necessary for each member country to take account of the

influence of population on their development strategy by formulating appropriate objectives in relation to population which are at least consistent with their development plans.

Project (b) : Development of programmes of action on population

It is conceivable that, in the majority of countries in the region, the population policies found necessary to support development objectives cannot be realized by leaving things as they are, or simply by having more complete information on population changes. It will be necessary to formulate and put into operation some minimum programmes on population so as to promote changes in the directions desired.

Project (c) : Research into methods and procedures for motivating population changes

Considerable study and testing will be necessary to evolve effective methods and procedures for changing the attitudes of people in different communities and for motivating behaviour in the directions necessary to produce desired changes.

Programme IV - PROMOTION OF EDUCATION ON POPULATION AND ON FAMILY PLANNING

297. Educational curricula are already overloaded with requests for the inclusion of additional subject matter. Nonetheless, it is socially beneficial to educate young people and others on basic population phenomena and concepts. If not in school, then through suitable out-of-school programmes, but some elementary education on population and family planning should be made available to all members of each community.

Project (a) : Education of young people

Plans should be put in hand to introduce education on population concepts and issues into school curricula at second and third levels.

Project (b) : Education of leaders and administrators

Under this project, conferences and seminars should be planned for community leaders and government administrators on population concepts and issues and on the need for national population policies.

Project (c) : Popularization through mass media

Educational (popularization) programmes can be organized through the use of mass media for the public, on issues relating to population phenomena, social and economic development, and the quality of life (e.g., significance and use of census data, importance of vital statistics, rapid population growth, family planning, etc.).

## Chapter X - TRANSFER OF TECHNOLOGY

### Introduction

298. The title of this Chapter is the customary one employed within the U.N. system to denote what is essentially only a part of the general question of the acquisition of technology by the developing countries. Under this very general title, the transfer of technology for manufacturing and general production purposes within the sectors of industry and construction is to be understood.

299. The technology for production operations in industry and construction is largely held as proprietary technology by a limited range of suppliers, and is normally made available to potential users as an article of commerce. The use of the general title "transfer of technology" for this restricted area of concern has led to the confusion of the special needs for action on this subject with the more general question of the acquisition of technology and its application to development, a subject which encompasses practically the whole field of technological development and includes such very large domains as the education and training of manpower.

300. The intention under this Chapter is to consider the specialized problem of the commercial acquisition of technology for industrial production and the emphasis within the programmes for action will be on this aspect of the general question.

301. The general issues which have to be taken into consideration in dealing with this topic in any less developed country are the following:

- (a) Transfer of any type of technology is only possible provided a certain foundation of technological infrastructure exists already, namely:

- A stock of trained technological manpower in the form of professional engineers (technologists), technicians and skilled craftsmen;
- An infrastructure of organizations or institutions for technological design, research and development.

The larger the stock of trained technological manpower, and the wider the network of organizations for design, research and development, the easier it will be to acquire commercial technology, and what is more important, the better the chances of making such technology take root in a country;

- (b) Transfer of commercial technology in the African countries is made more difficult by the fact that in most countries the demand for commercial technology is not fully determined and assessed in advance. This makes it impossible to carry out the necessary planning as to the sources for such technology, the infrastructure to receive it, and the terms under which it might be obtained;
- (c) On a worldwide basis, the suppliers' market for commercial technology is itself more or less imperfect. At the moment, there are few if any sources of information available which could furnish information on the range of technology available for a certain category of production, or the existing sources of supply and the range of terms available to purchasers. The purchaser cannot take advantage of any competition that there might be among suppliers unless he has a good knowledge of the range available;
- (d) Finally, one must point out the fact that unlike other fields of commerce, the suppliers of commercial technology often have non-financial objectives affecting their willingness to transfer. Such non-financial objectives may be to withhold improved technology from countries to which they are ideologically opposed, or to maintain defence strategic advantages. In such situations, ideological and political factors may play the crucial roles.

302. An action programme for the transfer of technology must also take cognizance of the predominant patterns of transfer of technology in the African countries. These are:

- Direct investment in fully-owned or partially-owned enterprises by foreign companies;
- The purchase of turnkey plants by indigenous companies and African Governments;
- The purchase of the services of consultants for design, supervision of construction, and management.

303. It is also important to bear in mind the impact of technology transfers on one of the key factors of the economic policies of practically all African Governments, namely to provide opportunities for employment in industry. In this respect special consideration will have to be given to the adaptation of technologies to be imported, since the greater part of the stock of technology available from suppliers in the developed countries has been developed against a background of high labour costs and relatively cheap capital.

304. The programmes for the promotion of the transfer of commercial technology within the region should answer to the existing major problems in this domain in addition to anticipating some of the issues which will become more important as industrialization progresses in the African countries, such as the terms of the acquisition of licenses and patents and restrictions on markets. The programmes that will be of greater value will be those directed at making transfers easier and less expensive, and which will at the same time promote the fixation of transferred technology in local institutions and trained manpower so as to reduce dependence on external suppliers on future occasions.

#### Objectives

305. The following objectives are proposed for this sector of the Plan:

- (a) The provision of more complete knowledge of the national needs for commercial technology so as to furnish a basis for policies and planning;
- (b) The provision of improved access to supplies of technology on a more competitive basis and hence on improved terms;
- (c) The development of appropriate government policies and measures to stimulate and support technology transfers and to promote its fixation in suitable receptor organizations in the importing country. Receptor institutions for imported technology should be designed so that they will be capable of following-up progress in any imported technologies or of making indigenous improvements locally.
- (d) The provision of government support for the creation of national capability in new technologies essential for industrial expansion through the provision of special funds to support indigenous consulting organizations or research bodies.

#### Programme I - ASSESSMENT OF THE NEEDS FOR OPERATIVE TECHNOLOGY

306. Without doubt, the point of departure for a programme of commercial technology transfer is a determination of the needs of the country for operative technology in the light of known development objectives. Knowledge of this type will enable immediate, medium and long term objectives to be set for the acquisition of technology, and the necessary plans and appropriate strategies for each type of technology transfer to be devised.

Project (a) : Studies of the technological needs of existing national industrial activities

At any given time in each country some local manufacturing is going on whether in the form of traditional handicrafts or small-scale industries. Examples may also be found of medium-scale enterprises engaged in production. Most of these will be engaged in the processing of local agricultural materials, particularly food processing and textiles, in the conversion of other local materials to semi-finished or finished form, and in the maintenance and repair of equipment, particularly equipment for transportation.

A survey of the existing national industrial activities, particularly in the small- and medium-scale industries, can provide a good picture of the needs for technological improvements in product design, processes, quality and standards.

Project (b) : Studies of the medium-term needs for additional (or new) technology

The medium-term requirements for additional technology can be obtained in the first instance from an analysis of the 5 or 6-year national development plans together with the programmes for industrial expansion in the private sector.

Project (c) : Studies of the long-term needs for operative technology

This should be based on the perspective plans (10-20 years) for social development, trade development, industrialization and urbanization. In particular, the studies here should review the needs of technology for the exploitation of natural resources.

Programme II - ORGANIZATION OF ACCESS TO EXISTING OPERATIVE TECHNOLOGY

307. This programme is directed at the organization of the greater component of the supply side of the technology transfer equation. Existing technology will constitute the greatest source of the technology requirements of the African countries during the Second Development Decade.

Project (a) : Surveys of sources of supply of technology

Systematic knowledge of the sources of supply of technology for different types of products or services has hitherto been unavailable in the countries within the region. Many industrial enterprises set up in these countries have been based either on technologies promoted by equipment vendors, in effect without any opportunity to select; alternatively the selection has been based on the very limited range of knowledge of the local investor.

This project should provide information on the alternative technologies available for each type of production and the sources of supply. It will, of course, be necessary in the case of any particular country to decide on the kinds of production activities for which new technology is to be imported. The survey can then be focussed on the sources of supply of the relevant technologies.

Project (b) : Studies of the costs and conditions of supply of technology

There are two aspects of such studies to be borne in mind. The historical aspect will involve case studies of existing industries operating in the country and will enable any lessons to be learnt from existing experience to be extracted from the record. The second aspect of these studies will be directed towards obtaining normative guidelines for policies and action in the future. Studies in this latter category could most usefully be on an industry basis and should include information on the range of costs and conditions of transfer from different sources and perhaps on the experience of other less developed countries.

While it is expected that individual countries would undertake some studies on their own under this project, this is an area where considerable assistance could be provided by the appropriate United Nations organizations.

Project (c) : Manpower development schemes

This project is intended to provide for manpower development through "internee" programmes in selected industries in other countries for technologists from African countries.

Programme III - DEVELOPMENT OF POLICY INSTRUMENTS TO PROMOTE TECHNOLOGY TRANSFER

308. In order to promote effective and reasonably rapid technology transfer in each country, there must be a firm government commitment to support and facilitate the process. Some of this support will be required in the form of appropriate policies expressed in legislation, through budgetary subventions and in other forms of action. The decisions of Government in all phases of the industrialization process with which it is concerned should provide support for this objective.

Project (a) : Training attachment schemes for all major industrial or infrastructural projects

At one time or another, all Governments engage in major infrastructural projects such as construction of transportation networks, hydro-electric schemes and so forth. In a

few cases development plans provide for entire new industries to be created with public financing. The technology transfer opportunities offered by the design and implementation of such schemes have often been completely lost in most cases, primarily because of a lack of policy for taking advantage of the training possibilities offered by these projects. Government policy expressed in suitable legislation to ensure the provision of training attachment schemes for all important projects of this type would be a very effective instrument for promoting technology transfer. It may be necessary in some cases for funds to be provided to support the implementation of such attachment schemes from a special budget separate from the particular project budget.

Project (b) : Promotion of local consulting expertise and consultancy services

Practically every project in the economic development plans of each country whether in the public or private sector requires the utilization of expertise to plan, design, construct and commission it. In the case of industrial plants, outside expertise may also be required to operate the plant for some considerable period, and for maintenance.

The proportion of the investment budget allocated for the purchase of expertise is often of the order of 25%. Customarily, this expertise is provided by engineers and other kinds of technologists working as consultants for the investor-client.

The promotion of local consulting services should therefore be a major programme of both Government and the private sector in their planning for technology transfer. An important portion of technology transfer involves the development of local capacity to apply available technology to solving problems and designing new facilities. In the main, this capacity is developed "on-the-job". Hence countries desirous of increasing their indigenous technological capabilities should as a matter of official policy utilize what indigenous consulting expertise is available as much as possible.

In addition to this, Governments should adopt policies to promote the development and extension of existing indigenous consulting capacity. The effective methods of doing this are to provide for the association of a local group of consulting engineers to any foreign firm of consultants brought into work on any public project.

The local consulting group would be paid a fraction of the total fees but should be fully involved in all phases of the project, from the preliminary investigations to the commissioning.

A second scheme is often employed, even by Governments of developed countries. If it is desirable in the plans of the country for capability to be developed in any special area of consulting, particularly design capability, the Government would provide funds to a selected number of indigenous firms to put in hand a suitable scheme of training and special studies so as to extend their expertise into the new areas desired.

Project (c) : Promotion of R. & D. capability in large local industrial concerns

Most of the larger local industrial concerns involved in manufacturing are subsidiaries of multinational companies. This usually implies that all product research, development and design is carried out abroad by the parent companies. Hence the technical expertise on which the operations of the company are based are not transferred to the host country.

Policy measures should be devised under this project to encourage such companies to develop a defined minimum R. & D. capacity in the organization of their local subsidiaries.

Programme IV - ADAPTATION OF IMPORTED TECHNOLOGY

309. This programme is placed here in the regional plan because it is particularly relevant to the subject of transfer of technology. However, it can also be provided for under the programmes for industrial design, research and development.

310. The basic idea behind the programme is that there might be considerable benefits in providing institutional facilities for the adaptation of imported technology to local manpower and material resources. Such institutional provisions would have to be closely related to defined government policy on the subject of desirable factor proportions in industrial manufacturing.

311. In particular, institutional facilities will be necessary to deal with the adaptation of imported technology in any or all of the following respects:

- (a) To suit employment characteristics of the importing country, particularly with respect to the level and range of available skilled manpower;
- (b) To utilize local materials or locally manufactured components;
- (c) To adapt product design more closely to cultural preferences and consumer tastes in the local market.

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