No. 35

Science and technology in African development

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PREFACE

The Conference of Ministers of African States responsible for the Application of Science and Technology to Development (CASTAFRICA) was organized by Unesco with the co-operation of the Economic Commission for Africa and the Organization of African Unity, and took place at Dakar, Senegal, from 21 to 30 January 1974. The first part of this publication consists of the Final Report of the Conference, giving highlights of the debates and the texts of the Dakar General Declaration and the recommendations adopted, together with organizational details. As part of the follow-up to CASTAFRICA it was recommended that Unesco should take appropriate steps to publish the Conference's main working document, and accordingly it has been included here as the second part of this publication. In preparation for the Conference Unesco undertook a survey to identify possible areas for African inter-country co-operation in science and technology. The results of this survey were presented in full at the Conference and an abbreviated version summarizing the salient points is given here as an Appendix.

The experience of most African countries in science and technology planning and policy-making is fairly recent. But with the rapid growth of research and support facilities, and the brisk rise in qualified personnel, the problems of making best use of these resources assume increasing importance and complexity. It is hoped that the exchange of experience recorded in this document will prove helpful in resolving these problems.

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PART ONE

THE MINISTERIAL CONFERENCE

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I. ORGANIZATION OF THE CONFERENCE

1. Background

The Conference of Ministers of African Member States Responsible for the Application of Science and Technology to Development was held at Dakar (Senegal) from 21 to 30 January 1974. Organized by Unesco with the co-operation of the United Nations Economic Commission for Africa and the Organization of African Unity, the Conference was convened by the Director-General of Unesco in pursuance of resolution 2.121 (a) adopted by the General Conference at its seventeenth session. The composition of the Conference, which falls into Category II of meetings organized by Unesco, was determined by the Executive Board at its 89th and 91st sessions, in accordance with the provisions of Article 21.1 of the Regulations for the general classification of the various categories of meetings convened by Unesco.

2. Attendance

The following countries were invited to send delegates: Algeria, Burundi, Cameroon, Central African Republic, Chad, Congo, Dahomey, Egypt, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritius, Mauritania, Morocco, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Tunisia, Uganda, Upper Volta, Zaire and Zambia.

The agencies of the United Nations system and a number of intergovernmental and non-governmental organizations and foundations were invited to send representatives or observers. As is indicated in the list of participants annexed to this report, several non-African Member States sent observers, as did a non-Member State that had been invited to the Conference.

The Conference was attended by 132 delegates representing 32 African Member States, 16 observers from non-African Member States, 3 observers from a non-Member State, 39 representatives or observers from 11 United Nations agencies and observers from 18 intergovernmental organizations, 7 international non-governmental organizations, and 1 foundation. The delegations included 15 persons of ministerial rank.

3. Purpose of the Conference

As with the similar conferences previously convened by Unesco in other regions, the purpose of the Conference was to enable the participating Member States to:

exchange information on their national science and technology policies;

improve the application of these policies and the execution of research activities;

promote scientific and technological research which is an essential element in the cultural, social and economic development of nations;

stimulate technological innovations with a view to increasing productivity;

examine the rôle of science and technology in government activity as a whole; and

foster international co-operation to meet these goals.

As far as the CASTAFRICA Conference was concerned, the above themes formed the subject of the discussions under, successively, items 7, 8 and 9 of the Conference's Agenda, the text of which appears as an annex to this report, together with a list of the Conference documents.

4. Preparation of the Conference

In preparation for the Conference, a meeting of experts was held in Nairobi from 26 to 30 October 1971 in order to advise the Director-General concerning three main points:

(a) definition of the questions that should be given priority attention;

(b) suggestions concerning the form and content of the main working document which the Unesco Secretariat was to prepare; and

(c) suggestions concerning the Conference time-table and the organization of its work.

In addition, six sub-regional consultations were held between the CASTAFRICA national liaison officers officially designated by the Governments and the Unesco Secretariat: Cairo (2-5 October 1972), Nairobi (4-6 December 1972), Abidjan (22-25 January 1973), Lagos (30 January-1 February 1973), Yaoundé (6-8 February 1973) and Algiers (15-17 March 1973).

The preparation of several working documents has, consequently, been spread over a number of years.

5. Opening of the Conference

The Conference opened on 21 January at the Palace of the National Assembly of the Republic of Senegal, where its meetings were due to take place. H. E. Mr. Léopold Sédar Senghor, President of the Republic, honoured this opening session with his presence. He delivered an address in which he stressed "the need for a strictly formulated science and technology policy", a need that, however, "did not become apparent in the majority of our countries - any more than it did in several industrialized countries - until after the last world war. In fact", he went on, "the acceleration of scientific progress is a relatively recent phenomenon in the world and has been reflected in the daily lives of the inhabitants of the developed countries in spectacular improvements in the level and the quality of life". As an example of the kind of urgent problems that had to be faced by countries whose characteristic feature was, for the most part, a predominantly agricultural economy, the President referred to the "fiendish drought cycle (that) has swept the countries in and even well beyond the Sudan-Sahel zone, bringing our economies face to face with well-nigh insurmountable difficulties ... In the face of calamities of such vast proportions, often aggravated by a prodigious population explosion, it is not surprising that our scientific and technological possibilities must be basically slanted towards the seeking of practical solutions."

Mr. René Maheu, Director-General of Unesco, stressed in his address that although the amount spent by Africa on research and development activities represented only a small percentage of total world expenditure in that field and while there were some people who persistently maintained that scientific research was an expensive luxury which African countries would be well advised to abandon, the essential fact was that the movement was under way, that it was growing and that science and technology were establishing themselves in the intellectual life of the African countries and in their practical achievements. "The foundation now exists", the Director-General stated, "and everything must be done to reap the maximum advantage from this effort and what it has already achieved in order to enhance its effectiveness and extend its benefits to all by increased scientific and technological co-operation at regional and international levels". The Director-General pointed out that "the data before the Conference provided it with the means of tracing the main outlines of a programme of scientific co-operation such as would mobilize international assistance to Africa. To implement such a programme Unesco was", continued the Director-General, "ready to carry out in full the central rôle that it can justifiably be expected to assume having regard to the vital place that science, education and culture occupy in development. It is for you", he concluded, "to take advantage of the possibilities that Unesco offers you, by defining the objectives to whose achievement you wish to see its action preferably directed".

The opening session continued with statements by Mr. G. Kamanda Wa Kamanda, Deputy Secretary-General of the Organization of African Unity, and Mr. David Wasawo, Chief, Natural Resources Division, United Nations Economic Commission for Africa, who read an address by the Executive Secretary, Mr. Robert Gardiner. A message from the UNDP Administrator to the Director-General of Unesco on the occasion of the opening of the CASTAFRICA Conference was then read.

The various speeches and the message from the UNDP Administrator are reproduced in the annexes to this Report.

6. Organization of the Conference - election of the Steering Committee

Following the unanimous adoption of its Agenda and Rules of Procedure, the Conference elected, by acclamation, the following officers to form the Steering Committee.

President:

H. E. Mr. Djibril Sene
Delegate-General for Scientific and Technical Research (Senegal)

Vice-Presidents:

H. E. Dr. Sayed Gaballah
Minister of Planning (Arab Republic of Egypt)

H. E. Mr. Jean Guede Lorougnon
Minister of Scientific Research (Ivory Coast)

H. E. Mr. Jean-Marie Shingiro Mbonyumutwa
Minister of Planning and Natural Resources (Rwanda)

H. E. Dr. Wilbert K. Chagula, M. P.
Minister for Economic Affairs and Development Planning (United Republic of Tanzania)

Rapporteur-General:

Mr. K. M. Sape
Secretary, Council for Scientific and Industrial Research (Ghana)

H. E. Mr. Taita Towett, Minister of Education, Kenya, attended the meetings of the Steering Committee in his capacity as Chairman of the African Group of the seventeenth session of the General Conference of Unesco.

7. Appointment of a Drafting Party

On the proposal of the Steering Committee, the Conference, at its 7th plenary session, established a Drafting Party composed of the Rapporteur-General as Convener, and the following nine delegates, appointed in their personal capacity:

Mr. Michel Bekale-Emane (Gabon)
Dr. Dawit Deguefu (Ethiopia)
Dr. Abdalla Yacoub El Sammani (Sudan)
Mr. J. E. Jonah (Sierra Leone)

Dr. D. S. Nkunika (Zambia)
Mr. Jean Nya Ngatchou (Cameroon)
Mr. Ramdane Ouahes (Algeria)
Mr. Samuel François Rajaona (Madagascar)
Mr. Mamadou Sarr (Mali)

The Conference moreover appointed, in their personal capacity, Mr. Yacoubou Barra (Dahomey) and Dr. Mostafa Mahmoud Hafez (Arab Republic of Egypt) to assist the Rapporteur-General during the Drafting Party's work relating, respectively, to points 8 and 9 of the Agenda.

8. Conference documents

The two main working documents of the Conference were:

1. "Science and Technology in African Development" (SC/CASTAFRICA/3);
2. "African Regional Plan for the Application of Science and Technology to Development" (SC/CASTAFRICA/4).

The main reference document was "National Science Policies in Africa", No. 31 in the "Science Policy Studies and Documents" series published by Unesco.

The complete list of Conference documents forms Annex VI to this Report.

9. Closing of the Conference

At its final plenary session, on the morning of Wednesday, 30 January, the Conference adopted its report in its two working languages (English and French).

Thirteen speakers addressed the Conference's closing session, on the afternoon of 30 January.

The representative of the Organization of African Unity thanked the host country and the organizers of the Conference and stressed that CASTAFRICA was the result of many years of close co-operation between OAU, Unesco, the Economic Commission for Africa, the United Nations Advisory Committee on the Applicatior of Science and Technology to Development and its Regional Group for Africa. He emphasized the need to make full use of existing institutions to ensure the application of science and technology while taking care to see that man did not become technology's slave. CASTAFRICA, he went on, was a milestone on Africa's road to development and unity.

The representative of the Economic Commission for Africa highlighted the part played by the Conference in making African science and technology policy-makers aware of those matters to which it was essential that they should pay urgent attention, concentrating their efforts and co-operation so that research workers could be trained, research conducted and technologies developed and adapted. The abundant harvest of information provided by Unesco and the delegations attending the Conference ought to enable Africa's scientists and technologists to work more effectively to house, feed, clothe and care for African people in general and more especially rural workers at present living in poverty. He concluded by saying that a political will on the part of African States was needed if the continent were to get off the ground scientifically and technologically speaking.

Zambia on behalf of the Member States of East Africa, Nigeria on behalf of those from West Africa, the Arab Republic of Egypt on behalf of those from North Africa, and Gabon on behalf of those from Central Africa, unanimously expressed their appreciation of the Conference's work. They stressed the high level of the discussions and made particular mention of the excellent way in which the Conference had been prepared, both by governments and by UNACAST's Regional Group for Africa, the Organization of African Unity and the Economic Commission for Africa. They emphasized the tangible results generated by the Conference from the very first stages of its preparation which had led to an awareness in African Member States of the important topics discussed by CASTAFRICA. They strongly urged African Governments and the international and regional organizations concerned not to let the hopes and decisions of the Conference remain without effect.

The head of the delegation of Kenya moved a vote of thanks to the Government of Senegal and Unesco. The motion was supported by the heads of the delegations of Tunisia, Upper Volta, Sudan and Cameroon and was adopted by acclamation. In this vote of thanks, the Conference particularly welcomed the spirit of mutual understanding and co-operation which had informed its work and thanked the Director-General for the efficiency of the Secretariat's services. It also thanked the Organization of African Unity, UNACAST and its Regional Group for Africa and the Economic Commission for Africa for their co-operation and congratulated the President of the Conference on the efficiency, courtesy and good humour with which, with the assistance of the members of the Steering Committee, he had directed the Conference's work. The vote of thanks also expressed the Conference's great gratitude to the President of the Republic of Senegal for having honoured the Conference with his presence. It also expressed the Conference's thanks to the people of Senegal for having allowed Unesco to convene this Conference in their capital and thanked the Senegalese staff provided for the Conference for their devotion and skill which had made for the smooth running of its work.

Addressing the session, the Director-General first of all thanked the Senegalese authorities, and through them the people of Senegal, for the friendly and pleasant atmosphere in which the Conference had taken place and praised the skill, impartiality and courtesy shown by the President of the Conference. He said that the policy laid down by the General Conference of Unesco concerning Conferences of Ministers Responsible for Science and Technology would doubtless be pursued if one was to judge by the success of CASTAFRICA. The Organization's international activities, basically deontic and standard-setting in character, were complemented by its practical activities at national level carried out at the express request of Member States. Although it was at national level that development projects took concrete shape, the

Director-General stressed the importance of regional activities as affording an insight into the political and cultural currents of the African continent and also as constituting a vital intermediate stage between world-wide conceptions and national realities. The problem of co-operation between international, regional and sub-regional organizations, which had been mentioned on many occasions during the Conference, was certainly not a problem to which an easy solution could be found. Those organizations worked at different geographical levels and each had political, economic and other objectives which certainly converged but whose harmony was not pre-ordained. This harmony had to be built up daily through an appeal to the goodwill of all parties concerned.

After reviewing the Conference's achievements, the Director-General asked how the words of the Conference were going to be expressed in deeds. He pointed out that follow-up action to CASTAFRICA depended on decisions which were the responsibility of three kinds of authorities. First of all were the African Governments themselves who had to show the political will for the recommendations of the Conference to find practical expression. They then had to instruct and empower the international and regional bodies accordingly, so that the desired activities might be actually launched or continued. Recommendations to Unesco would be submitted, as appropriate, to the Organization's Executive Board or to the General Conference, to which the Director-General would submit a report on CASTAFRICA at its eighteenth session. To facilitate co-ordinated implementation of the Conference's recommendations, the Director-General said he was ready to invite the representatives of OAU and ECA to study how practical co-operation with Unesco could be intensified.

In the course of his closing address, the Minister of Education of the Republic of Senegal, H. E. Mr. Doudou N'Gom, said that "Resolutions do not always bring about change. For the necessary change to come about, we must all be moved by a common will to succeed and we must firmly resolve to consult together on a continuing basis with a view to achieving fruitful co-operation". The Minister mentioned several of the Conference's major conclusions concerning the integration of scientific development in the immense drive for economic and social development currently under way in Africa.

Referring to the close links between the general expansion of education and the continent's scientific future, he continued: "You have forcibly stressed the almost general lack of high-level scientific and technical personnel in Africa and the vital part which African universities must play in improving the situation. Bearing in mind the serious proportions of the brain drain which you did not fail to emphasize, I have no doubt that our States, in the near future, will see that appropriate steps are taken to reverse the tide so as to attract and retain in our continent the specialists vital for its development".

II. GENERAL CONCLUSIONS

Certain fundamental concepts emerged during the debates at the Conference. The delegates judged it necessary that these concepts form a special section of the report.

These considerations provided the elements, on the one hand, of a General Declaration adopted by acclamation during the plenary session on the afternoon of 28 January 1974 and, on the other, of three general recommendations.

1. DAKAR GENERAL DECLARATION

The text of the Dakar General Declaration is the following:

During recent years the African countries have made a great effort to formulate a science policy that will enable them to achieve scientific and technological progress.

They have encountered a great many difficulties in this task. The experience gained makes it possible today to see clearly the precise nature of the problem raised by the use of science and technology in our continent and, thus, to identify more accurately, in order of priority, the tasks to be undertaken.

The Conference has observed that efforts to develop scientific and technological activities have invariably come up against obstacles of an economic, social and cultural type.

It is obviously not within the power of science and technology to remove these obstacles, which are, indeed, none of their making, and to engender the development process; what has to be done, on the contrary, is to ensure that there are present all the necessary conditions for development and thus for systematic utilization of the benefits of scientific and technological progress.

The problem of the implantation of science and technology in Africa is therefore in reality a problem of development and raises the major question as to the choice of development strategy.

In this connexion the fourth Summit Conference of the Non-Aligned Countries (Algiers, 5-9 September 1973) rightly stressed that:

> "The failures of the first Development Decade and the unsatisfactory implementation of the recommendations of UNCTAD III together with the disappointing results of the first three years of the current Decade have already jeopardized the achievement of the objectives of the International Development Strategy.
>
> The numerous projects intended to enable the developing countries to benefit in an organized way from the results of scientific research and technological progress have not even begun to be seriously implemented, whereas there is a continuous drain of a large number of highly qualified personnel especially scientists and technicians, from the developing countries continues unchecked.
>
> Clearly, however, only a proper conception of development based on the requisite changes to internal structure particular to each country, and which encompasses growth in all the key sectors will enable our countries to achieve their development targets. This process is inseparable from the social process which calls for full employment, income

redistribution and the overall solution of problems such as health, nutrition, housing and education. It is equally obvious that these aims can only be achieved through conscious and democratic participation of the masses which is one of the determining factors in any national endeavour to achieve dynamic, effective and independent development." (United Nations General Assembly document A/9330 of 22 November 1973, pages 60 and 62).

The Conference also noted, at the same time, the continuing weakness of African scientific and technological potential. Since men represent a country's main wealth as well as the agents of its development, the first task must be to develop African universities and apply an education policy aiming at the democratization and reorganization of instruction, including more especially the upgrading of scientific and technical training at all levels.

To this end, there must be on the one hand access by the broad masses to instruction and knowledge, an indispensable condition governing the transformation of structures and attitudes and the spread of progress among the peoples; and on the other, the construction of genuinely African university institutions capable of training the number and type of men and women that the continent needs, trained to tackle and solve the problems facing and concerning Africa.

Africa must rely, first and foremost, on its own strength. It has, then, to reconsider the ties of dependence that have been imposed on it and fashion links of a new type which will be radically different from those of the past.

It is particularly urgent for Africa to tighten the links between its universities and its research organizations and to find the most suitable personnel for scientific and technical exchanges.

The rôle of the Organization of African Unity is vital in this connexion. The Conference thus advocates the development of the activities of the African Science Council and the organizations that come under it.

It urges countries in the continent to hold an increasing number of regional and inter-regional meetings and to set up rapidly at these two levels appropriate machinery for exchanging experience and information in regard to science and technology and for pooling, with a view to their more rational utilization, the resources that Africa possesses.

It advocates the tightening of scientific links between the Third World countries and, more particularly, between African and Arab countries, within the framework of Arab-African solidarity.

2. GENERAL RECOMMENDATIONS

In addition to the recommendations that it adopted concerning the three themes on its Agenda, the text of which is to be found in Sections III, IV and V of the present Report, the Conference also adopted three recommendations of a general character, reproduced below. These recommendations - basically quantitative in nature - have a bearing on the specific recommendations relating to the three substantive themes.

Recommendation No. 1: FINANCIAL RESOURCES DEVOTED TO R&D

The Conference,

Aware of the fact that a long-term scientific and technological policy cannot be effectively formulated in the absence of a stable and adequate budgetary framework,

Aware of the fact that as long ago as the Lagos Conference (1964) the African Member States recommended that about 0.5% of their Gross National Product be allocated to R&D expenditure,

Aware of the fact that the World Plan of Action drawn up in 1970 by the United Nations Advisory Committee on the Application of Science and Technology to Development also refers to this minimum target figure of 0.5% which the developing countries should endeavour to attain by 1980 as regards the amount they devote to research and experimental development proper,

Noting that the World Plan of Action suggests, in addition, a target figure of 0.5% of the Gross National Product for the financing of supporting scientific and technological activities (in particular, scientific and technological public services),

Aware, finally, of the fact that UNACAST has recognized that those countries which at present devote a very low percentage of their Gross National Product to research and development (R&D) and scientific and technological public services (STS) will have difficulty in reaching the overall target of the World Plan of Action which calls on the developing countries to devote by 1980 at least 1% of their Gross National Product to these activities,

Noting with satisfaction that the statistics supplied to Unesco by African Member States show that certain countries have made a considerable effort to increase the sums allocated to research and development (R&D) and supporting scientific and technological public services (STS),

Recommends:

1. That the African Member States improve their budgetary procedures and national accounting systems in regard to R&D proper and the supporting scientific and technological public services, so as to enable them to compile serviceable statistics in this regard, according to the standards proposed by Unesco and to carry out comparative international studies in this field;

2. That African Governments improve their financing, fiscal and customs regulations so as to enable R&D institutions to operate with a high degree of efficiency and with the maximum possible freedom for the management of their financial resources;

3. That public expenditure for R&D and supporting scientific and technological public services (STS) be recapitulated in the annual state budget in the form of an aggregate functional budget constituting, as it were, the total budgetary allocation for R&D and supporting scientific and technological public services (STS);

4. That Member States, taking into account national demand for R&D, increase their annual expenditure on R&D and supporting scientific and technological public services (STS) so as to attain, if possible before 1980, the target figure of a minimum of 1% of their Gross National Product as proposed by UNACAST in the World Plan of Action;

5. That the African Member States undertake a careful study, with the technical assistance of Unesco if they so desire, in regard to the budgetary and programming procedures that are needed for the purpose of preparing functional budgets for R&D and supporting scientific and technological public services (STS) and formulating long-term plans for inclusion in their National Development Plans.

Recommendation No. 2: UNESCO SPECIAL FUND FOR AFRICAN R&D DEVELOPMENT

The Conference,

Considering that the gap between the level of scientific and technological development of the African region as compared with that of the other regions is ever widening,

Considering that 16 of the 25 least developed of the developing countries are in Africa and that the United Nations General Assembly resolution 2768 (XXVI) and similar resolutions of the Unesco General Conference, particularly resolution 17 C/2.01, bind the Organization to do everything in its power to give special attention to the science needs of these countries,

Considering, further, that the financial resources which will be made available for activities to promote scientific and technological development in Africa, under Unesco's Regular Budget, will not be nearly sufficient to permit the implementation of a large-scale programme,

Recommends that Unesco establish a Special Fund for African R&D development, to be used for the strengthening or launching of R&D activities, including the training, at the appropriate levels, of R&D manpower.

Recommendation No. 3: HUMAN RESOURCES FOR SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

The Conference,

Considering that the lack of financial resources coupled with the shortage of duly qualified

African scientists and research technicians needed for R&D activities and the supporting scientific and technological public services (STS) constitutes the main obstacle to the effective application of science and technology to development in Africa,

Considering that the statistics supplied to Unesco by Member States clearly demonstrate that the provisional target fixed for Africa as a whole by the Lagos Conference - a minimum ratio of 200 scientists and engineers per million inhabitants to be attained by 1980 - has already been exceeded by a number of African countries, whereas other countries in the continent, more especially those included in the list of the 25 least developed of the developing countries, have not yet reached it,

Considering that the African Member States should be in a position to evaluate their effort in this domain by reference to new targets established by the CASTAFRICA Conference,

Considering that the scientists and engineers required to carry out R&D activities have normally to be recruited from among the total stock of national scientists and engineers,

Noting that the ratio between the total number of scientists and engineers and that of scientists and engineers engaged in R&D activities is approximately 10 to 1,

Believing that it would hardly be reasonable to expect that in Africa, where there is an acute shortage of scientists and engineers, an abnormally high percentage of such personnel could be assigned to R&D activities and that it is therefore desirable that the Conference should establish targets in respect of both the total stock of scientists and engineers per million inhabitants and the number of scientists and engineers engaged in R&D activities per million inhabitants, in order to establish an effective link between national policy in higher education, on the one hand, and science and technology policy on the other,

Recommends:

1. That Member States take the measures needed to attain, if possible before 1980, the targets set out in the table below, having regard to the fact that the target of 200 scientists and engineers engaged in R&D activities per million inhabitants is that adopted for Africa by UNACAST in its "World Plan of Action" and that it is barely half of those established for Asia and Latin America:

Economic development level (per capita GDP) $	Number of scientists and engineers per million inhabitants	Number of scientists and engineers engaged in R&D per million inhabitants (10% of the figure in column (2))
(1)	(2)	(3)
200 or over	2,000	200
100 to 200	1,400	140
Under 100	1,000	100

2. That Member States continue their efforts to implement the Lagos Conference recommendation advocating the training of two specialized technicians for each scientist or engineer engaged in R&D activities.

III. TRENDS OF SCIENCE AND TECHNOLOGY POLICIES IN THE COUNTRIES OF AFRICA

1. HIGHLIGHTS OF THE DEBATE

The tone of the Conference was set by the general acceptance of science and technology as vital levers essential for economic and social development. This in turn implies some means of control and guidance over the development of scientific and technological manpower and facilities, and their harnessing to the national development effort.

The acceptance of this view is indicated by the remarkable growth of science planning and policy-making bodies in African countries during recent years. Most countries, though not yet all, have set up national science policy organs. This trend has stemmed primarily from a recognition that, with limited human and financial resources at their disposal, the optimal allocation of these resources and their proper orientation are of critical importance. The need is seen to organize science for development while it is still relatively young in Africa.

Science policy structures vary a great deal from one country to another, reflecting the particular problems and approaches. This is as it should be. Science policy organization must be dynamic, and within any country must be adaptable to the ever-changing circumstances. But it is acknowledged that most of these bodies are still at the formative stage, and their present shortcomings are recognized. While a policy for science is already relatively well-developed in some countries, a policy based on science is only now beginning to take shape.

The major concern of existing bodies is the co-ordination and guidance of the national R&D effort, particularly within the public sector. Typically, in operational terms, this effort is undertaken in a variety of institutions, under the direct control of different ministries and other government agencies. The problem of co-ordinating this array of activities was reflected in the Conference discussions. Science policy bodies in most cases lack any direct budgetary powers to effect positive control in the implementation of national science policies. On the other hand, a body with too wide powers and too heavy a hand, may result in resentment and resistance from the operational departments. The answer to this problem is broad representation of all sectors concerned with science and technology, including scientists and the users of scientific knowledge and improved technology, in the formulation of science policies. Effective implementation of science policy depends on consensus rather than coercion. Priorities in science must be determined by a collective process.

Evidently, the starting point for this assessment is the national development strategy aimed at agreed objectives. Science policy is simply one aspect of this strategy, and not an independent entity. The Conference drew attention to the decisive importance of an intimate collaboration between the national science policy planning body and the overall national socio-economic planning organs. But the discussions showed that putting this concept into practice is no easy matter, and the methods for formulating a science policy in practical terms remain a matter for concern. A vital part of this process is deciding what research to undertake. Various approaches to this problem were discussed, but more concerted action on developing methodologies and training personnel in their use was considered desirable. At the same time, it must be recognized that while in the short- to medium-term science policy must stem from national objectives, in the longer term science and technology have a contribution to make in the formulation of these objectives and there needs to be a two-way interaction.

To provide a basis for sound decision-making in this area, the national science policy-making body requires the support of a permanent cadre of science policy planners capable of in-depth studies in strategically important areas. Such a team needs to have training in systems analysis, operations research and cost/benefit analysis, and must also be economically literate and able to maintain an effective dialogue with economic planners. Some bodies have recognized the need for this analytical capability, on a continuing basis. Some countries have attempted to build up an appropriate analytical team from a mixture of scientific disciplines and managerial experience, given carefully structured training. Training this type of team would seem a fruitful area for regional co-operation and international assistance.

The use of accurate statistical data in the

formulation of science policy was underlined. The Conference, having examined the statistical data on the human and financial resources devoted to R&D by African countries, and which were published in Unesco's Science Policy Studies, document 31, felt that there was a need for in-depth study of statistical terminologies used in this type of survey and their interpretation so as to evolve norms which will ensure not only a greater reliability in the results but also comparability on an international basis.

A considerable scientific infrastructure has now been built up in many African countries, with some substantial research and extension activities. Often, however, these have been based on inherited institutions which are not necessarily best suited to the needs of a country aiming at rapid development. Some countries have found it necessary to rely heavily on foreign-based institutions, staffed largely by expatriate scientists. While these have made a useful contribution, they are not readily harnessed to development needs. Many countries are therefore in the process of restructuring their research and supporting organizations towards a more coherent force for development. Co-operation with non-African institutions can be useful but only in the context of strong national institutions.

Important concepts which are of considerable concern to African science administrators are the efficiency and effectiveness of their research institutions. Techniques for measuring efficiency and effectiveness are not yet fully developed, though it is possible that a technique being developed by Unesco for this purpose will shortly be available. Efficiency and effectiveness are all to do with research management, which in African countries is developing fast, but still tends to cling to old-fashioned methods. The Conference felt that workshops on research management and assessment would be extremely valuable.

The productivity of research institutes and of industry depends to a great extent on the provision of supporting scientific and technological services. It was agreed that these are generally inadequate or even absent in most African countries. Many countries expressed the need for help and advice in building up these services, with specific mention of information and documentation, materials testing, industrial standards and cartography. The problems of instrument upkeep and repair were frequently raised, with a common tale of expensive instruments unused because of lack of spare parts or inadequate servicing. Unesco's support was elicited with a view to improving the provision of spare parts and servicing facilities by overseas manufacturers, and to building up local repair and maintenance capabilities.

Undoubtedly the major constraint in this process of building up research and other scientific institutions is the acute shortage of qualified personnel, whether research workers, scientists, technicians or managers. Though the situation is improving rapidly, African countries are generally well below world standards in this respect. In part this shortage stems from a lack of interest among young people to follow a technical career. It was the general view of the Conference that the key to this problem lay at the primary and secondary school levels. The education system needs to be reorganized with priority to scientific disciplines. At the same time the status of scientific and technological workers in the society must be considered. It was noted that Unesco is in the course of preparing a draft International Recommendation on the "Status of Scientific Research Workers" which, approved by the General Conference, will be made available for general use. Salary scales are also important. In these ways parents and pupils must be convinced that a career in the field of science or technology is worthwhile. Bearing on this also is the general scientific climate in the country, which is discussed later.

A recurrent theme in this context was the "brain drain", still a significant problem in many countries. Limited post-graduate training facilities at present require that research workers be trained overseas. This raises many problems. Many do not return, and those that do are often frustrated on their return. Their training is usually not appropriate to the work they are required to do, and they have often lost touch with national problems. Ideally, training at this level should be carried out at home, if not in the home country at least within the African region. Building up training facilities at this level is expensive, and this again may be a fruitful area for co-operation. To retain trained scientists within the country, financial incentives were stressed, but an appeal to civic conscience and instilling a sense of mission was considered at least equally important.

The Conference realized also that the political atmosphere in a country can contribute immensely to the exodus of scientists from that country. From a broader aspect, close attention is being given to rectifying the distortion and imbalance which is often found in the present manpower supply. In particular stress was laid on the shortage of technicians at all levels. Quite apart from the requirements of industry, in research laboratories the ratio of research workers to technicians is well below that found advisable elsewhere. Urgent attention to increased polytechnic training facilities is called for.

The essential rôle of universities and other institutions of higher learning in national research programmes was generally agreed. Some now play a prominent rôle in this respect, but others are still inclined towards more theoretical work. In attempting to improve the integration of research at the universities into other national programmes, the general trend was towards a pragmatic approach encouraging a sympathetic attitude towards national development plans, without sacrificing their traditional responsibility for fundamental research. Funding of specific research projects through the national science planning agency, and joint research projects in association with other national bodies are among the techniques which have been found useful.

Many references were made to the problem of translating research results into practical application. The links between research workers

and the users of research results are acknowledged to be weak. It is however recognized that these linkages should be very important and that there is need for a permanent two-way communication between those concerned with both the supply and the demand for scientific knowledge and improved technology. The rôle information and documentation services play in the development of science and technology was stressed. There was general agreement that African countries could only make effective use of the services to be provided by the UNISIST programme recently launched by Unesco, if the region is provided with information and documentation centres at regional, sub-regional and national levels. An important aspect of this problem is the rôle of the social scientists, whose place is sometimes not fully appreciated by natural scientists. In consequence research is sometimes carried out without adequate considerations of the social questions involved, so that the results of the work prove unexploitable, a waste which no country can afford.

The widespread growth of education is perhaps one of the greatest social forces at work in Africa today. But with growing aspirations will come a need for a greater awareness of the potential of science and technology, and a recognition of the need to devote significant resources to their application. The successful application of science and technology to development presupposes a certain level of scientific awareness in the community at large. In the absence of a modern intellectual scientific environment, apathy or even resistance to technological change is common. There may be not only lack of knowledge of the benefits which science and technology can bring, but lack of interest. To overcome these attitudes calls for mass literacy campaigns and the active promotion of science awareness, which many countries have now initiated. It is important to introduce scientific attitudes into daily life - to introduce an appreciation of cause and effect in everyday terms. Science can help to eliminate the constraints which tradition and superstition may place on development. This process must include both adults and children at the pre-primary level. It was suggested, for example, that toys and games should be devised, with the African personality clearly in mind, to help change the traditional ways of thinking.

At the same time, however, African countries are determined not to lose their cultural identity through the cult of modernization. Africans are very conscious of these problems and dangers, and are determined to work out their own solutions. In this area, again, the social sciences have evidently a great part to play.

2. RECOMMENDATIONS

Recommendation No. 4: SCIENCE AND TECHNOLOGY POLICY ORGANS IN AFRICAN COUNTRIES

The Conference,

Realizing the need to establish in each country, at the highest level, appropriate machinery to be responsible for the elaboration of national science policy and the co-ordination of science and technological activities,

Recognizing the important rôle such machinery plays in the development of science and technology,

Noting, however, that some African countries have not created such machinery,

Recommends that:

1. Each of the countries that have not yet created such machinery should study the options available to it in this regard, and endeavour to establish, as early as possible, a machinery that best suits the level of technological development as well as the socio-economic and cultural conditions of the country;

2. Unesco, in co-operation with other institutions of the United Nations family, should assist those African States that have not established such machinery to enable them to do so, and also assist in the strengthening of such machinery where it has already been established;

3. Member States that have established their science policy planning machinery should keep it under constant review with a view to effecting the necessary changes at the appropriate time so as to ensure the effective functioning of the machinery;

4. Such machinery, in the performance of its functions, should always liaise closely with the national organs responsible for socio-economic development planning;

5. Unesco, in collaboration with other governmental and non-governmental agencies, should assist African Member States in implementing programmes within their National Development

Plan, in particular by assisting Member States in project design and preparation under the various programmes in their National Science Plan.

Recommendation No. 5: SOCIAL AND CULTURAL ASPECTS OF THE APPLICATION OF SCIENCE AND TECHNOLOGY IN AFRICA

The Conference,

Having regard to the important part that socio-cultural factors play in the propagation of scientific and technological innovations and in development,

Considering that science and technology have sometimes been applied without due regard for the interests of the population,

Considering that means should be sought of increasing the effectiveness of the application of science and technology,

Recommends that due account be taken of human factors in all activities for the promotion of scientific and technological development and that specialists in the natural sciences, on the one hand, and those in the social and human sciences, on the other, should use their combined ingenuity in seeking, under the auspices of Unesco, formulas which will allow the application of science and technology to go hand in hand with the safeguarding of African cultural values.

Recommendation No. 6: TRAINING OF SCIENTIFIC AND TECHNOLOGICAL CADRES

The Conference,

Aware of the fact that during the colonial period the main purpose of R&D activities was to exploit natural resources and protect colonial administrators,

Considering that there was at that time very little or no training of Africans for R&D purposes, as can be seen from the fact that R&D was in existence and developed before universities were established,

Convinced that the shortage of competent scientific staff is a major handicap for research and development,

Convinced, furthermore, that African scientists should be encouraged to take up careers in research work in order to serve Africa's development,

Considering that the development of science and technology in Africa depends fundamentally on the scientific training of national personnel,

Recommends:

1. That the training of African scientific and technological personnel should be treated by governments as a matter of absolute priority;

2. That governments should revise curricula at all educational levels so that science and technology may occupy an important place in the education of both schoolchildren and students;

3. That the development of science and technology should be approached from a comprehensive point of view, which entails not only the training of the requisite number of qualified high- and middle-level personnel in the appropriate scientific fields but also the teaching of science from primary school on, use of the mass media to make the general public aware of scientific and technological problems and the organization of courses in industry, R&D institutes and the national public service;

4. That, where appropriate, Member States should establish or strengthen institutions for scientific and technological training at all levels;

5. That new methods developed with the help of Unesco be taken into consideration for science and technology teaching.

Recommendation No. 7: THE BRAIN DRAIN PHENOMENON

The Conference,

Considering the slow rate at which African scientific personnel are being trained and, thus, the shortage of national R&D staff,

Conscious of the difficulties often encountered by African scientists,

Noting the studies already carried out by Unesco, UNITAR and other international organizations in an effort to throw light on the phenomenon of the outflow of scientific personnel,

Recommends:

1. That Unesco carry out further studies in Africa on questions relating to the brain drain and its effects;

2. That governments draw up a policy aimed at steering scientists towards scientific research careers, by providing research workers with a satisfactory status - as regards both material and moral conditions - within the framework of the national public service,

3. That young African scientists and research workers display a sense of civic responsibility by devoting themselves to work of concern to their respective countries or their continent.

Recommendation No. 8: ADVANCED TRAINING OF AFRICAN SCIENCE POLICY AND R&D MANAGEMENT SPECIALISTS

The Conference,

Aware of the scarcity of African science policy and research management specialists,

Conscious of the importance and the urgent need for African States to take fully into their own hands responsibility for the implementation of research policy and for the management of research undertaken in their countries,

Recommends that African governments, with the help of Unesco and other competent international organizations, should endeavour to create teams of experts to help them in the management of science programmes including the problems of financing of research, programming and analysis, training of research workers and the organization of documentation and publication services.

Recommendation No. 9: SCIENCE AND TECHNOLOGY POLICIES AND THEIR RELATIONSHIP WITH UNIVERSITIES

The Conference,

Conscious of the decisive rôle the African national high-level scientists and technologists should play in the process of formulation, execution and follow-up of research plans and in the adaptation of transferred technology to suit local conditions,

Considering that the quantity of highly qualified personnel in African countries remains far short of actual needs,

Stressing the need for designing and revising, where appropriate, university curricula to meet the requirements of the socio-economic and cultural development of each country,

Recommends that:

1. African countries accord the highest priority to the creation or strengthening of national universities and supply them with the necessary resources to enable them to contribute in the best manner in the training of national cadres;

2. African countries make maximum use of the potential in the national universities when formulating national science policies and associate universities closely with that task;

3. African universities be urged to orient their research activities towards problems of a local nature, for instance by training highly qualified personnel - particularly at the post-graduate level - able to tackle national socio-economic development problems, and to help African societies to fulfil their aspiration for progress;

4. The ratio of science and technology students in African universities to students in other disciplines be raised to meet the ever-increasing demand for scientists and technologists in Africa;

5. Training abroad of African nationals be restricted as far as possible to disciplines not being taught at present in African universities, and that in this case the training include orientation on problems proper to Africa, whenever this should be feasible.

Recommendation No. 10: THE NEED FOR NATIONAL AND REGIONAL SURVEYS OF SCIENTIFIC AND TECHNOLOGICAL POTENTIAL

The Conference,

Noting that accurate data are necessary for effective planning of the application of science and technology to development,

Recognizing that the regional surveys of the scientific and technological potential of the African countries, published by Unesco in 1963 and 1970, constitute useful documentation for this purpose.

Recommends:

1. That African States undertake regular and comprehensive surveys of their national and technological potential, utilizing, where possible, data processing methods;

2. That Unesco update, from time to time, its own regional surveys of the scientific and technological potential of the countries of Africa;

3. That Unesco continue to assist African States in the evaluation of their national scientific and technological potential and convene a meeting of experts for the purpose of evolving well-defined norms to form a basis for the collection of comparable and accurate data in Africa.

Recommendation No. 11: PROBLEMS OF EFFICIENCY AND EFFECTIVENESS OF R&D

The Conference,

Considering that in order to ensure the efficiency and effectiveness of research there must be sound management of research institutions and rational utilization of the limited human and financial resources available to African States,

Noting that in most African States there is still a shortage of people trained in modern management techniques,

Recommends:

1. That Unesco pursue the action in which it is already engaged with a view to developing a methodology making it possible to evaluate the efficiency and effectiveness of scientific and technological research units in Africa;

2. That it organize, within a reasonable period of time, symposia or workshops for African scientists and research workers, devoted to problems of efficiency and effectiveness of research units;

3. That the use of African scientists and research workers be governed by a strategy based on the complementary character of the disciplines and skills involved, taking into account the aims of the research programmes, which would necessarily be geared to the financial resources available.

Recommendation No. 12: THE ROLE OF SCIENTIFIC AND TECHNOLOGICAL PUBLIC SERVICES (STS) IN THE DEVELOPMENT OF AFRICAN COUNTRIES

The Conference,

Considering the basic importance of scientific and technological public services (STS) which form the essential infrastructure for scientific research activities,

Aware of the fact that scientific research and industrialization cannot take place without these services,

Recommends:

1. That the African States attach great importance to the development of scientific and technological public services (mapping and surveying facilities, scientific information and documentation services, scientific museums, etc.);

2. That Unesco, in collaboration with the other competent international organizations, supply African Member States with the technical and material assistance they need for establishing or strengthening these services.

Recommendation No. 13: INFORMATION RESOURCES OF AFRICAN COUNTRIES IN THE FIELD OF SCIENCE AND TECHNOLOGY - THE UNISIST PROGRAMME

The Conference,

Realizing that scientific and technological information is indispensable for the progress of scientific and technological activities, and the popularization of science and technology,

Aware of the rapidly increasing amount of such information throughout the world which is often not easily accessible to African countries,

Aware that Unesco has launched the UNISIST programme to facilitate the free exchange of scientific and technological documentation and information in the world,

Convinced that the creation of scientific and technological documentation and information services and centres in Africa at national, sub-regional and regional levels will help the African countries to make better use of this global information service,

Recommends that:

1. All possible efforts be made by African Member States to create and strengthen scientific and technical documentation centres in their respective areas, with Unesco's assistance, at the national, sub-regional or regional level, as appropriate;

2. African Member States promote and facilitate the free exchange of scientific and technical information among the African Member States themselves and between them and the rest of the world.

Recommendation No. 14: LINKAGE MECHANISMS BETWEEN THE NATIONAL R&D SYSTEMS AND THE USERS OF RESEARCH RESULTS - EXTENSION SERVICES

The Conference,

Recognizing the importance attaching to the exchange of ideas between research workers and the users of research results with a view to making effective use of such results in national economies,

Aware that the availability of specially trained local extension personnel is necessary for the proper dissemination and utilization of the results of national R&D,

Realizing that locally trained extension personnel are also required to facilitate the proper use of imported technologies and of overall know-how,

Recommends that:

1. Joint consultative machinery be set up in African countries to ensure the optimal use of research results;

2. Universities and other institutions of higher learning train at national and regional levels, as appropriate, extension specialists, technologists and technicians, so as to facilitate the proper and optimal use of appropriate technologies.

Recommendation No. 15: SCIENTIFIC EQUIPMENT NEEDS

The Conference,

Considering the large amount of scientific and technological equipment needed by African countries which wish to speed up their development process,

Considering the state of dependence in which these countries are placed vis-à-vis the developed countries with regard to the production and maintenance of scientific material,

Considering the difficulties frequently encountered by numerous African institutes for science and technology as well as by individual scientists and engineers,

Recommends:

1. That OAU, UNCTAD and ECA study ways and means likely to facilitate the acquisition by African countries, under more favourable terms, of the equipment required for research and experimental development activities, and for the establishment of scientific and technological services;

2. That Unesco, in collaboration with the other competent organizations, assist the African countries in setting up their own plants for the production and maintenance of scientific equipment.

IV. NEW TECHNOLOGIES: POSSIBILITIES FOR THEIR DEVELOPMENT AND APPLICATION IN AFRICA

1. HIGHLIGHTS OF THE DEBATE

Science and technology represent a means of development and emancipation for Africa, but they also harbour - technology in particular - dangers inasmuch as they may, because of their foreign origin, become the vectors of ways of life and thought dangerous for the African personality: such is the general conclusion that emerges from the discussion of this item of the agenda. It is, therefore, essential to recognize, as a first obvious fact, that technology must be made to serve Africa instead of Africa being indiscriminately subjected to techniques often invented elsewhere, sold at a high price and imported solely for their short-term profitability.

African development in every area - agriculture, industry, infrastructure, health, education - demands not only the development of local technologies but also the importation of new technologies in order to ensure economic growth and social changes. It is vital, in this process, that the imported technologies should be only those that answer African problems and that the prime aim should be to make Africa capable, eventually, of inventing and applying its own technological solutions to its development problems - in other words, to guarantee its technological self-sufficiency.

This is a long-term objective, given the comparative rates of production and application of knowledge in Africa and the rest of the world, and the time lags inherent in the processes designed to change this state of affairs. The priority task to which African countries will here and now have to apply themselves is the establishment of a scientific and technological base, resting mainly on qualified personnel (scientists, engineers and technicians) and a network of educational and research institutions and scientific services. The length of time and the size of the operation required to build up this base underline the urgent need to embark on this task as a large-scale operation.

Strategy for technological progress

The size and the complexity of the political, economic, social and other problems raised by the transfer of technology justify the formulation of an overall strategy for Africa, providing a framework for the formulation of national strategies. This overall strategy remains to be defined but certain of its features are already apparent from a number of considerations evoked by numerous speakers in the debate.

Technology should, in general, meet the aspirations and be in consonance with the level of development, of those who are to be its ultimate beneficiaries, and fit into their social and cultural patterns.

The African populations are predominantly rural and technological development should, therefore, be designed to contribute, first and foremost, to raising the standard of living of the rural population.

Africa lacks capital but has a large pool of manpower. With capital becoming more and more expensive to raise, imported technology will preferably have to be labour-intensive rather than capital-intensive. What is today called "appropriate technology" largely meets these two requirements.

The technology to be implanted must be scaled according to local possibilities. As far as possible it must be suited to the level of technical competence of the personnel available on the local market, thus making it less necessary to have to rely on foreign personnel. It must also be designed to make use of the country's natural resources (e. g. medicinal plants or building materials), thus making for savings and better integration with local conditions.

It would also be desirable to upgrade and update African technologies that have been supplanted by imported foreign technologies.

Lastly, particular attention should be paid to the physical environment, from the point of view of the possible effects on it of an imported technology, so as to avoid the harmful consequences that are to be seen nowadays in several developed countries.

On the basis of the foregoing considerations it would be possible to formulate criteria for selecting technologies to be developed or that are already available on the world market, and so obtain the first elements of a strategy.

Exploration of technological possibilities

Several speakers stressed that because of the urgent character of Africa's needs and the inadequacy of its scientific and technological base, it was essential that attention should first be turned to technologies that have already been developed and tested. It was nevertheless agreed that if it is to take its rightful place in tomorrow's technological world, Africa must also look to a more distant future and explore, here and now, the possibilities that might be afforded by new technologies which are still in the early stages of development.

There are two possible ways of identifying the most suitable technologies for development and implantation. The first, more direct approach, as emerges from the majority of the statements made, is to set out, as precisely as possible, the economic, social or technical problem to be solved, as then the (technological) solutions often become apparent of themselves. This, however, entails the systematic, detailed survey and ranking of the problems of development.

The other approach, complementing the first but less direct, is to survey the range of emerging technologies and to sift them according to their relevance to African problems. This has been the method adopted by Unesco in its Delphi survey on "Technologically feasible futures for Africa", carried out with the aid of a panel of African and international experts. This type of approach, proceeding from foreseeable technological developments to particular problems and needs, does not of itself ensure that the technologies listed will be of interest.

The selected list of technologies obtained from the survey can, however, provide useful information to African countries in their choice of areas in which to co-operate for the development and implantation of new technologies. These findings arrived at in consultation with the experts should, naturally, be interpreted with a measure of reserve, since overall and qualitative assessments of time-frames, costs and benefits involved in the implantation of a technology may fail to take into account the extremely complex circumstances peculiar to each country

In this connexion it would be highly desirable to improve current forecasting methods - including the Delphi method - with a view to increasing their reliability, and make a careful study of the particular conditions relating to their application, as, for example, the selection of the expert panel members, or the mode of stating the questions dealt with, in this case the list of future technologies to be assessed by the experts.

Several technologies in this list were referred to by a number of delegations as being of direct relevance to their countries; all-terrain vehicles, small self-contained power sources, new uses of solar energy and wind power, improved exploitation methods for low-grade ores, educational techniques for home use, use of African plants in pharmaceuticals, use of local materials in building, production of leaf protein, freeze-drying, production of nitrogenous fertilizers from by-products of oil refineries, synthetic sources of nitrogen, glandless cotton seed varieties, storage facilities which prevent the development of aflatoxin, and non-polluting pesticides.

Other new technologies not listed in the survey merit consideration, particularly those relating to animal husbandry (vaccines) and agrostology, mineral prospecting and the inventory of natural resources in general, and new ways of processing certain ores based on the use of local raw materials.

This initial identification can provide a basis for the in-depth feasibility studies which would in all cases be necessary before decisions can be taken concerning the development or adaptation of these new technologies; and for such studies the African countries would have to combine their efforts.

All these new technologies must be considered in conjunction with those which have already been listed in the African Regional Plan for the Application of Science and Technology to Development, and priority might be given to studying technologies which appear in both lists.

Barriers to technological progress

The development and implantation of new technologies and the transfer of technologies that have been tested and are currently available may encounter numerous barriers, of a scientific and economic, as well as of a social and cultural character. The barriers mentioned in the various statements often correspond with those listed and classified by the panel of experts consulted in the Delphi survey: first and foremost shortage of qualified personnel (scientists, engineers, technicians at all levels), also inadequacy of the funds devoted to scientific training and research, lack of communication between African research laboratories, unreadiness of government departments to seek advice from local scientists, lack of basic scientific education among the population at large.

Other barriers mentioned included inadequacy of the scientific support services (e. g. centres for calibration and repair of scientific instruments), lack of uniform regulations governing patents, the small share of the indigenous private sector in the financing of research, lack of foreign exchange, the entire dependence of Africa on foreign countries for the supply of scientific equipment, absence of facilities such as to retain scientific and technical personnel in their own country, inadequate co-ordination between universities and research laboratories and, lastly, lack of detailed information on the technical and economic characteristics of existing or new technologies.

Technology transfer mechanisms

As regards types and mechanisms of technology transfer, it is unanimously recognized that the African continent will still, for a long time, have to import a major part of its technologies (horizontal transfer), but there is also a general agreement that Africa should progressively produce its

own technologies (vertical transfer), which implies the building up of a fundamental and applied research potential capable of conducting the necessary scientific studies. Meanwhile various measures will have to be taken in order to exercise strict supervision over the conditions under which horizontal transfer is effected so as to place the African countries in a stronger negotiating position vis-à-vis the suppliers of foreign technologies, especially the multinational companies.

In particular, it would be desirable to study the technical aspects of the implantation of foreign industries in order to adapt them to local conditions as regards the use of raw materials and the labour market.

Another matter to which attention should be given is the transfer of technology within Africa and the consequent necessity for a machinery regulating the exchange of patents.

As regards vertical transfer (the chain leading from R&D through technical innovation and preliminary design studies to a pilot plant), due importance must be attached to the exploitation of research, for which purpose appropriate machinery should be set up in each country to ensure that research findings are put to economic use, with particular attention to the relatively high investment required for this type of research as compared to investment required for laboratory research.

Regional co-operation

Technological development in Africa will necessitate in large measure a resolve to consult and co-operate with a view to the pooling of scientific and technical resources. One of the most important tasks will be to set up regional information services in regard to technologies, established or new, local or foreign. These services should form, as it were, a scientific and technical information data bank, organize seminars on technological transfer and, where necessary, provide consultant assistance. Such services would require a system of national correspondents in each country to provide links with local users.

The assistance of regional and international organizations will be of real aid to Africa in achieving its scientific and technological aims. The regional information services mentioned above might, for example, fall within the scope of the UNISIST programme initiated by Unesco.

It is essential, furthermore, that Unesco, OAU, and the other international organizations (ECA, UNITAR, UNIDO, UNCTAD) which have a part to play in the transfer of technology in Africa should closely co-ordinate their efforts.

2. RECOMMENDATIONS

Recommendation No. 16: CRITERIA FOR CHOICE IN TECHNOLOGY POLICY FORMATION

The Conference,

Considering the need for African countries to import new technologies, including industrial plants, capital and technical know-how,

Conscious of the necessity of adapting these new technologies to the socio-economic and political conditions prevailing in African countries and the possible impact of such technologies on the African environment,

Being aware of the fact that the ultimate aim of all scientific and technological activities is to serve the greatest number of the population,

Recommends that:

1. African countries, in selecting new technologies, take into consideration the size of the country and the level of its technological development and import only those which are best suited to local conditions, in particular those which will benefit their people directly by ensuring:

   (a) the rational management of all national resources,

   (b) the protection of their environment, in accordance with the recommendations of the United Nations Conference on the Human Environment (Stockholm, 1972),

   (c) the generation of employment for as many people as possible,

   (d) the most favourable economic terms for the country concerned. "

2. African countries, through their research institutions, give priority to the use of local raw materials and to the improvement of local technologies.

Recommendation No. 17: POLICIES FOR TECHNOLOGICAL PROGRESS

The Conference,

Convinced of the vital rôle that technology plays in the advancement of national economies,

Realizing the need in African countries for clear policies relating to the implantation of different technologies to satisfy the socio-economic strategies of development in each African country,

Aware that the successful use of imported technology depends on an adequate availability of certain infrastructural and institutional facilities including trained manpower at different levels,

Aware of the necessity for African countries to undertake joint efforts to make scientific and technological applications to development effective,

Recommends that:

1. African countries work out strategies for the utilization of technologies best suited to the African socio-economic and cultural conditions and develop legislations in order to regulate the importation and development of technologies;

2. Training in national African institutions at all levels be directed towards solution of local problems and that appropriate changes be made in the curricula and methods of instruction accordingly;

3. Research activities in national institutions of higher learning be oriented towards local problems and that African Governments provide these institutions with all the resources they need for their work;

4. Regional and sub-regional co-operation be undertaken both for special training and specific research activities to enable inter-African exchanges to be effective and economical;

5. R&D machineries in each African country re-appraise the findings of the Unesco Delphi survey as related to their own development plans.

Recommendation No. 18: TRANSFER OF TECHNOLOGY

The Conference,

Mindful of the need for African countries to define long-term national policies in regard to the transfer of technologies,

Considering that the establishment of a national technological potential helps in strengthening a society's sense of integrity and national identity and in consolidating national independence,

Considering the urgency of reducing the technological gap between the industrialized countries and the poor countries and of speeding up the latter's economic and social development,

Considering the extremely heavy financial cost of horizontal technology transfer in respect of patents, licences, know-how and trademarks,

Considering that the range of technologies available in the industrialized countries does not always correspond satisfactorily to the specific problems of African countries,

Recommends:

1. That the African countries give special attention and effective support to scientific and technological research programmes designed to solve short- and medium-term problems that arise in selected areas;

2. That the international organizations and African countries take all necessary steps to ensure that the grant of patents, licences and trademarks and the acquisition of know-how take place on terms that are most favourable to the African countries;

3. That contractual arrangements concerning technology transfer be concluded on an equitable basis;

4. That African States put into effect a strategy affording a wise combination of the two types of transfer process, i. e. combining imported foreign know-how with a national drive towards original technological innovation;

5. That the African States consider the establishment of inter-African enterprises entrusted with negotiating the terms of the importation of technologies and the purchase of equipment.

Recommendation No. 19: APPLICATION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT IN AFRICA

The Conference,

Conscious of the work accomplished by United Nations organizations such as ECA, UNIDO, UNCTAD, UNITAR, etc. in the sphere of technology transfer,

Recommends:

That Unesco and the other United Nations agencies co-ordinate their activities in regard to the application of science and technology to development in Africa and draws their attention, in particular, to the African Regional Plan which has already been approved by all Unesco's African Member States.

Recommendation No. 20: ROLE OF UNIVERSITIES AND RESEARCH INSTITUTIONS

The Conference,

Considering the important part that universities and research institutions have to play in technology transfer,

Recommends:

That a meeting be organized, under the auspices of Unesco, ECA and OAU, in order to examine the rôle of universities and research institutions in technology transfer in Africa.

Recommendation No. 21: TECHNOLOGIES OF POTENTIAL BENEFIT TO AFRICA

The Conference,

Appreciating the work done by ECA and Unesco regarding the identification of technologies of potential benefit to African countries as indicated in the African Regional Plan,

Aware of the fact that the present scientific and technological programmes and future activities involving technology development and technology transfer require in-depth study and documentation,

Recommends that:

1. Unesco, in collaboration with ECA and OAU, make a study so as to identify technologies which might contribute towards attaining the developmental objectives and goals outlined in the African Regional Plan and the World Plan of Action;

2. Unesco and ECA convene meetings at sub-regional level to explore and review the exploitation or development of the technologies thus identified;

3. A central data bank be established by African countries, with sub-regional branches as appropriate, for the storage, analysis and dissemination of information on various imported or local technologies.

Recommendation No. 22: AFRICAN MEDICINAL PLANTS

The Conference,

Conscious of the widespread use of local plants in traditional African medicine,

Aware that African plant materials are utilized in the pharmaceutical industry,

Noting the projects on African medicinal plants and African pharmacopea which are being carried out in various African countries and also under the auspices of the OAU's Scientific Council for Africa,

Recommends that:

1. Unesco, in collaboration with WHO and OAU, provide support for the establishment and strengthening of African research centres engaged in scientific work on medicinal plants;

2. African countries embark on programmes directed towards the economic exploitation of medicinal plants in the local manufacture of pharmaceutical products, with assistance from the appropriate United Nations and other agencies.

Recommendation No. 23: PUBLIC UNDERSTANDING OF SCIENCE AND TECHNOLOGY

The Conference,

Realizing the need to create a public awareness of the importance of science and technology in socio-economic development,

Aware of the rôle which Unesco can play in helping to create this awareness,

Recommends that:

1. Unesco continue to provide the necessary support for the promotion of the public understanding of science and technology in Africa;

2. African countries which have not done so take concrete steps to implement the recommendations of the first African Regional Seminar on the Promotion of Public Understanding of Science and Technology which was held in Lusaka in 1971, under Unesco's auspices. 1/"

1/ Unesco document SC/WS/496: Report of the first African Regional Seminar on the Promotion of Public Understanding of Science and Technology (Lusaka, 15-18 November 1971).

V. SCIENTIFIC AND TECHNOLOGICAL CO-OPERATION IN AFRICA

1. HIGHLIGHTS OF THE DEBATE

There was a general consensus that scientific co-operation in research and development (R&D) has become one of the major topics in the formulation of national science policies, and that such a co-operation would optimize efforts of African countries in the field of science and technology, while also sustaining their cultural and political unity.

As science is universal and knows no national boundary, it augurs well for Africa to foster and strengthen scientific co-operation, both at the regional and the international levels. Isolation might be detrimental to African hopes and aspirations, as not many countries in the continent could alone cover the entire range of R&D, due, partly, to the comparative shortage of African trained personnel, and also, to insufficient budgetary resources. It was pointed out that co-operation, aside from furthering the unity of the continent, will strengthen the scientific potential of each country, thus enabling it to progress towards greater R&D self-sufficiency.

The Conference agreed that many of the existing problems are of common interest to specific groups of countries with ecological homogeneity and therefore lend themselves to solution on a continental or an international basis.

For the solution of these types of problems, intra-African or international co-operation, or a combination of both, might be expected to produce better scientific results.

Intra-African co-operation in science is known in the continent and does exist on a sub-regional or regional basis in several regions of Africa.

Moreover, several African institutions, such as the International Centre for Insect Physiology and Ecology (ICIPE) at Nairobi, provide a basis for both inter-regional and international co-operation.

Before independence, the West African Regional Research Office (WARRO) had established mission-oriented research stations supported by Ghana, Nigeria, Sierra Leone and The Gambia. Other main regions of Africa possessed similar research stations or scientific institutions to undertake and carry out both mission-oriented and discipline-oriented research. It was pointed out that during the last decade there has been a trend away from co-operation in scientific and technological activities, but that this was explained by the fact that each of the African countries was occupied with consolidating its newly-gained independence.

It was also noted that, given the necessary encouragement and scientific environment, with proper facilities and financial support, African scientists can make excellent strides in research and development and a valuable contribution to socio-economic growth through the application of science and technology.

There are other pressing problems where international scientific co-operation is of greatest importance and significance as it reinforces the scientific programmes and activities in Africa, and thus helps to accelerate the process of development and to sustain future scientific progress.

The discussions on the question of co-operation at the Conference centred on the following six broad areas:

(a) scientific research and experimental development (R&D);
(b) scientific and technological services (STS);
(c) scientific and technical documentation and information;
(d) mobility of scientific and technological personnel;
(e) institutional needs of African countries in science and technology;
(f) scientific co-operation between universities.

Some delegations expressed reservations about the Unesco Matrix Method for Identifying Areas for Scientific Co-operation but a number of delegations felt that the replies to the matrix survey, from 20 African countries, would greatly facilitate the dialogue on the issue of co-operation which CASTAFRICA was already generating.

The volumes published by Unesco and respectively entitled: "National Science Policies in Africa" (No. 31 in the series Science Policy Studies and Documents) and "Survey on the scientific and technical potential of the countries of Africa" (Unesco Regional Office for Science and Technology, Nairobi) are useful guides to African countries in determining areas of co-operation. Desire was expressed that these volumes be updated from time to time.

In view of the fact that the existing scientific infrastructure is at various stages of development in many African countries, there was an agreement on the need for discipline-oriented as well as mission-oriented scientific co-operation, and several countries made declarations of intent to foster and strengthen scientific co-operation in specific fields.

Given the extremely vivid interest evinced by the delegates concerning regional and international co-operation in science and technology, the Conference posed itself the question of whether it was possible for it to propose concrete steps to be taken to further such co-operation.

The Conference thus agreed:

(i) that a limited number of fields - say 40-50 - both disciplines and missions, should be identified first and discussed amongst the countries concerned, and fields having topmost priority be selected as a first step;

(ii) that the Unesco regional offices for science and technology in Cairo and Nairobi should be involved from the outset in the process of identification and follow-up, and for this reason be strengthened; and that serious consideration should be given to the setting up of a sub-regional science office for West Africa;

(iii) that the African States concerned with bringing about African unity within the ambit of scientific and technological co-operation should decide to reinforce the functioning of the Scientific Council of the OAU and of its subsidiary organs;

(iv) that OAU, ECA and competent Specialized Agencies of the United Nations should collaborate with Unesco in related activities;

(v) that these joint efforts should lead to the formulation of action programmes based on the recommendations of the Conference;

(vi) that the eighteenth session of the General Conference of Unesco should consider and take appropriate action on the recommendations adopted by CASTAFRICA.

2. RECOMMENDATIONS

Recommendation No. 24: NEED FOR A JOINTLY AGREED TERMINOLOGY AND METHODOLOGY FOR THE IDENTIFICATION OF AREAS OF SCIENTIFIC AND TECHNOLOGICAL CO-OPERATION

The Conference,

Aware that among African countries there are variations in terminology and methodology for the identification of areas of scientific and technological co-operation,

Convinced, thereby, that uniformity of terminology and methodology would in the long run make co-operation among African countries more effective,

Recommends:

That Unesco undertake with the collaboration of OAU and the Association of African Universities a study of terminology and methodology used for scientific and technological co-operation in Africa, with a view to making appropriate recommendations in this regard.

Recommendation No. 25: OPTIONS OPEN TO AFRICAN NATIONS, TO OPTIMIZE BOTH THEIR INDIVIDUAL AND COLLECTIVE INVOLVEMENT IN INTRA-AFRICAN AND INTERNATIONAL CO-OPERATIVE EFFORTS IN SCIENCE AND TECHNOLOGY

The Conference,

Considering possible options regarding co-operative efforts in science and technology,

Convinced that inter-country collaboration and co-operation would enhance the application of science and technology to development, especially the introduction of advanced technologies,

Aware of the limitations of current sub-regional groupings,

Recommends that:

1. African States make determined efforts to institute, at a policy level, inter-country co-operative measures and programmes in the application of science and technology;

2. Unesco, with the co-operation of OAU and ECA, consider the implications of the current sub-regional groupings in so far as they touch upon scientific and technological co-operation, and suggest, where appropriate, new criteria involving ecological similarities and common scientific interests;

3. Unesco convene, in co-operation with OAU, meetings - on a regional and sub-regional basis as appropriate - of research scientists and managers from countries having similar ecological zones and facing problems of common interest, for the purpose of exchanging information and identifying priority projects for implementation on a regional co-operative basis, and also provide assistance for translation services for such meetings.

Recommendation No. 26: IDENTIFICATION OF FIELDS FOR SCIENTIFIC AND TECHNOLOGICAL CO-OPERATION

The Conference,

Convinced that co-operation between African countries in the fields of science and technology is an essential factor in their progress and development,

Considering that the method used in the Unesco Matrix Survey on scientific and technological co-operation facilitates definition of priority subjects for co-operation between groups of African countries,

Believing that this co-operation should not be limited because of geographical or linguistic considerations,

Realizing that inter-African regional co-operation will initially be limited to a small number of fields,

Believing that the results submitted do not clearly bring out the priority fields, especially in regard to scientific and technological services (STS),

Recommends that:

1. Unesco, in collaboration with ECA, OAU and the African Member States, undertake review studies of the fields of co-operation in which African countries have shown the greatest interest, with a view to strengthening existing programmes of co-operation and initiating new ones wherever and whenever the social, political, economic and environmental conditions permit;

2. A working group be set up in respect of each field so identified in order to study the practical and financial modalities of co-operation.

Recommendation No. 27: CO-OPERATION IN THE PROVISION OF FACILITIES FOR TRAINING SCIENTIFIC AND TECHNOLOGICAL PERSONNEL

The Conference,

Aware of the limited resources available to African countries, particularly in the field of training facilities,

Realizing, however, that some African countries are in a relatively better position as far as training possibilities in certain fields are concerned,

Noting that bilateral or multilateral co-operation in the field of training constitutes an integral part of national science and educational policies,

Noting that the Association of African Universities possesses an inventory of the possibilities of African universities,

Recommends that:

1. African countries which possess training experience and facilities in certain fields, be this at the higher or lower level, make their facilities available to other countries wishing to make use of them;

2. Unesco, in collaboration with OAU and with the co-operation of the Association of African Universities and relevant United Nations agencies, facilitate such inter-country co-operation by providing the necessary frameworks in consultation with African Member States concerned.

Recommendation No. 28: FIELDS OF REGIONAL CO-OPERATION

The Conference,

Desirous that African countries make the best use of regional and international scientific and technological co-operation possibilities open to them,

Aware of the increasing number of international institutions whose programmes sometimes duplicate those of the institutions of the regions where they undertake activities,

Recommends that:

1. International governmental and non-governmental organizations, including Unesco, assist African countries in recruiting leading research scientists to train men and women in their home environment, and so contribute to the production of trained people capable of handling their own problems and help to retain them in their own home countries;

2. Regional and international institutions located in the same region of Africa co-ordinate their programmes with similar national institutions in the particular area where they are located or in the region, render support to them and make use of the national high-level staff in their recruitment policies.

Recommendation No. 29: MOBILITY OF SCIENTIFIC PERSONNEL IN AFRICA

The Conference,

Considering the obstacles to scientific and technical co-operation between African countries, such as language barriers and the ties which to a greater or lesser extent often link African scientific institutions to similar institutions in the developed countries,

Aware of the desirability, for each country, of ensuring that its research workers as a whole are constantly alive to the problems of national development, with a view to facilitating the application of existing knowledge,

Noting the important part played by universities and research institutions in the development of scientific and technological research,

Recommends that:

1. Measures be adopted with a view to eliminating language barriers among inter-African organizations and their joint consultation bodies and to reducing the costs involved in research workers' residence in other countries;

2. Steps be taken in the African countries to foster the mobility of scientific personnel within Africa and encourage productive co-operation between existing research institutions and the users of research results in the public and private sectors;

3. Relations be established between African universities and research institutions so as to facilitate exchanges of teaching and research staff and enable research personnel to work together on subjects of common interest, these activities to be developed with the participation of the Association of African Universities.

Recommendation No. 30: UNIVERSITY CO-OPERATION IN THE FIELD OF R&D

The Conference,

Aware that collaboration and co-operation in science and technology are determining factors in the development of the African continent,

Expresses the wish for regular consultations on a sub-regional basis between those responsible for science policy, to be held, for example, every six months;

Proposes joint study, using sub-regional research and development institutes, on specific scientific themes;

Recommends:

1. That African universities establish official relations amongst themselves so that it will be possible to arrange exchanges of teaching staff, make use of trained African personnel in and for Africa and carry out work on subjects of common interest;

2. That OAU and Unesco study the possibility of establishing an African university and advanced research centres along the lines of existing institutions in the other continents, to stimulate and bring about inter-African co-operation by enabling African scientists to return to their continent and contribute to its economic "take-off".

Recommendation No. 31: APPROPRIATE MACHINERY AND ACTION PROGRAMMES AS A FOLLOW-UP OF CASTAFRICA

The Conference,

Aware of the fact that inter-African and international scientific co-operation would maximize the scientific efforts of African countries,

Noting that the shortage of competent scientific personnel represents a handicap to research and development,

Considering the urgent need to formulate projects of common interest at regional and sub-regional level,

Aware of the need for a continuous critical examination of the national science policy machinery of Member States to make it better suited to fulfil the socio-economic targets through the application of science and technology,

Noting the existence of the Regional Plan for Africa which is derived from the World Plan of Action,

Aware of the capital importance of Unesco Regional Bureaux for Science and Technology in helping Member States in their scientific and technological endeavours,

Convinced that the main working document of CASTAFRICA (SC/CASTAFRICA/3) contains valuable material for those involved in the formulation of national science policy and R&D programmes, and taking into account the observations made about this document as well as considering the importance of the General Declaration of Dakar which has permitted the definition of the framework within which scientific and technological progress in Africa should take place,

Affirming the imperative and urgent need for African countries to implement the recommendations adopted at this Conference, and aware of the fact that Unesco and other agencies cannot initiate any worthwhile action on the implementation of the recommendations until they have been ratified by the General Conference of Unesco,

Recommends that:

1. African countries provide more support to the funding of the existing African agencies and establish closer co-operation amongst themselves for the purpose of training a large number of research workers in order to meet, within a relatively short period, the required needs of the continent;

2. African countries with common interests and problems draw up mission-oriented joint projects and take the necessary steps for their implementation. either on their own, or by channelling them through bilateral or multilateral financial sources;

3. Unesco, with the co-operation of OAU and ECA, convene meetings, from time to time, of the heads of African science policy-making bodies at sub-regional and regional levels, as appropriate, to discuss common problems;

4. The Regional Plan for Africa prepared within the framework of the World Plan of Action constitute the basis for the follow-up action with regard to inter-country co-operation in the application of science and technology to development, and that a joint programme be worked out between Unesco, OAU and ECA to ensure harmonious co-ordination in this respect;

5. Unesco co-operate with OAU and ECA in implementing the proposals concerning inter-African centres of excellence for research and training so as to induce African scientists to return to their continent and contribute to its economic development;

6. The Unesco Regional Bureaux for Science and Technology in Africa be strengthened considerably - including by means of the possible establishment of a sub-regional bureau for West Africa - so that they can respond more effectively to the demands of the various Member States, and be responsible for following up the recommendations of CASTAFRICA so as to ensure that they are implemented;

7. Unesco take appropriate steps to publish document SC/CASTAFRICA/3, taking into account the conclusions and the recommendations adopted by CASTAFRICA as well as the observations made, and ensure its wide distribution amongst Unesco Member States;

8. The Director-General of Unesco take the necessary steps to present the recommendations and resolutions adopted by CASTAFRICA at the eighteenth session of the General Conference of Unesco, with proposals for their implementation during the 1975-1976 and subsequent biennia.

ANNEX I

AGENDA

1. Inauguration of the Conference
2. Election of the President
3. Adoption of the Rules of Procedure
4. Adoption of the Agenda
5. Election of the Vice-Presidents and of the Rapporteur-General of the Conference
6. Organization of work of the Conference
7. Trends of science and technology policies in the countries of Africa
8. New technologies: possibilities for their development and application in Africa
9. International and regional co-operation, in Africa, for the promotion and strengthening of:
   (a) scientific research and experimental development
   (b) scientific and technological services
   (c) scientific and technical documentation and information
   (d) mobility of scientific and technological personnel
10. Adoption of the recommendations and final report of the Conference
11. Close of the Conference

ANNEX II

ADDRESSES PRONOUNCED AT THE OPENING OF THE CONFERENCE

Address by Mr. René Maheu

Address by H.E. Mr. Léopold Sédar Senghor

Address by Mr. René Maheu,
Director-General of the United Nations Educational,
Scientific and Cultural Organization

Mr. President of the Republic
Your excellencies,
Honourable delegates,
Ladies and gentlemen,

It is a great honour for me and it gives me great satisfaction to open this Conference of Ministers of African Member States Responsible for the Application of Science and Technology to Development.

The Government of the Republic of Senegal, which lays great store by its policy for science and technology, has generously offered to act as host to the Conference, and we could indeed have found no more appropriate setting for it than this radiant city of Dakar, so unreservedly at the service of international understanding. I am sure, therefore, that I speak for you all when I express our warm gratitude and our high esteem to His Excellency Mr. Léopold Sédar Senghor, President of the Republic, whose gracious presence here further enhances the splendour of this opening meeting.

I should also like to express my gratitude to the members of the Senegalese Government and their colleagues who have so efficiently seen to the material side of the Conference's organization, and to President Amadou Cissé Dia who has consented to making this magnificent Palace of the National Assembly available to us.

I am happy to welcome the numerous delegations assembled in this amphitheatre, many headed by a Minister, and also the observers from non-African Member States, intergovernmental institutions and international non-governmental organizations, whose presence attests to the interest which the scientific and technological development of Africa arouses throughout the world.

Finally, I should like to address a special word of welcome to Mr. G. Kamanda, Deputy Secretary-General of the Organization of African Unity, and Dr. David Wasawo, Chief, Natural Resources Division, United Nations Economic Commission for Africa, who have given Unesco valuable assistance in the preparation of your meeting. May I thank them here publicly for their support.

Ladies and gentlemen,

This Conference, convened in accordance with resolution 2.121 adopted by the General Conference at its seventeenth session, is the culmination of a series of regional meetings which have been organized by Unesco in Africa on problems relating to science and technology policies, the first such meeting having been held in Lagos in 1964.

How much progress has been made in ten years and how much there is for Africa to be proud of! The report before you entitled National Science Policies in Africa gives evidence of this in a very striking way. This report brings out one encouraging feature in particular, which is that the scientific and technological activities of African countries are being more and more closely co-ordinated with national development plans. Whereas the Lagos conference showed that most African States were handicapped through not having governmental bodies to formulate, promote and pursue a scientific and technological policy at national level, we find today that out of the 38 African States that are members of Unesco, 24 have a Ministry of Science or a body to direct national science policy. And, let it be said in passing, it is thanks to the co-operation of these governmental bodies that it has been possible to assemble the detailed and factual documentation which you have before you. We are most grateful to them for this.

Nevertheless, it is not enough to be in a position to make plans for scientific research. It is also necessary to be able to carry them out. Some sceptics still think that Africa's capability in this respect is insignificant, but what is the truth? The Survey on the Scientific and Technical Potential of the Countries of Africa, published by Unesco in 1970, shows that there were then over 700 establishments conducting research and experimental development work in Africa. These establishments employed over 6,000 full-time research workers, whether scientists or engineers, assisted by 5,000 others working on a part-time basis and by about 20,000 technicians. This brought to at least 30,000 the total number of those engaged in research and experimental development in Africa.

Furthermore, recent statistics gathered by Unesco show that Member States in the region are spending about $270 million each year on their research and development activities. It is true that this sum represents only 0.5% of total world expenditure in this field, but while there are some people who persistently maintain that scientific

research is an expensive luxury which African countries would be well advised to abandon, at least for the time being, the essential fact, in my opinion, is that the movement is under way, that it is growing and that science and technology are establishing themselves in the intellectual life of your countries and in their practical achievements. The foundation now exists and everything must be done to reap the maximum advantage from this effort and what it has already achieved in order to enhance its effectiveness and extend its benefits to all by increased scientific and technological co-operation at regional and international levels.

We should, in this connexion, call to mind the impetus provided by the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, held in Geneva in 1963. This impetus is being carried on today in the World Plan of Action prepared by the United Nations system as a whole under the aegis of the Advisory Committee on the Application of Science and Technology to Development (UNACAST), and adopted by the United Nations General Assembly in 1971. Under this World Plan, a regional plan for Africa was drawn up at the end of 1972 by the UNACAST Regional Group for Africa - whose distinguished Chairman, Mr. W.K. Chagula, I am happy to greet here - with the co-operation of the United Nations Economic Commission for Africa and all the Specialized Agencies of the United Nations operating in the region.

In this concerted effort Unesco assumes the main responsibility for questions concerning scientific and technological policy and institutions. And this has been the principal theme of the conferences of Ministers Responsible for the Application of Science and Technology to Development that Unesco has organized successively in 1965 for Latin America, in 1968 for Asia, in 1970 for Europe and, today, for Africa.

For this Conference the Secretariat has chosen, on the basis of the recommendations of the preparatory meeting held in Nairobi in 1971, three major themes of discussion.

The first, corresponding to item 7 in the provisional agenda entitled Trends of science and technology policies in the countries of Africa, will enable you to take stock of the present position by reviewing both the results achieved and the difficulties encountered.

You may perhaps wish, in this respect, to consider whether sufficient regard has been paid to the work done in science and technology in the establishment of national development plans and, conversely, whether such plans give an adequate place to research and experimental development. Similarly, you will probably wish to study the characteristics of the bodies set up to formulate and implement your science policies and to ask yourselves if these organizations are completely satisfactory or whether certain measures should not be taken to improve their effectiveness.

These questions, as you know, are of practical interest. Most Member States in the region have already established machinery with a view to bringing science and technology policy within the sphere of governmental action. And, to judge from the requests for technical assistance reaching Unesco, everything leads us to believe that very shortly all African countries, even the least privileged, will have adopted provisions to this effect. My satisfaction is all the greater since I see in this the endorsement of an idea which the Organization is proud to have been the first to put forward, namely, that there is no country which can fail to benefit from the possibilities of development offered by science and technology and that, for this purpose, scientific activity must be rooted in the nation's life in accordance with a rationally defined policy. Naturally the creation of institutions and the allocation of resources are closely bound up with the means at each country's disposal, but whatever such means and whatever the socio-economic system, the measures to be taken imply, at all events, action on the part of the public authorities.

In order to provide a frame of reference for governmental decisions in the coming years, the Conference might, I believe, establish a few major targets in regard to the size of the human and financial resources to be assigned to scientific research in Africa and, in particular, give its views on the number and type of scientists and engineers, and the scientific and technical facilities, that Africa will be likely to need between now and 1980. In order to assist your discussions on these matters the Secretariat has provided you with precise data in Chapter I of the main working document which is submitted to you under the title of Science and Technology in African Development.

I come now to the second major theme. This is item 8 of the agenda, entitled New technologies: possibilities for their development and application in Africa. The problem raised here is that of the transfer of science and technology. I do not need to tell you how important this problem is. Not only does it entail decisions of a delicate political and economic nature regarding the source of imported technologies, but, in addition, it raises the basic question of suitability of these technologies. Every foreign technology which is not suited to the specific possibilities and needs of its users is destined to remain an alien element whose potential cannot be exploited as it should and whose entry onto the scene may even result in dangerous tensions and distortions in the general development of the country.

At the present time the world is assigning some 65 thousand million dollars annually to research. Of this amount the developing countries are spending approximately two and a half thousand million dollars, which includes, as I have just mentioned, some 270 million dollars in respect of African Member States. These figures, whose relative size it is sufficient to bear in mind, show that from now until the end of the century - a crucial period during which the search for a new mode of organization and a new balance in the use of natural resources and power supplies will be imperative - it will be more especially in the industrialized countries that the new knowledge, in

particular, will be acquired. In these circumstances, what will be the attitude of the African countries in regard to this problem of acquiring new technologies? Should they count essentially on their own research efforts? Should they rely exclusively on imported science and technologies? Would it not be advisable for them to attempt to combine these two approaches?

It seems reasonable to suppose that this combined approach will be the one that is found to appeal both to African wisdom and to international solidarity. But the transfer of new technologies to Africa raises the twofold problem of what technologies are to be imported and how such transfer should be arranged. As to the choice of technologies suitable for conditions in Africa, the Secretariat has called on the imagination of some sixty African and non-African experts whom it has consulted by means of a Delphi survey carried out over a period of some four years. The detailed results of this survey are set out in one of the reference documents prepared for your Conference, SC/CASTAFRICA Ref. 2, entitled Technologically feasible futures for Africa, a photographic summary of which is provided in the exhibition arranged in this Palace.

With regard to the arrangements that should be made for the transfer of new technologies and their implantation in Africa, these form the subject of Chapter II of the main working document. You will find there a digest of current ideas in this domain as well as a series of questions which your Conference might usefully consider, particularly in regard to the transfer of scientific and technological information. May I recall in this connexion, that Unesco has been working since 1972 on the setting up of a world science information system (UNISIST) which is of very great interest to the developing countries. I earnestly request you to follow closely its practical developments so that you may draw the greatest possible benefit from them.

These questions stress the importance of international co-operation - on both a regional and world-wide level - for the development of science and technology. Hence the third and last topic included in your agenda, namely item 9 entitled International and regional co-operation in Africa.

In order to assist your discussions on this subject, the Secretariat has carried out two surveys, the conclusions of which are summarized in Chapter III of the main working document.

The first of these referred to science and technology sectors in which each African State has expressed its readiness to co-operate with other States indicated by name. The replies to this survey made it possible, for the first time in Africa, to establish on a country-by-country basis, "scientific and technological co-operation matrices", juxtaposition of which reveals the preferred fields of co-operation with selected partners.

The second survey deals mainly with the relationships between African countries and both multilateral and bilateral assistance. It forms part of the World Plan of Action for the Application of Science and Technology to Development, and Unesco was entrusted with its implementation at UNACAST's request as far back as 1971. It represents an initial inventory of the institutional needs of African Member States in the field of science and technology.

The detailed results of these two surveys have been made public in the form of reference documents which have been made available to your Conference.

The data which you thus have before you should provide you with the means - this is at least what I hope will be the case - of tracing the main outlines of a programme designed, first, to intensify inter-African scientific co-operation and, second, to provide a framework, established on the basis of your needs as you yourselves know them to be, for international assistance to Africa. To implement such a programme Unesco is, I can assure you, ready to carry out in full the central rôle that it can justifiably be expected to assume having regard to the vital place that science, education and culture occupy in development. It is for you to take advantage of the possibilities that Unesco offers you, by defining the objectives to whose achievement you wish to see its action preferably directed.

Ladies and gentlemen,

Whether we are thinking of the general conceptions on which you will agree, and which will be summed up in the form of conclusions in your Rapporteur-General's report, or of the directives that you will certainly wish to set out in regard to action to be taken, by adopting recommendations addressed, in the first place, to your own governments, on whom the vital decisions depend, and, secondly, to the international or regional organizations, in particular Unesco, the results of your discussions are, I am convinced, fated to mark an important, perhaps even capital stage along the road towards your countries' development and independence. For whereas culture is, admittedly, the source of your identity, only science, whose flowering it is the principal task of modern education to bring about, can, as you well know, at long last restore to you the intellectual and practical means of active participation in shaping the destiny of the world.

It is with these thoughts in mind that I wholeheartedly express my warmest wishes for the success of your work.

Address by H.E. Mr. Léopold Sédar Senghor,
President of the Republic of Senegal

Mr. President of the National Assembly,
Mr. Prime Minister,
Mr. Director-General of Unesco,
Mr. Secretary-General of the OAU,
Mr. Executive Secretary of the ECA,
Your Excellencies,
Ladies and Gentlemen,

I am particularly happy to welcome all the African delegations assembled here and to assure them of our unity of purpose with the great African family.

May I, on the occasion of this Conference, express the feeling of recognition shared by the African States towards the United Nations Educational, Scientific and Cultural Organization and, first and foremost, its Director-General. Indeed, Mr. René Maheu has at all times given us effective aid in our effort to assimilate scientific and technological discoveries for the purposes of our economic and social development.

I should also like to thank the representatives of the other international organizations present here for the interest that they have shown in our country and for the assistance that they have provided in attaining the targets adopted in our development plans.

Science and technology and international and regional co-operation in these sectors are going to be the themes of your discussions. I propose that you dwell with me for a moment on these problems in order to identify their main trends and, most important of all, establish principles of action.

We shall begin by removing the confusion between technique and technology, a confusion that often occurs today, thus conferring a certain prestige on the latter term. A technique is a set of processes used to produce a specific object or result, whereas technology attains the level of science. It is the general study not merely of techniques, but of machines, tools and materials as well.

We should, I also believe, remember that we are living in the era of homo sapiens, from whom all human beings are descended and that science and technology should contribute, thus, to the greater welfare of man but not conduce to his annihilation or subservience. How can we silence our concern when we note that scientific research budgets for military purposes are continually growing in the majority of the industrialized countries. The amount spent today on military research in the six most highly developed countries exceeds 25 thousand million dollars annually and if we add to this figure these countries' arms expenditure, we reach the staggering figure of 250 thousand million dollars. To take the first figure, 25 thousand million dollars per annum to perfect the means of destroying man represents, by and large, the gross domestic product of all the African States invited to take part in this Conference.

We cannot be other than taken aback by a revelation of this kind, for our requirements, in order to ensure the development of our States, are vast. Indeed, the characteristic feature of our countries, for the most part, is a predominantly agricultural economy and we are, thus, largely dependent not only on climatic conditions but on the world price situation as well. I have on many occasions referred to the considerable fluctuations in our export revenue and the ensuing difficulties for the financing of our development plans. In the case of Senegal I have shown that the overall loss for our economy due to the deterioration in terms of trade, has been just counterbalanced by external aid, received in the form of donations, loans and technical assistance.

I have referred to the caprices of our climates. For the past eight years, in fact, a fiendish drought cycle has swept the countries in and even well beyond the Sudan-Sahel zone, bringing our economies face to face with well nigh insurmountable difficulties. In the past our zone has experienced severe periods of drought, particularly from 1862 to 1870, during which entire populations have been wiped out. Today - and this is what provides comfort - a generous movement of solidarity has made itself felt throughout the world within both the international organizations and the countries which are our brothers or friends.

In the face of calamities of such vast proportions, often aggravated by a prodigious population explosion, it is not surprising that our scientific and technological possibilities must be basically slanted towards the seeking of practical solutions.

The need for a strictly formulated science and technology policy did not become apparent in the majority of our countries - any more than it did in several industrialized countries - until after the last world war. In fact, the acceleration of scientific progress is a relatively recent phenomenon in the world, and has been reflected in the daily lives of the inhabitants of the developed countries in spectacular improvements in the level, and particularly the quality, of life. We must stress, however, that these improvements often involve a wastage of natural resources due to the abuses of the consumer society civilization, not to mention the various instances of pollution on which I shall not enlarge.

Subject to these reservations it is clear, none the less, that scientific and technological progress is one of the most important factors in development, in Africa as in Europe, whether we are thinking of agricultural and industrial production, transport and communications, hygiene and public health, or housing and community facilities. Since the beginning of the century, the expectation of life has everywhere increased. In every part of the world, in spite of the difficulties that still exist, man is more prosperous in 1974 than he was a hundred years ago. All this progress is due, essentially, to the improvement of knowledge and expertise, to the building up of mankind's capital of knowledge. Are we sufficiently aware that half the number of scientists who have existed are still living today?

With the spread of scientific and technological progress to our States, bringing in its train an increased awareness of new needs, it was only natural that African Governments should seek to extend their concern to scientific matters. With the assistance of politicians, of course, but above all of economists, sociologists, planners and scientists themselves, our governments are trying to plot the future course of science so as to guide the way in which it develops, are working towards a policy for science, still more towards an actual science policy.

Thus, over the past few years, most of our States have set up machinery to control scientific policy, whether interdepartmental research councils, National Commissions, ministries or State secretariats. Our aim in the last resort is to work out a national strategy for scientific and technological development as a function of economic and social development. In practice the problem is to forecast and at the same time formulate both long- and medium-term scientific and technical development so as to know what human and financial resources should be devoted to the different research sectors.

In Senegal we have made a start by reforming education, giving the top priority to mathematics. Even before this reform, however, we set up by decree of October 1966, an interdepartmental council for scientific and technical research. Since the constitutional reform of 1970 this council has been presided over by the Prime Minister. At its regular meetings, held at least once a year, all the Ministers responsible for supervising the various research institutes are represented. The planning and co-ordination of research programmes is the responsibility of a delegate-general for scientific and technical research, who is attached to the office of the Prime Minister and works in close conjunction with the Minister for Planning and Co-operation. The interdepartmental council has been given the task of co-ordinating all scientific and technical research activities carried out in Senegal, ensuring that they conform to the priorities laid down in the "Plan for Economic and Social Development" and, lastly, taking any necessary action for the recruitment and training of research staff.

Most African States have had to face the problem of the status of research workers. In Senegal we have adopted an interim measure, encouraging officials who are seconded to research institutes by awarding them special allowances.

The fact remains that the staff and funds we can devote to research are not unlimited. We, therefore, have to exercise great care in selecting and drawing up our research programmes, our aim being to speed up our development not only in the economic and social but also in the cultural spheres.

With 33% of its budget earmarked for education, training and culture in general, Senegal devotes rather more than 1% of its Gross National Product to scientific and technical research. To date, the aid of the former colonial power has been decisive. However, with the interest which other friendly nations, and also the United Nations, are taking in our programmes, we are currently moving towards a diversification of aid.

Our goal for the year 2,000 in this field is not only to have good research teams but above all to have African research schools of international standing in fields differing as widely as mathematics and linguistics, economics and agriculture, human and veterinary medicine, fishing and environmental studies.

Naturally we must continue to pay close attention to the pioneer work being done in science and technology in the industrialized countries with a view to adapting it to our own countries' peculiar needs. That does not mean we wish to remain dependent on others in this respect, with all that it involves for our balance of payments, in patents and licences. On the contrary we are resolved ourselves to explore more deeply in certain areas most relevant to the problems specific to our environment - the utilization of solar energy, the control of pollution, the development of new strains of plants suited to the Sudano-Sahelian climate, etc.

Ladies and gentlemen,

During this Conference you are going to discuss problems of international and regional scientific co-operation, bearing in mind that in Bacon's words "Knowledge is power". Scientific co-operation between our States affords, in my view, unique opportunities for dialogue, by virtue of which we can together advance along the road of progress. I am convinced that a major step forward along this road will be made here at this

Conference. But for us Africans science must be imbued with the human spirit. The progress of science and technology must serve the flowering alike of individuals and societies. Whether in the field of education, employment, agricultural progress, water management, the control of pollution or industrial development, we are conscious of the decisive contribution that can be made by science but at the same time of the ethical requirements of African civilization, in its dual aspect, Arab-Berber and Negro-African.

It is in this profound conviction that I salute your Conference and wish it every success in promoting the development of our continent, one and undivided thanks to our common resolve.

ANNEX III

ADDRESSES PRONOUNCED AT THE FIRST PLENARY SESSION

Address by Mr. G. Kamanda Wa Kamanda

Address by Dr. David Wasawo

Address by Mr. G. Kamanda Wa Kamanda
Deputy Secretary-General of the Organization
of African Unity

Mr. President,
Mr. Director-General,
Your Excellencies,
Ladies and Gentlemen,

I should like, first of all, on behalf of the Secretary-General of the Organization of African Unity, to express our sincere gratitude to the President of the Republic, His Excellency Léopold Sédar Senghor, to the Party and to the Government and people of Senegal for the very warm welcome that they have given us, a welcome that in every way reflects the best traditions of African hospitality.

May I next thank the distinguished Director-General of Unesco, Mr. René Maheu - a man whose brilliance, culture, lucidity and resolve to put Unesco's ideals into practice, have always captured our imagination - for having been good enough to associate the Organization of African Unity in the preparation of this Conference.

The fact that we can today publicly congratulate ourselves on the excellence of the co-operation that exists between Unesco and the OAU is, we know, largely due to the presence at the head of Unesco of a man who loves Africa.

Mr. President,
Mr. Director-General,
Your Excellencies,
Ladies and Gentlemen,

The time at which this Conference is taking place cannot fail to influence our approach to the question of the application of science and technology to development. During the course of the last eight months, Africa and the world as a whole have experienced far-reaching changes in respect of attitudes, and as regards the political, economic, trade and monetary situation.

In February 1973 at Accra, on the occasion of the second Conference of Ministers of ECA, and in May 1973 at Abidjan, when the first African Ministerial Conference on Trade, Development and Monetary Problems was held, the OAU drew the attention of African countries to the fact that 1973 was, within the context of their evolution, a decisive year which would give them the opportunity to join in challenging the international economic, trade and monetary order whose flagrant injustices, we said then, risked producing a deep-seated feeling of frustration with serious consequences for international peace and security.

This was, then, a way of inviting all, rich and poor, the powerful and the weak, to take part in a productive exchange of views in the interests of mankind and a fairer organization in regard to co-operation among the nations.

Events have proved that those who held such views were in the right and have - we hope - convinced the sceptics.

The Yom Kippur war was sufficient to provide the Arab countries with the opportunity of using oil as a political weapon and thus bring about a new realization of the situation among the countries which are the raw material producers.

As Paul Streeten has so well put it: "There are vast untapped sources of bargaining power in the developing countries provided they are willing to unite".

This fact seems to be realized by the Third World countries and by Africa in particular, more than it was previously.

Thus, the world economic and trade order established on the basis of obsolete agreements and texts dating back to the beginning of the century has ceased to exist, through the fact that the young nations have reached a state of thorough awareness and are determined to occupy the place to which they are entitled among the nations.

The direct and indirect consequences of the Yom Kippur war have, throughout the world at large, pitched us onto the threshold of a new age.

We must realize that the era shaped by the ideas of the last century, the ideas of a generation, is coming to its end.

We have, therefore, not only to fashion the principles of the world of tomorrow but in addition - and this is, I would say, all-important - prepare ourselves to live by them; in other words, to believe in the new values of a universe striving to secure greater justice.

Whereas on the one hand the developed countries have realized that they are no longer invulnerable giants, the world's overseers, the developing countries, for their part are aware today that they are not devoid of assets. For after the

question of oil, they are necessarily going to turn to other important raw materials.

This is why no-one can maintain today, with the certainty of yesterday, who is poor and who is rich, who is weak and who is powerful. The raw material and oil-producing countries are guided, in their actions in this respect, not by the wish to diminish the quality of life in the developed countries, but by the desire to expose a genuine issue. We must set about remedying a situation which has, up to now, been characterized by the principle of might is right instead of by the force of justice.

There is thus now a genuine possibility of renewing the world order.

In fact, assisted by the international détente brought about by the initial action of the countries of Africa and the Third World, i.e., the non-aligned countries, the nations in the northern hemisphere are reorganizing the structure of their various relations in order to maintain their advance over the developing countries.

The nations in the southern hemisphere on the other hand - and the fourth Conference of non-aligned countries in Algiers has proved this abundantly - wish to set against this reorganization in relations between the northern hemisphere countries the unity and common resolve of the poorer countries, the oppressed peoples of yesterday, irrespective of their political and ideological divergencies or language differences - which cannot, in any case, represent an obstacle to co-operation - in order to find common solutions to common problems.

This evolution in the international situation, by creating effective conditions for discussion and negotiation among the developed countries and the under-equipped nations, should lead to a new concept of co-operation, free from the after-effects of the past as reflected in superiority or inferiority complexes, and seen as the equitable and rational organization of global interdependence.

It is my view that even the establishment of a consortium of consumer countries could not gainsay the developing countries' growing awareness of their power or the transformation of the world scene which is now in progress. And no sane man would assume the grave responsibility of resorting to the gun-boat in order to restore absolute injustice.

It is clear that all these momentary difficulties, all the problems of our time that stem from the existence of unjust relations between the developed countries and the others revolve around the question of development.

Africa would like this development to be smooth, balanced and integral, involving as it does a comprehensive process covering the transformation of structures in which the political aspect is no less important than the economic, just as the economic aspect has equal status with the cultural.

Mr. President,
Mr. Director-General,
Your Excellencies,
Ladies and Gentlemen,

This is, then, the situation and the context in which this Conference of African Ministers Responsible for the Application of Science and Technology is placed.

As the title of the Conference itself clearly indicates, it is within the context of African development, an accelerated, smooth and integral development, that we must tackle here the problem of science and technology.

This Conference is being held at a time when the premises on which Africa has, over a period of ten years, based its development, and viewed co-operation among nations, are in the melting-pot.

The context of our proceedings is thus clearly defined. This means to say that the task of this Conference will be to identify the contribution that science and technology can make to the acceleration of development in Africa, the development that Africa desires.

In other words the conditions that science and technology must fulfil to serve African development have to be defined.

As we stated at Port-Louis, Mauritius, on the occasion of the meeting of the OAU commission on education, science and culture: "Science, technology and techniques are the channels through which development necessarily takes place.

But varying levels of development are not necessarily served by the same science, the same technology and the same techniques.

Illiteracy, cultural backwardness, inadequacy or unsuitability of educational systems in regard to the aims pursued, can represent serious obstacles to the spreading of the innovatory ideas that science and technology bring with them.

Science is the prodigious and unceasing effort of man who refuses to admit the existence of the unknowable and who braves the unknown. We must therefore encourage the inventiveness, initiative and creativity of Africans and - this can never be repeated too often in regard to our development process - stress the need to use African specialists and experts in preference to others of equal ability for the simple reason that our own people vibrate to the throbbing beat of African culture, anguish and concern".

It is not, thus, a question of transferring techniques for the sake of transfer or of acceding to international conventions on the protection of patents or intellectual property because that is the thing to do.

It has been proved that the organization and technology that accompany foreign capital destroy employment openings more rapidly than new opportunities can be created. Vulnerability in regard to economic pressures and unregulated variations in the price of basic products is still further aggravated and the captive economies, instead of being effectively aided, are transferring an increasing volume of their resources and are thus aiding the industrial world to a greater and greater extent.

It has also been established that dependence in regard to foreign methods and plant or technical assistance has an enslaving effect in the same way as a drug, and increasingly widens the gulf between the westernized parasite towns and the rural zones, abandoned to their frustration. It becomes difficult in this case to remedy lack of self-confidence stemming from dependence. Incessant encouragement to adopt western attitudes, techniques and incentives stifles all possible attempts to foster a certain independence of action. The decisive power of foreign economic forces thus short-circuits the effort to seek creative potential in the inherited ways of thought.

The powerful economies of the developed countries exert a pull which brings our economies within their orbit and imposes structural limitations on them unless they are self-sufficient as far as basic needs are concerned.

It would be quite possible in these circumstances that the African countries, like those of the Third World in general - although Latin America is in a different position in this respect - should themselves block their march towards progress.

For this reason a way must necessarily be found to draw on the far-reaching and infinite resources of the African's creative capability.

It is difficult not to recognize that the transfer of modern techniques to poor countries is often effected in an ill-advised manner.

As Paul Streeten has very pertinently pointed out: "Modern technology is partly inadequately communicated to the poor countries and partly inappropriate to their factor endowments and their physical, social and cultural conditions. (Technologies) that are capital-saving, efficient and physically and socially appropriate to underdeveloped countries often do not exist. They have to be invented..."(1). It has been found that only a negligible percentage of major expenditure on research and development is at present devoted to inventing an appropriate technology.

The rapid transfer of certain methods and techniques can sometimes mean transferring too easily those that are not suited to the country, those which may result in increasing unemployment, underemployment, inequality and underinvestment.

What is therefore necessary is:

to mobilize resources for an appropriate technology;
to build up locally a technology or, more exactly, a technical capability that can be successfully grafted onto existing methods on the human, social and national planes;
to take steps to halt the brain drain from the African continent;
to attach more importance to discovering and putting into effect productive forms of technology;
to identify all obstacles to the application of science and technology with a view to eliminating them and ensuring that technology is effectively harnessed to the cause of development;
to organize close co-operation between African universities and research institutes, in particular the participation of academic personnel in applied research;
to organize the co-operation of government departments, trade and industry, universities and research institutes with a view to the training of African scientists;
to ensure that the results of local scientific and technological research are put to use in the production sector and for this purpose to promote co-operation between scientists and financial institutions in order to stimulate the application of research results to economic, industrial and other projects;
to have recourse to African scientists and other technical personnel in regard to specific applications of science and technology to African development (too often there is a tendency to use foreign specialists instead of training African scientific personnel).

Furthermore it is absolutely necessary to organize inter-African scientific and technological co-operation, to ensure that the different African countries' activities in this field are coordinated and to take concerted action at regional or sub-regional level for using the results of African research in carrying out multi-national projects for industrial, agro-industrial or agricultural development.

We remain convinced that mobilization of the continent's immense human resources with a view to promoting and guiding African constructive inventiveness will make it possible to speed up the transformation of African economies and to obtain for our peoples a rapid improvement in their living conditions.

It is in this spirit that the African Declaration on Co-operation for Development and Economic Independence adopted at the 10th Regular Session of the OAU Conference of Heads of State and Government invites Member States:

to ensure that the entire population will have a right to education and training suited to African conditions as a result of teaching conforming to Africa's needs and development goals;
to direct the programmes of universities and institutes towards the fundamental research needed for bringing about in due course scientific and technological independence and also towards applied research with a view to radical transformation of the environment in the interests of development;
to put an end to the brain drain and as far as possible ensure that trained African staff return to their countries, thus eliminating in the near future technical assistance from outside the continent, the aim of which, as has been said, should be to pave the way for its own disappearance;
to give their full support to the programme of the Association of African Universities and other organizations engaged in promoting co-operation in research and training (in those areas where there is a particularly acute need) or in studying

(1) Paul STREETEN: "Terms of trade are not made on paper". CERES, FAO Review - Vol. 5 - No. 2 - March/April 1972.

economic, social, cultural, scientific and technological problems of special importance for the development of Africa;

to eliminate obstacles to the transfer of appropriate techniques and knowledge so as to ensure that such transfer takes place on acceptable conditions and check the restrictive practices that impede it;

to intensify industrial, scientific and technical co-operation between African countries, for more importance should be attached to matters of common interest transcending the national frontiers of our States than to occasional concessions on the part of the rich nations.

The need for an intensification of inter-African scientific and technological co-operation does not express a turning in upon ourselves, for we really believe in international co-operation. But in order to recover our identity and self-respect, we must change the very trend of our economies. Instead of looking to the outside, our economies must be directed within and be more concerned with solving local problems than with facing up to the results of contact with the industrial world. For this reason each country should find its own path to development and try using local methods and techniques.

All that is needed is to profit from our experience and to rely basically on ourselves as far as development is concerned. Moreover, we would not be the first in history to draw in on ourselves in this way for this purpose.

In this connexion, Paul Bairoch has very rightly pointed out that: "While it would be an illusion to hope that the economic history of the industrialized countries might furnish simple recipes for solving the problems of underdevelopment, it would be absurd - and dangerous to boot - to ignore the lessons that can be drawn from (their) take-off experience ... Many seem to admit - explicitly or implicitly - that the periods of protectionism are but accidents in the history of the trade policies of developed countries; short-lived phenomena that disturbed a basic situation in which free trade reigned supreme. Now, the actual facts are quite different. In international trade, it is liberalism which has been the accident, or accidents, and protectionism the constant"(1).

To all intents and purposes this is true, for leaving aside certain periods in the development of the United Kingdom - an exception that confirms the rule - it is a fact that in the 200 years from 1750 to 1950, for virtually all the countries that are at present industrialized, the free trade interludes did not last even twenty years.

The leading champions of laissez-faire and free trade had also discovered the numerous advantages afforded by the protectionist barriers behind which they sought protection.

As Paul Streeten reminds us: "It is now more than twenty years since PREBISCH, SINGER and MYRDAL proclaimed the thesis that the poverty of the poor countries is largely the result of bad and worsening terms of trade between their primary exports and their manufactured imports".

The three writers in question recommended that in order to escape from the dependence in which they thus found themselves, the developing countries should embark on import-substituting industrialization behind the protection afforded by customs barriers.

Mutatis mutandis, what is said here in regard to economic and commercial development applies no less to scientific and technological development.

But for this purpose Africa needs courage and determination.

If the use of a paraffin lamp seems nowadays more commonplace in Africa than in the west, the reason possibly is that science and technology, which must be used for peaceful purposes, should not be given precedence over other social values either and so lead to a machine-like society in which man is crushed and science and technology, instead of being his tools, become his masters.

Science is and must be at the service of man, and man is not and must not be the slave of science and technology.

It is for us to find and define the necessary balance between the two.

Mr. President,
Mr. Director-General,
Your Excellencies,
Ladies and Gentlemen,

Such are the remarks which I wish to make on behalf of the Secretary-General of the Organization of African Unity, as this important conference begins its work.

To you, Mr. Director-General, I should like to say that once again you are to be praised for having posed the right question at the right time.

We know, moreover, that in our search for appropriate means of bringing about the scientific and technological independence of Africa, as in our search for ways in which science and technology can effectively contribute to the rapid and harmonious development of a truly independent Africa, we can count upon you and upon the experience of Unesco which has already given full proof of its readiness to serve Africa.

In closing, I venture to hope that by virtue of the conclusions it arrives at, this Conference will mark a milestone in the history of African development.

Long live international co-operation.

Long live the Organization of African Unity.

(1) Paul BAIROCH: "Free trade, myths and realities". CERES-FAO Review, Vol. 5, No. 2. March/April 1972.

Address by Dr. David Wasawo
Chief, Natural Resources Division
United Nations Economic Commission for Africa

Mr. President,
Honourable Ministers,
Your Excellencies,
Ladies and Gentlemen,

The Executive Secretary of the Economic Commission for Africa, Mr. Robert Gardiner, has asked me to convey his deep-felt regret at not being with us at this important meeting, as he has to be in New York for meetings with the Secretary-General of the United Nations. He has, however, asked me to represent him and to read, on his behalf, the address which he himself had hoped to give.

It is a pleasure for me to address this august assembly which has convened here to deliberate over one of the central issues in African development during the Second Development Decade, namely, the application of science and technology to development.

The Economic Commission for Africa has the mandate within the United Nations system for promoting and assisting the economic, social and technological development of the African countries. Unesco on its own side has the general mandate to promote educational, scientific and cultural collaboration among member countries of the United Nations in the interest of reinforcing world peace and security. One of the prerequisites for world peace and security is the elimination of economic and social under-development. It is clear, therefore, that the two organizations are complementary in their rôles and this complementarity has been translated from time to time into programmes for co-operation and collaboration between the two organizations in the African region on problems of common interest. One of such common areas of interest is the contribution which science and technology can bring to economic and social development.

Apart from meetings concerned with developments in education, this is the third meeting in which the ECA has collaborated with Unesco to examine what is being done, what can and should be done in utilizing science and technology for the benefit of social and economic progress in the African continent.

The first meeting was the International Conference on the Organization of Research and Training in Africa in Relation to the Study, Conservation and Utilization of Natural Resources held in Lagos, Nigeria from 26 July to 6 August 1964. This conference was organized in order to consider how science could be applied to enable the African countries to realize the potential benefits lying dormant in the natural resources of the continent. In the course of the conference, it became clear that attention had to be focused on a number of prerequisites to the utilization of science and technology in the development of Africa's natural resources. These prerequisites included the creation of national scientific policies, the establishment of government machinery for deliberation and decision-making in science and technology, the education and training of scientific and technological manpower, the financing of scientific research and the possibilities of international co-operation between African countries among themselves and between African countries and the rest of the world in the domain of science and technology.

This first meeting marked the beginning of a realization that science and technology have a considerable and a crucial rôle to play in social and economic development in Africa. How that rôle was to be organized and fulfilled was, however, not yet clear at the time for the member countries who participated at this meeting as well as for the sponsoring international organizations. The deliberations at the meeting constituted the first gropings in the definition of a rôle for scientific research in the African countries and a strategy to guide its intervention in promoting the general objective of development.

The second meeting took place six years later. This was the Regional Symposium on the Utilization of Science and Technology for Development in Africa which was held in Addis Ababa from 5-16 October 1970. The Symposium was organized with two main purposes in view. One was to obtain a picture of the situation within different countries in the region with regard to progress made since 1964 in developing national machinery, strategies and manpower for the application of science and technology for the benefit of development. The second purpose was to review some syntheses that had been made and were proposed in a number of papers as to doctrine and

methodology on a number of central issues and sectors of intervention of science and technology in economic development. Some of the theses and guidelines that were elaborated at this symposium were later applied in the preparation of the African Regional Plan for the Application of Science and Technology to Development.

This co-operation and collaboration with Unesco, the ECA is continuing and intends to expand in the interest of accelerated African development particularly in the fields of science and technology.

In the intervening period between 1964 and the present Conference, the Economic Commission for Africa has had the time to translate into practical terms and in the form of operating programmes, the charge contained in its terms of reference to study the needs for and to promote technological development in the African member countries. During the past six years, the Commission has developed a rôle and built up some competence in the general field of promoting technological development. The same period has seen the assignment to the Commission of specific responsibilties by ECOSOC and the General Assembly for developing guidelines for the contributions to be made by science and technology to the needs in different sectors of economic and social development, as well as responsibilities for co-ordination of the United Nations system support for the application of the World Plan of Action within the African Region.

The ECA therefore comes to this meeting with a little more maturity in dealing with the subject of the application of science and technology in African development; with the experience of participation in the elaboration of the global World Plan of Action, of responsibility for the preparation of the African Regional Plan and with the charge from the Conference of African Ministers Responsible for Development to promote and monitor the implementation of the regional plan in terms of projects at both national and regional levels.

Whilst the defined scope of concern of CASTAFRICA is science and technology policy and policy machinery in Africa and a review of the criteria to guide policy objectives, the Commission hopes that some time will be given to a consideration of the more general questions of technological development, particularly the implementation of the African Regional Plan. This Conference should also give some attention to clarifying the issues relevant to a more effective utilization of science and technology for the purposes of development within the prevailing context of African needs and priorities for economic and social development.

I hope that the Conference will also give some direction for further strengthening of regional co-operation in science and technology and that its conclusions will reinforce the deliberations and decisions already taken by such United Nations legislative bodies as the General Assembly, the Economic and Social Council and the Council of Ministers of the Economic Commission for Africa.

I wish you well in your deliberations.

ANNEX IV

MESSAGE OF THE ADMINISTRATOR OF THE UNITED NATIONS DEVELOPMENT PROGRAMME TO THE DIRECTOR-GENERAL OF UNESCO, ON THE OCCASION OF THE CASTAFRICA CONFERENCE

Dear Mr. Maheu,

It is with deepest regret that neither I nor Mr. Michel Dookingue, Assistant Administrator and Director of the Regional Bureau for Africa, will be able to attend the Conference of African Ministers Responsible for the Application of Science and Technology which is being held in Dakar these days. As you know, this Conference takes place at the same time as the seventeenth session of UNDP Governing Council, during which matters of particular interest to Africa are discussed.

I felt I should assure the distinguished representatives of African Member States, yourself, and the representatives of the Organization of African Unity and of the Economic Commission for Africa that the absence of a member of UNDP Directorate at the meeting is not a sign of lack of interest on our part. As I told the Second Committee of the General Assembly on 12 November last year, it is my belief that there is a fundamental necessity to build up an indigenous scientific capability in the developing countries. This necessity is even stronger in Africa where we find the largest number of least developed among developing nations. We also recognize that the wholesale importation of technologies designed for use in advanced economies is not always beneficial to the developing countries. Therefore, the transfer of technology, though necessary, is not an alternative to the local development of science in these countries. I have asked the UNDP office in Senegal to follow closely the deliberations of the Conference and it is my intention to consider most sympathetically the recommendations which will be made, as we are keen to contribute within our limited resources to the accelerated development of science and technology in Africa.

Please share with all the participants my best wishes for a successful Conference.

Rudolph A. Peterson
Administrator UNDP

ANNEX V

ADDRESSES PRONOUNCED AT THE CLOSING OF THE CONFERENCE

Address by Mr. René Maheu

Address by H.E. Mr. Doudou N'Gom

Address by Mr. René Maheu
Director-General of Unesco

Mr. President,
Ladies and Gentlemen,

At the conclusion of this Conference, I should firstly like to thank the Government of Senegal, and through it the Senegalese people, for their welcome which was infused with a generosity, friendliness and kindness that are not unrelated to the atmosphere of friendly and fruitful co-operation in which your work has proceeded. I should also like to express my gratitude to the President of the Conference for the skilful, impartial and courteous way in which he directed it. To all of you I should like to say how much the Unesco Secretariat appreciates the kind comments which you have been good enough to make concerning it.

Of all the conferences which it has been my fortune to attend, this is without doubt among those for which preparations were the most intense and the most painstaking. May I be allowed to say that I am happy and proud to direct the Secretariat to which the merit for this is due.

Your Conference has once again demonstrated what a useful purpose these meetings at ministerial level serve, and Unesco will clearly have to continue this practice, albeit with some improvements.

If this kind of activity is to be effective, one condition is that the Organization should be genuinely present in the Member States while remaining in close contact with the regional organizations to which they belong. The Organization's activity is, of course, essentially situated in a world-wide framework, and at the same time makes itself felt at national level. Between these two extremes, however, the world-wide, which is certainly best accommodated to Unesco's intellectual activity, and the national, where its practical activities develop most satisfactorily, it is quite clear that the regional or sub-regional framework enables it to come to grips with natural, cultural or geo-political factors which it is quite impossible to disregard. The regional or sub-regional framework is thus a useful and even vital intermediate stage between the world-wide and the national.

This, of course, raises the problem of co-operation between international and regional or sub-regional organizations which has been the subject of many exchanges of views in this chamber. This is not a simple problem and anyone thinking otherwise must be prepared for disappointment. There are, in fact, objective differences between the various organizations involved. They differ in their aims and in their nature, some organizations being more technical, others more economic, and others more political, so that they do not have the same priorities or the same programmes of action. Furthermore, as is natural, each of these organizations has its own decision-makes bodies, procedures, executive organs and resources. The harmonization of entities such as these is not an easy matter which can be achieved in an instant: it is under way and requires our attention. In my opinion, and I repeat it because it is my profound belief, not only is this harmonization necessary in the joint interests of Member States, but it is possible.

The differences I have mentioned are much more complementary than contradictory. They nevertheless exist. And what makes this even more true is that the regional organizations, particularly in Africa, are not all of the same kind. Some belong to the United Nations system as in the case of the United Nations Regional Economic Commissions. Others, on the other hand, like the Organization of African Unity, lie outside this system. This means that the problem of co-operation between organizations calls for varied approaches.

In the first case, that is to say when it is a question of relationships between an international organization and a regional organization both belonging to the United Nations system, for example Unesco and the Economic Commission for Africa, we use, as is only right, the system's internal co-ordination machinery. This, as you know, consists of, firstly, the Economic and Social Council, an intergovernmental body which has very great powers under the United Nations Charter, and, secondly, the Administrative Committee on Co-ordination, an inter-agency body operating at secretariat level.

In the second case, where we have an international organization belonging to the United Nations system and a regional organization outside this system, co-operation depends on the conclusion of certain agreements. This is true in the case

of Unesco and the Organization of African Unity, which have concluded an agreement in due and proper form. Co-operation must develop within the framework of this agreement and is in fact doing so, particularly in the field of education, where I think we have achieved very close co-operation. There is no reason why the same should not be true in the case of science and technology.

After these preliminary remarks, I should like to turn to CASTAFRICA itself, which I have set against the background of the Organization's general policy and its relations with other organizations.

The meeting has provided so much food for thought that it is clearly far too early to try and make an objective, critical review of what has been achieved. There is an abundant harvest of facts and ideas for us to reflect on, and this, I can assure you, is what the Secretariat of Unesco now intends to do, as will, no doubt, at your request, your respective governments. For the moment, I shall merely make a few brief and immediate observations about which I feel agreement could easily be reached.

To begin with, CASTAFRICA shows that since the Lagos Conference of 1964, your African countries have become clearly aware of the vital importance which science policies and the organization of research have for the process of self-sustaining development and, hence, for genuine independence and progress. The remarkable development that can be seen in this respect is, to my mind, the essential thing since it is on this awareness that all the rest depends.

You have not, however, confined yourselves to noting the importance of these problems. You have made a thorough examination of their various implications. Without going into detail, I shall quickly run through some of the broad headings under which the recommendations you have adopted fall.

First of all, you have considered the link which exists between the planning of scientific development and development planning pure and simple. On this vital question, the preliminary General Declaration which you have adopted is very direct and very precise. The planning of scientific development is not an adjunct of development planning but occupies a central position in it. There is thus an essential interaction between the way in which development is thought of and the way in which the implantation of scientific progress is thought of.

Secondly, you have studied in detail, as your resolutions show, the structures and methods necessary for this planning of scientific development linked with general development planning.

Thirdly, you have considered the problem of building up scientific and technical potential, a problem which, in Africa, assumes a very special importance and urgency.

Finally, the present inadequacy of this potential has led you to analyse the problems connected with the import, transfer and adaptation of technologies.

For each of these, in truth, formidable and difficult problems, you have given a very precise answer. These answers are clearly expressed in your recommendations, which are themselves elucidated by the introductory reports preceding them. I should here like to congratulate and thank the Rapporteur-General and the other rapporteurs who have achieved a real feat by bringing together, in concise and clear form, a very large number of ideas on particularly complex problems.

The last impression I carry away from this Conference is of everything which has been said about regional and international co-operation and, more particularly, its political and economic context.

You have stated with warmth and sometimes with passion how much importance you attach to the movement for African unity. It was a very valuable immersion, so to speak, in African-ness and the views expressed are of the greatest interest to the Unesco Secretariat. It is very true that the problem of the implantation and development of science and technology cannot be seen in isolation from the political and economic context. In particular, even if science may be said to be neutral (and this, in any case, is not certain), technology, for its part, is certainly not so. Consequently, when we have to apply science and technology to development, it is vitally important to know what economic, political, social and cultural context we have in mind. On this point, you have made your feelings, desires and wishes clear and I think that an international organization like Unesco must bear them in mind.

You have, in particular, expressed the wish to see Unesco continue more resolutely with the decentralization of its administration and activities. The General Conference, which has already adopted this line of approach, felt that it should be applied progressively. Your Conference, on the other hand, wants the process to be speeded up and I shall certainly make your feelings known to the appropriate authorities in the Organization when I convey to them the resolutions which you have adopted.

You also expressed the wish for better co-ordination not only between international and regional organizations but between the international organizations themselves. Indeed, in the application of science and technology to development, Unesco, in the natural course of events, finds itself co-operating with other sister agencies in the United Nations system, and I think that more intensive co-ordination would give more tangible results.

I should none the less like to make another observation on this point which is that not everything depends on the organizations and even less on their secretariats. When the activities of various agencies have to be co-ordinated in any given country, the prime responsibility for this devolves upon the government since it is the government which has the means to determine the objectives and, consequently, to conjoin in as judicious a way as possible the various contributions it receives from international or regional agencies or even from other sources such as bilateral co-operation. Real co-ordination cannot come from outside. It must essentially come from within.

I now come to the question of the follow-up to

CASTAFRICA. Again this afternoon, several speakers have quite rightly said: "After all, this isn't the end of the story, but only the beginning" You have done what you were called upon to do, that is to say you have examined the problems that arise and have made very clear recommendations. There is, however, no magic by which words can be transformed into deeds, and what has to be done now is to ensure that the report you have adopted crosses the dividing line between words and action. For this purpose it should be clearly recognized that the passage from words to action is linked to two types of decision which are the responsibility of two very different kinds of authority.

To my mind, the most important decisions are those which will be taken by your governments. Do not think that the international or regional organizations to which some of your recommendations are addressed can, by themselves, put them into practice. Read these recommendations again and you will see that, basically, they imply a political will. Political will is the business of governments and not of international institutions, which are instruments of co-operation and not political entities. It is thus chiefly the responsibility of your governments to take the decisions by which your recommendations can be translated into acts. These decisions are on two different planes.

There are, first of all, decisions on a national plane. Your Conference, in fact, dealt essentially with two major problems, viz. the application of science and technology to development and the rôle of science and technology planning in development planning. Now all this is entirely a matter for your governments. And it must be said in all frankness that if your governments do not do what is necessary, quite clearly any amount of external aid and co-operation agreements can have only a marginal influence. Since you are, first and foremost, the messengers of this Conference to your respective governments, I would urge you to tell them what the consensus of this Conference has been in regard to the questions which have been discussed here.

But, in addition to the decisions which have to be taken at national level, one should not forget that governments are represented on regional or international bodies and it is important that their representatives should everywhere be inspired by the spirit of CASTAFRICA, whether in the Economic Commission for Africa, the Organization of African Unity, Unesco or any other organization of the United Nations system. If they are not, all this machinery, whether regional or international, whether forming part of the United Nations system or not, will to some extent be hamstrung.

It is thus first of all to your governments that I appeal, through you, asking them to do all in their power to ensure that the wise recommendations which you have made to them are followed up in as concrete a manner as possible. But naturally it would be inconceivable that I should not say something about the recommendations which you have made to Unesco. The very number of these recommendations, their importance and, on occasions, the difficulties they present show that you genuinely expect much of the Organization. It can certainly feel some pride on this account but it must be admitted that the responsibility it entails is rather formidable. In any case, the decision on this point, as you know, depends on the Organization's governing bodies, the Executive Board and General Conference, to which, I can assure you, I shall faithfully convey your wishes.

In the last resort it is the General Conference which will decide on the action to be taken pursuant to your report within the framework of the Organization's general policy, either in the short or in the medium term. Various possibilities have been mentioned on this point and, only this afternoon, some speakers made a point of spelling them out. While not excluding these possibilities, I should like to remind you that every organization has its own structure and general policy, decided upon by its sovereign body, in this case the General Conference.

For my part - unable to say in advance what these decisions will be and confining myself to my own level of responsibility - when with my advisers I examined and prepared my proposals for the Draft Programme and Budget for 1975-1976 I took CASTAFRICA into account as fully as possible, within the framework of budgetary possibilities whose limitations are known to all those who have attended the discussions of the General Conference. To the extent that these possibilities allow, I am, however, going to go through the proposals which I then made with a fine tooth-comb, so that they shall reflect your wishes as accurately as possible, and I shall take these wishes into consideration also in drawing up the document concerning medium-term planning.

In addition, to satisfy your wish for co-operation in a regional framework, I intend, in the next few weeks, to invite my colleagues from the Economic Commission for Africa and the Organization of African Unity to examine with me the steps to be taken, either jointly or separately but in a complementary way, to follow up the recommendations made by CASTAFRICA. This meeting, which I feel must take place not only in a spirit of confidence and cordial fellowship but also in a spirit of realism, bearing in mind the actual possibilities of each, should lead to a joint or co-ordinated strategy so that action can be taken on your recommendations at secretariat level.

These are the only measures which I can take at present. I nevertheless hope that I have said enough to convince you of my sincerity.

In conclusion, Mr. President, ladies and gentlemen, I should like to reassure you all of my devotion and reaffirm here my complete faith in Africa's future and in the fraternal co-operation of Africa and Unesco.

Address by H.E. Mr. Doudou N'Gom
Minister of Education of the Republic of Senegal

Mr. Director-General of Unesco,
Mr. Deputy Secretary-General of OAU,
Mr. Representative of ECA,
Your Excellencies,
Honourable Delegates,
Ladies and Gentlemen,

In his address to the Conference, the President of the Republic told of his faith in the effectiveness of science and technology harnessed to serve overall development, particularly development in Africa, saying: "For us Africans, science must be imbued with the human spirit".

He thus set before CASTAFRICA the aim of reconciling the requirements in regard to scientific and technical research and the transfer of technologies from industrialized to developing countries with respect for the individuality and peculiar characteristics of each of the States concerned.

You have devoted your discussions to finding the most suitable ways of reaching this objective. The work of CASTAFRICA, which it is my privilege to bring to a close today, falls foursquare within the framework proposed by President Senghor. The resolutions and recommendations you have adopted bear eloquent testimony to the fact that your work has been fruitful and full of promise.

Nevertheless, the conclusions of this inter-African meeting are only the first steps towards the integration of scientific progress with the overall process of our common development, a development which must not forget our traditional values.

Resolutions, in fact, do not always bring about change. For the necessary change to come out, we must all be moved by a common will to succeed and we must firmly resolve to consult together on a continuing basis with a view to achieving fruitful co-operation.

Together, you have considered and discussed the problems raised by the development of a science strategy. Your conclusions on this point are unambiguous. You recommend that science and technology should be activated in such a way as to harness them to the economic and social development of our States.

You have forcibly stressed the almost general lack of high-level scientific and technical personnel in Africa and the vital part which African universities must play in improving the situation. Bearing in mind the serious proportions of the brain-drain which you did not fail to emphasize, I have no doubt that our States, in the near future, will see that appropriate steps are taken to reverse the tide so as to attract and retain in our continent the specialists vital for its development.

The widespread development of education is one of the phenomena that are modifying the structures of African society. It is also something which our people want. As this desire grows, it appears increasingly necessary to take stock of the possibilities which science and technology can offer mankind in resolving both the problem of making education universal and that of fitting it for the task of preparing young people for life.

The problem then arises of evaluating the human resources needed for the various steps entailed by the introduction of science and technology into our societies.

For, although the organization of scientific research must be directed towards solving the immediate problems of development, it must also play a part in laying the necessary basis for making scientific culture generally available to the public at large.

As tomorrow's research workers are still in the primary and secondary schools, it is vital for research establishments to give serious thought to the assistance which they can provide to scientific education in elementary and secondary establishments, in regard both to changing its content and to the scientific training of the teaching staff whose task it will be to teach the rising generation.

The problems of scientific and technical co-operation gave rise to very useful exchanges of views. You have reaffirmed your will to develop scientific and technical co-operation between African States while remaining receptive to all the contributions which world science can make. I hope that, on the occasion of CASTAFRICA II, we shall be able to see that regional co-operation between our States has developed and grown stronger through the use of all available means by which we can be helped to progress together and more rapidly.

Mr. Director-General of Unesco,

By coming to Dakar to attend this Conference, you have shown the African Member States of the United Nations Educational, Scientific and Cultural Organization your desire to give science and technology in Africa the necessary impetus to spread their wings. We have pondered this together. We know we are working for future generations. May they know that peace and happiness which are the foundations of the San Francisco Charter and the bedrock on which the activities of the various organs of the United Nations and its Specialized Agencies rest.

Mr. Director-General,

I speak for all the delegations present here in expressing my gratitude to you for having stayed so long among us and for having made an invaluable contribution to the discussions.

My very warm thanks go to the Ministers and Heads of the various delegations who have directed the work of their delegations with so much skill and who have made such an effective contribution to the debates.

The duties of the President of the Conference, the Vice-Presidents and all its other officers have been very onerous. I should like to thank them one and all very sincerely for their hard work, tact and tolerance which have contributed to the success of CASTAFRICA.

I must also thank the members of the Drafting Party and the Rapporteur-General for the quality of the reports they submitted within the time available.

I should finally like to thank President Amadou Cissé Dia who made the Palace of the National Assembly available to us to assist our work. Neither must I forget to thank all those who, in any way whatever, have contributed to the success of the Conference.

On behalf of the President of the Republic of Senegal and his Government, I must express my sincere thanks to all those who have made CASTAFRICA a success, and my country's gratitude for the honour which you have done it by meeting in Dakar.

This fresh start, which comes ten years after the resolutions of the Lagos Conference, enables us to face the future with greater confidence and we hope that other meetings, similar to the one which is closing today, will continue to mark our road and enable us to see, day after day, what progress we have made along the path towards a better life for the men and women peopling our continent.

It is with this hope that I declare the CASTAFRICA Conference closed.

ANNEX VI

LIST OF DOCUMENTS

1. WORKING DOCUMENTS

Agenda	SC/CASTAFRICA/1
Annotated agenda	SC/CASTAFRICA/1 Add.
Rules of Procedure	SC/CASTAFRICA/2

Science and Technology in African Development

		Agenda Item No.	
Chapter I.	Trends of science and technology policies in the countries of Africa	7	SC/CASTAFRICA/3
Chapter II.	New technologies: possibilities for their development and application in Africa	8	
Chapter III.	Scientific and technological co-operation in Africa	9	
Appendix:	Summary of Government communications relating to scientific and technological co-operation in Africa		

Regional Plan of Action for the Application of Science and Technology in Africa (submitted by Secretariat of the United Nations Economic Commission for Africa)	SC/CASTAFRICA/4

2. REFERENCE DOCUMENTS

National Science Policies in Africa	Unesco publication
Survey on the scientific and technical potential of the countries of Africa	Unesco publication
Statistics on research and experimental development in African countries	SC/CASTAFRICA/REF.1
Results of a Unesco Delphi Survey on "technologically feasible futures for Africa"	SC/CASTAFRICA/REF.2
Propagation of new technologies in Africa (submitted by Secretariat of the Organization of African Unity)	SC/CASTAFRICA/REF.3
Report of the ECA/Unesco Regional Symposium on the Utilization of Science and Technology for Development in Africa	SC/CASTAFRICA/REF.4

Trends of African imports and exports of scientific and technological equipment (submitted by Secretariat of the United Nations Economic Commission for Africa)	SC/CASTAFRICA/REF. 5
Unesco's activities in the field of science and technology in Africa	SC/CASTAFRICA/REF. 6
Points of discussion	SC/CASTAFRICA/REF. 7

3. INFORMATION DOCUMENTS

General information	SC/CASTAFRICA/INF. 1
List of documents	SC/CASTAFRICA/INF. 2
List of participants	SC/CASTAFRICA/INF. 3

4. CONFERENCE ROOM DOCUMENTS

World Plan of Action for the Application of Science and Technology to Development	United Nations publication
Results of a Unesco/UNACAST survey of institutional needs of African countries in the field of science and technology	Unesco document
List of scientific and technical periodicals published in 32 countries of Africa from 1960 to 1970	Unesco document
Inter-institutional links in science and technology	Unesco document

ANNEX VII/ANNEXE VII

LIST OF PARTICIPANTS/LISTE DES PARTICIPANTS

Names and titles in the following lists are reproduced as handed in to the Secretariat by the delegations concerned. Countries are shown in the English alphabetical order.

Les noms et titres qui figurent dans les listes ci-après sont reproduits dans la forme où ils ont été communiqués au Secrétariat par les délégations intéressées. Les pays sont mentionnés dans l'ordre alphabétique anglais.

AFRICAN MEMBER STATES INVITED TO PARTICIPATE IN THE CONFERENCE (DELEGATES)

ETATS MEMBRES AFRICAINS INVITES A PARTICIPER A LA CONFERENCE (DELEGUES)

Algeria/Algérie

1. M. Ramdane Ouahes
   Directeur de la recherche scientifique
2. M. Ahmed Bendeddouche
   Chef du Bureau de l'Unesco au ministère des Affaires étrangères
3. M. Djamel Labidi
   Responsable de la planification de la recherche

Burundi

1. M. Théodore Mubamba
   Professeur de chimie à l'Université du Burundi

Cameroon/Cameroun

1. M. Jean Nya Ngatchou
   Directeur de la recherche scientifique et technique
2. M. Jacques Kamsu Kom
   Doyen de la Faculté des sciences

Central African Republic/République centrafricaine

1. M. Barthelemy Mmndjo Mandekouzou
   Délégué permanent de la République centrafricaine auprès de l'Unesco
2. M. Jérémie Ikoli
   Directeur de l'enseignement technique

Congo

M. David Cardorelle
Secrétaire général de la Commission nationale congolaise pour l'Unesco

Dahomey

M. Yacoubou F. Barra
Secrétaire général de la Commission nationale du Dahomey pour l'Unesco

Egypt/ Egypte

1. H. E. Dr. Sayed Gaballah
   Minister of Planning
2. H. E. Prof. Dr. Abdel Monem Abou-el-Azm
   President of the Academy of Scientific Research and Technology
3. Dr. Mostafa Mahmoud Hafez
   Scientific Counsellor
   Academy of Scientific Research and Technology
4. Mr. Hamed Mahmoud Habib
   Under Secretary, Ministry of Industry
5. Abd Elhamid Said Gharib
   Director-General of the Ministry of Industry
6. Mr. Mohamed Ahmed El-Khazindar
   First Secretary
   Ministry of Foreign Affairs

Ethiopia/Ethiopie

1. Dr. Haile Selassie Belay
   Head of Regulatory, Research and Services Department

2. Ato Haile Michael Misginna
   Permanent Delegate of Ethiopia to Unesco

3. Dr. Dawit Deguefu
   Dean, Faculty of Science
   Haile Selassie I University

4. Dr. Makonnen Wolde Amlak
   Associate Dean, Faculty of Technology
   Haile Selassie I University

5. Ato Tamene Wolde Yohannes
   Chief Engineer Operations
   Ethiopian Electric Light and Power Authority

Gabon

1. S. Exc. M. Martin Bongo
   Ministre de l'Education nationale et de la Recherche scientifique

2. M. Marcel Ibinga Magwangu
   Conseiller à la Présidence de la République
   Directeur de l'enseignement supérieur

3. M. François Owono-Nguema
   Secrétaire d'Etat à la Culture et aux Arts
   Recteur de l'Université nationale du Gabon

4. M. Maurice Bouma
   Directeur de la recherche scientifique

5. M. Michel Bekale-Emane
   Président de la Commission nationale pour l'Unesco

Ghana

1. Major R. J. A. Felli
   Commissioner of Economic Planning
   Ministry of Economic Planning

2. Col. J. M. Hamidu
   Ghana Ambassador to Senegal

3. Mrs. Mary Chinery-Hesse
   Principal Economics Officer
   Ministry of Economic Planning

4. Mr. E. Lartey
   Director, Industrial Research Institute

5. Dr. K. M. Sape
   Secretary
   Council for Scientific and Industrial Research

6. Dr. S. La-Anyane
   Professor of Agriculture
   University of Ghana

Ivory Coast/Côte-d'Ivoire

1. S. Exc. M. Jean Guede Lorougnon
   Ministre de la Recherche scientifique

2. M. Saliou Touré
   Conseiller technique
   Ministère de la Recherche scientifique

3. M. Christian du Plessix
   Directeur des affaires scientifiques au Ministère de la Recherche scientifique

4. M. Touapri Joseph Zozo
   Attaché de Cabinet
   Ministère de la Recherche scientifique

5. Mme Marthe Achy-Brou
   Conseiller technique du ministre du Plan

Kenya/Kenia

1. H. E. Mr. Taita Towett, M.P.
   Minister of Education

2. Mr. Harris Mutio Mule
   Deputy Permanent Secretary
   Ministry of Finance and Planning

3. Mr. Hannington Fredrick Mtula
   Principal of the Kenya Polytechnic

4. Professor Joseph Maina Mungai
   Deputy Vice-Chancellor of the University of Nairobi

5. Mr. Joseph Nguta Kiio
   Under Secretary of the Ministry of Education

6. Mr. Enan Wangai
   Senior Education Officer (Technical)

Liberia/Libéria

1. H. Exc. Dr. A. E. Nyema Jones
   Minister of Lands and Mines

2. Mr. Emmanuel O. Gardiner
   Assistant Minister of Sectoral Planning
   Ministry of Planning and Economic Affairs

3. Mr. J. H. Deyior Wilson
   Assistant Minister for Science and Technical Education
   Ministry of Education

Libyan Arab Republic/République arabe libyenne

1. H. E. Mr. Milad A. Schmeyla
   Under Secretary
   Ministry of Planning

2. Dr. Yousef Muharrak
   Dean of the Faculty of Science
   Libyan University

3. Dr. Abdulgader Sherif
Director-General
Agricultural Research Centre

4. Dr. Yusef I. Elmehrik
Dean, Faculty of Science

Madagascar

1. M. Edmond Razafindrakoto
Maître de conférence à la Faculté des sciences de l'Université de Madagascar

2. M. Samuel François Rajaona
Secrétaire général de la Commission nationale malgache pour l'Unesco

Mali

M. Mamadou Sarr
Directeur général adjoint des enseignements supérieurs et de la recherche scientifique

Mauritania/Mauritanie

1. S. Exc. M. Ahmed Ould Sidibaba
Ministre de l'Information et de la Culture

2. M. Sidi Mohamed Ould Abderrahmane
Ambassadeur de la République islamique de Mauritanie au Sénégal

3. Dr. Oumar Ba
Directeur du Centre national d'élevage et de recherches vétérinaires

Morocco/Maroc

1. S. Exc. M. Abdelkrim Halim
Sous-secrétaire d'Etat chargé de l'enseignement supérieur

2. S. Exc. M. Taufik Kabbaj
Ambassadeur du royaume du Maroc à Dakar

3. M. Abdellatif Ben Abdeljlil
Doyen de la Faculté des sciences de Rabat

4. M. Ouazzani Belmahi
Professeur à la Faculté des sciences de Rabat

5. M. Jaafar Cherkaoui
Directeur du Cabinet au Secrétariat d'Etat au Plan

Malawi

Dr. Lewis Kajera Mughogho
Principal, Bunda College of Agriculture, University of Malawi

Niger

1. M. Sadou Galadima
Directeur de l'INDRAP

2. M. Kindo Aboubacar
Inspecteur de l'enseignement primaire

Nigéria

1. Mr. G.A. Nwanze
Deputy Permanent Secretary
Federal Ministry of Education

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17. M. Babacar Faye
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18. Dr Papa Gaye
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28. M. Karim Sidibré
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30. M. Oumar Thiaw
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France

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2. M. Jean Richaud
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République fédérale d'Allemagne

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India/Inde

Dr. Sivaramakrishna Krishna Subramanian
Secretary, National Committee on Science and Technology, New Delhi

Mexico/Mexique

Ingeniero Aliber Guajardo-Canto
Jefe de Organismos internacionales
Comisión Nacional de Ciencia y Tecnología
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Union of Soviet Socialist Republics
Union des républiques socialistes soviétiques

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United Kingdom of Great Britain and Northern Ireland/Royaume-Uni de Grande-Bretagne et d'Irlande du Nord

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United States of America/Etats-Unis d'Amérique

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3. Mr. Julian Engel
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4. Mr. Bill L. Long
   Agency for International Development

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   Nonce apostolique
2. M. le professeur Louis Leprince-Ringuet
3. M. René Huchard

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ORGANISATIONS INTERNATIONALES

(i) Organizations of the United Nations System (Representatives or Observers)
Organisations du système des Nations Unies (Représentants ou observateurs)

United Nations/Nations Unies

United Nations Economic Commission for Africa/Commission économique des Nations Unies pour l'Afrique

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United Nations Industrial Development Organization/Organisation des Nations Unies pour le développement industriel

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United Nations Development Programme/Programme des Nations Unies pour le développement

Mr. E. V. Furst

United Nations Children's Fund/Fonds des Nations Unies pour l'enfance

M. Knud Christensen

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International Labour Organization/Organisation internationale du travail

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Food and Agriculture Organization of the United Nations/Organisation des Nations Unies pour l'alimentation et l'agriculture

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3. M. Roger Schwob
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World Health Organization/
Organisation mondiale de la santé

Mr. Louis Atayi
WHO Representative

International Atomic Energy Agency/
Agence internationale de l'énergie atomique

Mr. Oliver Lloyd
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Technical Assistance

World Meteorological Organization/
Organisation météorologique mondiale

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Deputy Director of the Education, Training and
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Inter-Governmental Maritime Consultative Organization/Organisation intergouvernementale consultative de la navigation maritime

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African Development Bank/Banque africaine
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Commission des communautés européennes

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Association of African Universities/
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Catholic International Education Office/
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International Confederation of Free Trade Unions/ Confédération internationale des syndicats libres

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International Council for Philosophy and Humanistic Studies/Conseil international de la philosophie et des sciences humaines

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International Council of Scientific Unions/Conseil international des unions scientifiques

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International Federation for Documentation/ Fédération internationale de documentation

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Secretary-General of the Conference/ Secrétaire général de la Conférence

Mr. Y. de Hemptinne

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Mr. O. Ibukun

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PART TWO

THE CONFERENCE'S PRINCIPAL WORKING DOCUMENT

SUMMARY

The present document constitutes the main working paper of the Conference of Ministers of African Member States Responsible for the Application of Science and Technology to Development.

The three Chapters correspond to the three substantive items of discussion on the Provisional Agenda of CASTAFRICA as follows:

		Agenda Item No.
Chapter I.	Trends of science and technology policies in the countries of Africa	7
Chapter II.	New technologies: possibilities for their development and application in Africa	8
Chapter III.	Scientific and technological co-operation in Africa	9

A Table of Contents for each of the three Chapters is given at the beginning of the Chapter concerned.

The Unesco Secretariat invited the participating African Member States to submit communications relating to scientific and technological co-operation in Africa. A Summary of communications received is included as an Appendix to the present document.

FOREWORD

In presenting this main working paper to CASTAFRICA, the Unesco Secretariat does not purport to provide an exhaustive review of the situation as regards present or future possibilities for the application of science and technology for development in Africa.

On the contrary, the aim is to discuss the main items of substance on the Conference's provisional agenda, singling out a few topics which seem of exceptional importance, as a basis for the initiation of the discussions.

In connexion with specific questions of interest, the reader may therefore wish to refer to other CASTAFRICA Conference documents, a list of which is given in Annex VI to the Final Report of CASTAFRICA.

Preparations for the conference were undertaken by the Director-General in pursuance of two resolutions adopted by the Unesco General Conference (resolution 2.11, sixteenth session; and resolution 2.121, seventeenth session), and of resolution 2.3.4 adopted by the Executive Board at its 89th session.

CASTAFRICA is a sequel to three similar science policy conferences at Ministerial level, respectively convened in Latin America (CASTALA, 1965), Asia (CASTASIA, 1968) and Europe (MINESPOL, 1970). The general aims of such conferences are to enable the participating Member States to:

(i) exchange information on their national science and technology policies;

(ii) improve the management of their science and technology policies and of their scientific and technological research and experimental development activities;

(iii) promote scientific and technological research as an essential element in the cultural, social and economic development of nations;

(iv) stimulate technological innovation with a view to increasing productivity;

(v) examine the rôle of science and technology in government activity as a whole; and

(vi) foster international co-operation to meet these goals.

Finally, the reader might bear in mind that CASTAFRICA is but a step - doubtless justified and timely; but a step nevertheless - in the collective process of conceptualization and planning which African nations have engaged within the ambit of Unesco, by means of intergovernmental conferences at the level of ministers. The subjects to be discussed at CASTAFRICA are complex and multifaceted, and have a bearing on questions discussed by previous major conferences and meetings such as the following:

15-25 May 1961	Conference of African States on the Development of Education in Africa, Addis Ababa (convened by Unesco and the United Nations Economic Commission for Africa);
26-30 March 1962	Meeting of Ministers of Education of African Countries Participating in the Implementation of the Addis Ababa Plan, Paris, Unesco House, (organized by Unesco in co-operation with the United Nations Economic Commission for Africa);
3-12 September 1962	Conference on the Development of Higher Education in Africa, Tananarive (organized by Unesco in co-operation with the United Nations Economic Commission for Africa);
17-24 March 1964	Conference of Ministers of Education of African Countries Participating in the Implementation of the Addis Ababa Plan, Abidjan (organized by Unesco in co-operation with the United Nations Economic Commission for Africa);
28 July - 6 August 1964	International Conference on the Organization of Research and Training in Africa in Relation to the Study, Convervation and Utilization of Natural Resources, Lagos (organized by Unesco in co-operation with the United Nations Economic Commission for Africa);
10-21 July 1967	Symposium on Science Policy and Research Administration in Africa, Yaoundé, (convened by Unesco);
16-27 July 1968	Conference on Education and Scientific and Technical Training in Relation to Development in Africa, Nairobi (convened jointly by Unesco and the Organization of African Unity, in co-operation with the United Nations Economic Commission for Africa);
5-16 October 1970	Regional Symposium on the Utilization of Science and Technology for Development in Africa, Addis Ababa (under the joint auspices of Unesco and the United Nations Economic Commission for Africa).

For their part, the Arab States, which include six countries in North Africa, have held the following conferences:

9-13 February 1960	Conference of Representatives of Ministers of Education of Arab Member States of Unesco on the Needs for Educational Development, Beirut, (convened by Unesco);

9-14 April 1966	Conference of Ministers of Education and Ministers Responsible for Economic Planning in the Arab States, Tripoli, (convened by Unesco in co-operation with the League of Arab States);
12-20 January 1970	Third Regional Conference of Ministers of Education and Ministers Responsible for Economic Planning in the Arab States, Marrakesh (convened by Unesco with the collaboration of the League of Arab States).

In the text of the present document references to the above conferences and meetings are made by citing the place of the meeting and year when it took place.

CHAPTER I

TRENDS OF SCIENCE AND TECHNOLOGY POLICIES IN THE COUNTRIES OF AFRICA

CONTENTS

INTRODUCTION

1. The present chapter is intended to facilitate discussion of item 7 of the CASTAFRICA provisional annotated agenda: Trends of science and technology policies in the countries of Africa.

2. Unless otherwise stated, the information contained in the chapter is drawn from related CASTAFRICA documents, particularly a book prepared on the occasion of CASTAFRICA and presented as volume No. 31 in the Unesco "Science policy studies and documents" series, under the title "National science policies in Africa".

3. The first part of the chapter looks into the questions posed by science policy planning and policy-making in Africa.

4. The second discusses the possibility that CASTAFRICA establish minimum targets for scientific and technological development in Africa, to be achieved by 1980.

5. A few comments as to the past and present might here seem in order, as a general introduction to the chapter and to the discussions under item 7.

1. The past

6. Africa's past is characterized by a relatively low population density except in a few well-circumscribed areas. Of the continent's 30,320,000 sq.km. approximately 8,500,000 correspond to Northern Africa, typified by little and irregular rainfall. Southern Africa, mostly below the tropic of Capricorn, accounts for some 2,700,000 sq.km., and benefits from a sub-tropical climate. By far the most extensive part of Africa is, therefore, warm and humid Tropical Africa, with approximately 19,000,000 sq.km. comprising three regions of about equal size: Western Africa, Middle Africa and Eastern Africa(1).

7. By its huge territorial surface, Africa is therefore the largest continent by some measure, if North and South America, and the USSR, are counted separately(2). In terms of land suitable for agriculture, existence of vast forests, potential for cattle raising and fisheries, energetic resources, and, last but not least, mineral deposits, Africa is, on the whole, a very wealthy continent.

That is the reason why Africa came to be coveted.

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(1) The list of countries and territories for each of these five major regions is given in Table 2 of the Introduction to Unesco/document SPS/No. 31: "National science policies in Africa", which forms a part of CASTAFRICA documentation. A graphic presentation of conditions in Tropical Africa is given in Tropical Africa an atlas for rural development, by H.R.J. Davies, University of Wales Press 1973 (published with financial assistance from Unesco).

(2) United Nations, 1971 Demographic Yearbook, page 111.

8. Until the nineteenth century Africa was but a very little known part of the world as evidenced by the fact that, after millenia of explorations, the sources of the Nile came to be determined with precision only through the explorations of Livingstone and Stanley who were amongst the first foreigners who brought scientific knowledge, in the modern sense of the term, to the African hinterland.

9. By the end of the nineteenth century Africa had become the main area in which Anglo-French rivalry could be continued, and in the 1870s and the 1880s the Belgians, Italians and Germans also made their appearance on the continent. By 1939 the only remaining politically independent country in Africa was Liberia, founded in 1847.

10. The major event in the recent past of Africa has therefore been the process of accession to independence, starting with Ethiopia in 1941, Libya 1949, Morocco and Tunisia 1956, Ghana 1957 and then extending gradually to practically the entire continent.

11. However, many of the African countries have retained close formal or informal ties either with the French Community, the British Commonwealth or Belgium. Until recent years, such scientific and technological activity as was undertaken in Africa was to a large extent an emanation of bilateral links with scientific institutions in non-African nations.

12. As will be seen from data given below, higher education in Africa was incipient indeed when independence came and is only now making solid progress. It is therefore not surprising that, lacking national scientists and engineers, the continent has depended and still substantially depends either on the importation of the results of foreign R&D or on expatriate R&D scientists working in Africa.

2. The present

13. It is thus for the main part in the period that corresponds to the United Nations First Development Decade (1960-1970), that the African nations, as an aftermath of independence, have been in a position to carve out for themselves and for their peoples - however precariously - a place in world scientific endeavours.

14. Quite logically, during the First Development Decade they concentrated on the strengthening of the infrastructure for the carrying out of indigenous R&D (particularly through the development of higher education, an aspect dealt with in paragraphs 48 to 53 of Chapter I); and by inserting, within the wheels of government, the financial means and institutional mechanisms required for the fruition and application of national scientific and technological policies.

15. The problems associated with formulating and implementing a science and technology policy have in this way gained increasingly serious attention by African governments.

16. At the Lagos Conference (1964)[1] it was noted that African countries were handicapped by an absence of an adequate national science policy, and generally speaking the lack of any national machinery for co-ordinating and preparing such a policy. In particular they were suffering from an extreme shortage of senior scientific and technical personnel, and inadequate training and research facilities.

17. By the time of the Yaoundé Symposium[2] three years later, it was remarked that the most important result of the Lagos Conference by that time had been the fact that many States had either set up or had reinforced their national agencies for science planning, decision-making and co-ordination. Much by then had also been done towards preparing and implementing a national science policy that was adapted to development needs.

18. In the intervening years since Yaoundé there have been further important developments, and most countries in Africa are working towards central machinery for policy-making and planning in science and technology, even though it may still be, as yet in an evolutionary or tentative stage. The contribution which science and technology can make to economic and social development, and the need for a well-defined science and technology policy by which to co-ordinate and guide research and other scientific and technical activities so as to maximize this contribution, is becoming ever more widely appreciated.

19. As an introduction to the subject of science and technology policy-making in Africa it may first of all be useful to recapitulate briefly the historical background which has led to the present situation, and to highlight trends for the future which are already in evidence.

20. Until the mid-1950s, at least, most of the African countries had colonial or quasi-colonial administration and at that time the national R&D institutions were largely confined to a limited amount of fundamental research of an essentially academic character and applied R&D in a number of agricultural and medical institutions. In the case of agriculture the work was chiefly related to export crops, and performed mainly by expatriate scientists. R&D related to manufacturing and extractive industries was very limited, as was any form of privately-financed R&D (with some notable exceptions, such as the Mauritius Sugar Research Institute). Expatriate companies, in so far as they required the results of research, relied mostly on importing the improved technology resulting from research carried out elsewhere.

21. Following independence many countries made attempts to expand and to africanize the existing R&D network, part of this effort being to bring the work at universities more into line with urgent national needs. "Science policy-making bodies" were set up to promote this process - one of the earliest (1959) being the Council for Scientific and Industrial Research in Ghana.

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(1) Final Report of the Lagos Conference, Lagos, Nigeria, 28 July - 6 August 1964, Unesco, 1964, 102 pages.

(2) Unesco science policy studies and documents, No. 11, The promotion of scientific activity in tropical Africa: Transactions of the symposium on science policy and research administration in Africa, 1967, 111 pages.

22. African countries are now at the beginning of a third phase, showing a more comprehensive interest in an integrated approach to the question of bringing science and technology to bear on problems of national development and survival. Tentative moves are now being made by African countries towards seeking a proper balance, within national science policy bodies, between academic research undertaken in support of post-graduate education and training on the one hand, and development-motivated research and experimental development on the other. Expenditure on R&D is steadily rising, and the qualified manpower for the two fairly distinct (but intercommunicating) aspects of this work is becoming increasingly available.

23. In conclusion to this Introduction, it may be said that many African countries are feeling their way towards a concerted science and technology policy and the fruition of such a concerted policy is therefore the major issue of the first substantive item of the Conference Agenda. Some of the problems that should particularly retain the attention of the Conference in this respect are discussed below.

I. SCIENCE AND TECHNOLOGY POLICY-MAKING AND PLANNING IN AFRICA

1. General concepts of science and technology policy

24. It seems advisable to consider the general concepts of science and technology policy, and to give this subject an early look before CASTAFRICA deliberations become too advanced and crystallized.

25. A discussion of these concepts by the CASTAFRICA Conference might at the outset be facilitated by drawing a clear distinction between what is science and what is technology, as seen from the policy-maker's point of view.

26. In this connexion, science may be defined as mankind's organized attempt, through the objective study of empirical phenomena, to discover how things work as causal systems. By means of rational and systematic thought, expressed essentially in the symbols of mathematics, science brings together bodies of knowledge in an effort to reconstruct the world a posteriori by the process of conceptualization. The purpose of science is therefore to comprehend, not to invent.

27. Technology denotes the whole - or an organic part - of knowledge that relates directly to the production or improvement of goods or services. Engineers, whose tasks it is to apply technology in order to satisfy concrete human needs and wants, thus deal with the conception, design and use of new forms of equipment, machines or installations and with ensuring the most efficient ways of reaching well-defined social or economic objectives by such means. In other words, science can be schematically described as "know-why", while technology rather pertains to "know-how".

28. New knowledge being the product of research (often symbolized by the letter R), and practical innovations being the result of experimental development (often symbolized by the letter D), it is perhaps also advisable to attempt to define the meaning of the term "R&D" as here used. The R (research) refers both

to scientific and to technological research. The D (experimental development) consists of the systematic use of the results of research and of empirical knowledge directed towards the introduction of new materials, products, devices, processes and methods - or the improvement of existing ones - including the development of prototypes and pilot plants. It comprises the studies needed to ascertain the technical, social and economic feasibility, usefulness, acceptability and profitability of the innovations.

29. It should be clearly understood, in the light of the preceding definitions, that science and technology have nowadays become very closely interlinked. Thus, while science policy and technology policy may be differentiated conceptually, in terms of research and development or transfer of operational knowledge they cannot be separated.

30. Let us now consider the chain of activity constituted by research, experimental development and production. One line of argument, based on past experience, contends that science and technology grow separately, though a symbiotic relation between the two activities is recognized. According to this view, the true relationship between science and technology is not a serial or sequential one; it is rather an orthogonal one with science and technology going on side by side and stimulating each other.

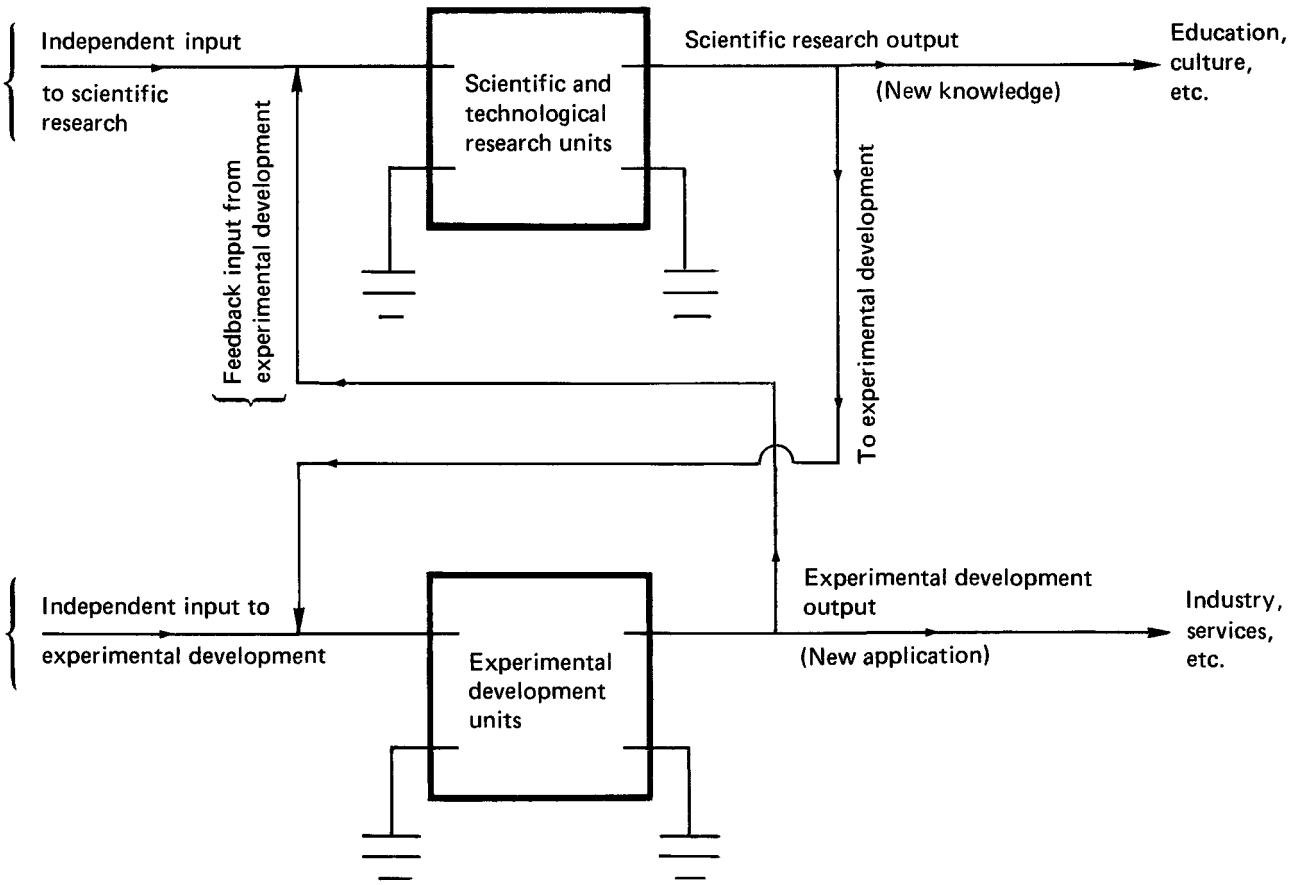
31. The other line of argument claims that the comparison of the rate of growth of a particular field of knowledge and application in each of the three links of the chain "research - experimental development - production", allows definite conclusions to be drawn. According to this scheme, higher rates of development of knowledge have to be ensured in the technological sector than those for the corresponding production sector, and the corresponding fields of natural sciences in turn should develop at an even higher rate than the related technology, in order that the required intellectual driving force be maintained. This second approach implies a direct causality relationship between scientific research and experimental development, apparently conflicting to some extent with the "symbiotic" view described above.

32. In fact, the two approaches can be reconciled by considering the relation between scientific and technological research on the one hand, and experimental development on the other, as a double feedback system as illustrated in Diagram A below.

33. The Diagram shows that there are independent inputs (ideas, empirical knowledge etc.) to research and to experimental development. The output from research (new knowledge) is split into two parts: one which feeds into education and cultural channels while the other feeds into technological development. Similarly the output from experimental development (new application) is split into two streams, one of which flows into industry and services, while the other flows back to research in the form of new and improved instruments, equipment, techniques, etc.

Diagram A

RELATION BETWEEN RESEARCH AND EXPERIMENTAL DEVELOPMENT



34. It is thus obvious that the scope of science (and technology) policy is not restricted to the sphere of discoveries and inventions, but encompasses the whole of the R&D operations leading to practical innovations in the productive sectors of the economy.

35. While the concept of "science policy" is generally taken to cover all spheres of knowledge including technology, some authors have used the expression technology policy in the sense of "technological choices for industry" which is in fact a part of industrial policy. Unesco consistently refers to "science policy-making" as pertaining to all research and experimental development (R&D) operations, including the related scientific and technological services (STS); it makes no difference as to whether the discipline concerned is biology, sociology, technology or any other of the numerous areas covered by modern research. This is particularly true of documentation and information services where it would be completely erroneous to try to separate out, as if they were two clearly distinguishable parts, what is "scientific documentation and information", on the one hand, from "technological documentation and information", on the other.

36. Furthermore, as shown in Diagram B (see page 88), the interconnexions between science policy and the main aspects of national life are so manifold and heterogeneous that it would be unrealistic and nefarious, in this ambit, to try to establish watertight compartments between the natural, the social or the technological sciences.

37. As previously stated, it is hoped that the above considerations will facilitate discussion, by CASTAFRICA, of the questions mentioned under item 7 of the CASTAFRICA Annotated Provisional Agenda (document SC/CASTAFRICA/1 Add.).

2. Relationship with overall national planning

38. It must be recognized that science and technology policy governs the "change" component of development in so many areas of social and economic policy that planning in both areas should be closely interlinked. In practice, this means that the policy-making bodies for national science and technology and the national development planning agencies must co-operate intimately with each other.

39. Since national planning agencies are generally run by economists, practical problems arise in such co-operation due to differences in time horizons and difficulties of communication.

40. National development plans are typically concerned with short- to medium-term economic growth problems, rather than with the long-term issues of technological changes and Africa is no exception to this pattern. Reducing the technological gap that separates Africa from the highly developed countries certainly calls for imaginative application of science and technology, and it is the rôle of R&D to widen the range of options offered to the socio-economic planners in this respect. Science planning then becomes an integral part of overall development planning primarily characterized by its responsiveness to new knowledge, new information and changing circumstances. Such planning must at the same time recognize and take into account the fact that scientific research and the building up of scientific and technological institutions, with the manpower training which this implies, are long-term activities that are highly sensitive to erratic fluctuations of policy orientation or financial support.

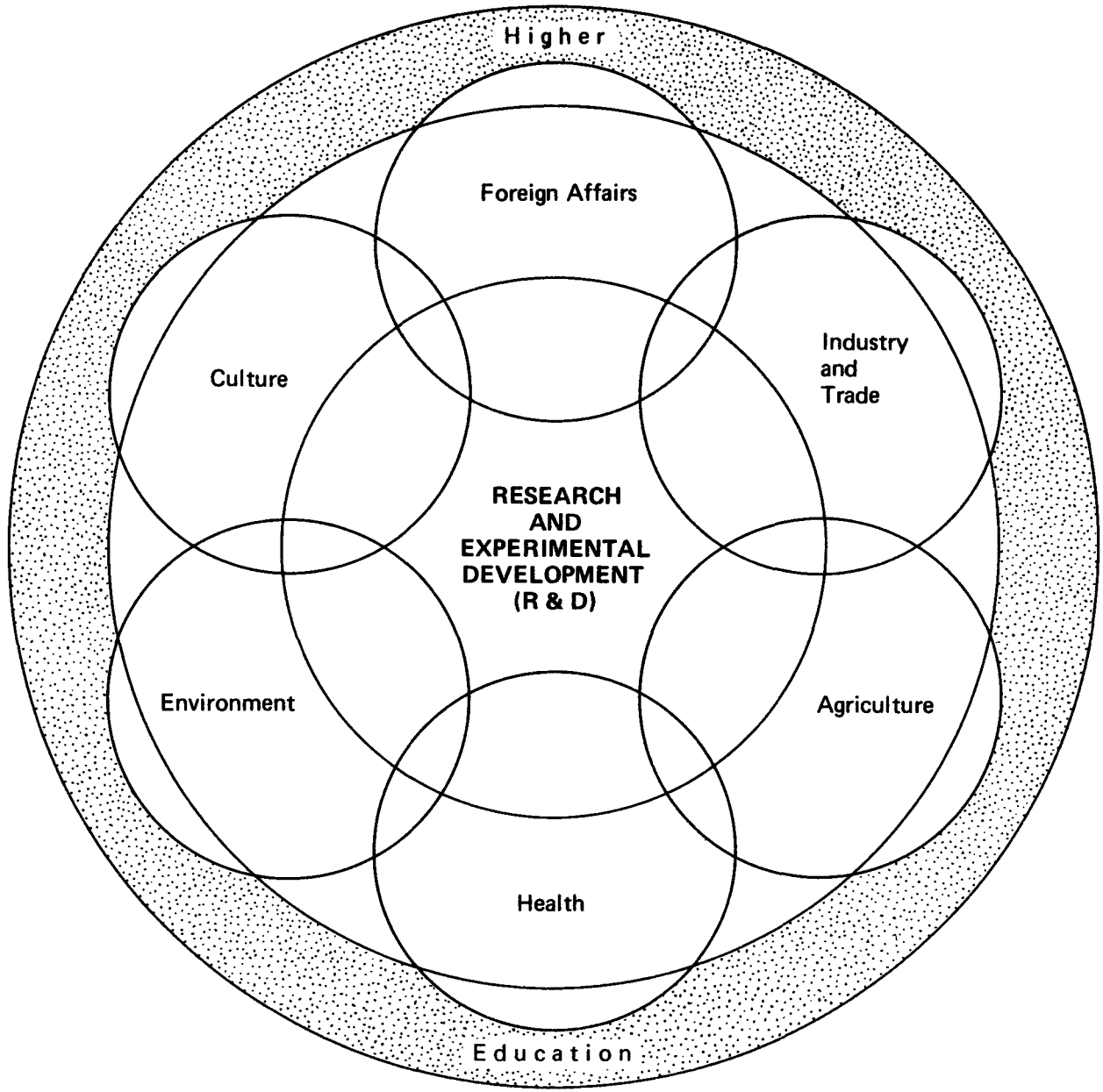
41. There remains the problem of communication. Scientists and economists, with different motivations and working in different contexts, do not speak the same language. In the dialogue which must take place between them, it is often inevitable that the economists have the final word, simply because they hold the strings of the money bag. This "raison de force" does not always make the economists right. Inversely, science planners may on occasion not be realistic; they may be seen, by the economists anyway, as special pleaders for their particular fields of interest: one group of pleaders amongst many which are seemingly of equal weight.

42. Therefore, if science planners are to have credibility with economic planners they must have both technical and economic literacy and possess a knowledge of the planning techniques used by the economists. A science and technology planning capability requires the training of a cadre of scientists and engineers in economic planning methods and in modern analytical techniques, systems analysis, operational research and so forth.

Diagram B

SCIENCE POLICY

and its principal interconnections with other aspects of national life



43. CASTAFRICA may wish to recommend measures for the building up of such capabilities in African countries, and in particular the training of the necessary analytical teams required to support informed decision-making involving application of science and technology to development. In this regard it seems appropriate to stress that effective economic and science policies necessarily involve "horizontal" co-ordination of many activities cutting across the traditional boundaries of government departments. To ensure an adequate level of discussion and participation in such inter-ministerial co-ordination - which will help to make decisions as acceptable as possible to all concerned - informal as well as formal mechanisms are needed which must be designed to suit the particular society concerned.

44. When viewed from the two angles discussed above (i.e. the long-term and communication viewpoints) it can be stated that science policy-making and planning has been making quite remarkable progress, if only in certain African countries, during recent years. Throughout the continent science policy is now generally seen to have two main aspects: the long-term development of a national scientific and technological potential, and the most effective use of this potential to meet development needs. It is accepted that a national science and technology policy should be a reflection of long-term national goals and objectives, and of the overall economic and social development plan designed to achieve these aims; and, also, that only within the context of such an overall plan can a valid science policy be formulated.

45. In practice, nevertheless, few countries in Africa as yet have a science and technology policy clearly formulated in these broad terms. They rather have an agglomerate of many partial and implicit science and technology policies, more or less co-ordinated at the centre. This is substantially true whatever the planning system, whether normative, instigative or exploratory(1), and to some extent is an inevitable consequence of the large number of controlling forces at play. The situation is however typically less complex in countries of Africa than in market-economy countries of Europe or North America because the financial control of indigenous scientific activities and of economic development is here placed largely in government hands, thus making a coherent governmental science and technology policy more feasible.

46. In conclusion on this question, it can be said that over the past decade the intellectual dimensions of African science policy have evolved from a primary concern with the allocation of resources for the support of basic research to a recognition of science and technology as key components in economic development. In any event, a few countries have already included special chapters or sections dealing with science and technology in their overall national development plans (Cameroon, Ethiopia, Senegal, Tunisia and Zambia). The Madagascar Plan includes research policy in relation to agriculture, and several others show an appreciation of the value of scientific research by making substantial financial allocations.

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(1) Cf. document UNESCO/NS/ROU/234 (SC/WS/488) of 24 July 1972: Section III: Management by objectives in science policy.

47. Thus, assuming that suitable operative links can be established between science planning and national planning, CASTAFRICA may wish to turn to some of the key questions of science and technology policy, in the African context.

3. Relationship with universities

48. An important aspect specifically reflected in Diagram B (outer ring) is that of higher education in its relation to science-policy-making and the execution of R&D.

49. CASTAFRICA will doubtless wish to discuss this question in some detail, not only because of its conceptual significance and implications, but because the simple fact is that research units and research workers in Africa are very often located in the universities and should be discharging extremely important functions within the development process. It is the universities which, within the national scene, must bring home the message - quite different from that arising from the economic-development-at-all-costs approach - that scientific and technological development is not an end in itself. Science and technology are essential factors in the process of the conversion and development of society. Social and economic considerations are basic to the formulation of plans which can and should be carried out in this field.

50. A specific aspect which might merit debate at the Conference is the need for an adequate amount of research in the field of the social sciences, and economics, to accompany the R&D effort within the exact and natural sciences. Only the universities are in a position to make a significant contribution to social sciences research in Africa, including educational, cultural and linguistic studies and research. The fundamental importance of this aspect was vividly brought out, to cite but one instance, during the Round Table on Regional Social Science Activities in Africa South of the Sahara, held at Lomé, Togo, on 2-6 October 1972, under Unesco's auspices(1).

51. A further question which warrants careful analysis is the voice which universities have or should have in the proceedings of national science policy-making bodies. This is of importance because many basic questions arise in connexion with the integration of university R&D with the research needed for national socio-economic development, while, at the same time, safeguarding the principles of academic freedom.

52. Finally, CASTAFRICA might wish to examine the evolution of African higher education as it relates to the provision of R&D manpower. The data provided below is intended to facilitate the discussion of this similarly salient issue(2):

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(1) A description of the work done in this field by many African universities sometimes in co-operation with foreign universities, is given in Unesco document SHC/WS/272 of 3 November 1972: "The situation and perspectives of social science in tropical and equatorial Africa", by the International Social Science Council.

(2) Data here given are a summary of more extensive information in document SC/CASTAFRICA/REF.1. Figures are for 1969, 1970 or 1971.

There are, on the average, 480 students in higher education per one million inhabitants in the Unesco African Member States excluding Egypt. This represents 1/5th of the ratio for Asia (excluding Japan and China), 1/10th of that in Latin America and only 1/20th of that in Europe (excluding the USSR).

Over half of the students studying at national institutions of higher education are enrolled in the faculties dealing with humanities, education, fine arts, law and social sciences.

Engineering and agriculture are the smallest groups of study in most African countries (on the average 5.3% and 4.8% respectively). This fact, of course, has dire repercussions for the building up, within the African countries (Egypt excepted), of an adequate potential for industrialization, for the mechanization of agriculture, and for economic growth and national development as a whole(1). Similarly, the low percentage of students in the agricultural sciences (barring exceptions such as Mauritius) is blatantly low for countries very largely dependent on rational utilization of land resources for the production of food and of cash crops, as well as for the exploitation of forests.

One might be tempted to think that the above situation is righted to a good extent by large numbers of African students studying engineering, agriculture or medicine abroad. This is unfortunately not the case because the number of students abroad is, in absolute numbers, relatively small, and the distribution by field of study of those who study at home and those who study abroad is not significantly different. It is a fact that for many African countries study abroad is an essential supplement to local higher education, and that, in certain instances (Central African Republic, Dahomey, Gabon, Mauritius and Upper Volta) the number of students abroad is several times higher than those in national institutions. But, excluding Egypt, the total number of students from African countries studying abroad (in 50 selected countries of study) was only around 36,000 vs. 126,000 enrolled locally; a ratio of approximately 1 to 3.5. Egypt, where higher education is relatively well developed and the proportion of students abroad is considerably lower, brings tha ratio down, for the whole of Africa (excluding Southern Africa) to about 1 to 9 (40,000 students abroad vs. 344,000 locally in 1969).

A further aggravating factor for scientific development, of a general nature, is that the number of graduates from national institutions of higher learning is very low if related to population. For every 100,000 inhabitants, 5 to 10 students graduate annually in twelve countries, and only in five countries does the ratio reach 20. Since no noticeable change has taken place in the composition of the student enrolment in recent years, the distribution of graduates by field of study is likewise fairly stable and no immediate relief is in sight for the shortage of scientists, engineers and medical doctors of African origin.

53. The above statistical facts and comparisons leave no doubt that the present situation of third-level education in the African Member States, with the possible exception of Egypt, is not encouraging in terms of the future development

(1) In Asia, for instance, 10% of total third-level students study engineering; in Latin America the proportion is 14% and in Europe it is 18%.

of R&D on the continent, even when taking into account the ratio of students enrolled abroad. This is a fundamental question which the CASTAFRICA Conference will doubtless wish to consider in some detail so as to set sights for the future.

4. Scientific and technological potential

54. CASTAFRICA has before it a wealth of information about Africa's scientific and technological potential (STP). Providing such data is, in fact, the main object of much of the Conference's documentation (cf. the list of CASTAFRICA documents in Annex VI of the Final Report) and no attempt will here be made to reproduce it.

55. A glimpse of Africa's STP, as it arises from the Conference's documentation, might however assist CASTAFRICA in its discussion of this question. A brief summary is thus provided below under four headings: (a) R&D manpower; (b) R&D finances; (c) R&D institutions, facilities and equipment; and (d) scientific and technological information(1).

(a) R&D manpower

56. The R&D manpower situation in Africa may be summed up as follows(2):

In terms of the number of scientists, engineers and technicians per million population, a majority of the African countries possess but one-half to one-third of the corresponding numbers in Asia, and only 1/30th of those in Europe.

The number of scientists, engineers and technicians engaged in R&D in most of the countries does not exceed 10% of their total stocks, which is roughly comparable to the proportions of R&D scientific and technological manpower either in the developing or the developed countries of Asia and Europe.

No African country has so far achieved the target set for the Second United Nations Development Decade within the framework of the World Plan of Action prepared by the United Nations Advisory Committee on the Application of Science and Technology to Development (UNACAST): 200 research workers per

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(1) Few African countries have as yet carried out the inventory of their STP in an exhaustive way. Those who wish to do so might consult Unesco document SPS No. 15: "Manual for surveying national scientific and technological potential: Collection and processing of data; Management of the R&D system", Unesco, Paris, 1970, 251 pages.

(2) The data given in this section are taken, for the main part, from document SC/CASTAFRICA/REF.1 "Statistics on R&D in African countries"; and from Chapter IV of the Introduction to document SPS No. 31. The years to which the data refer are indicated in the source documents, and not repeated here. Most data refer to 1969, 1970 or 1971.

one million inhabitants by 1980[1]. In 24 out of 36 African Member States for which data is available the ratio is less than fifty. The countries closest to the target are: Mauritius 137, Egypt 84, Gabon 81, Ivory Coast 78, Senegal 77, Kenya 65, Tunisia 62, Congo and Ghana 60. Moreover, these figures include persons of foreign nationality, which in the instance of certain countries (e.g. Kenya) can represent up to 70% of the stock of scientists and engineers.

Part-time scientific personnel appear to constitute a considerable proportion of total scientists and engineers in R&D (48%, on the average, for all the countries surveyed).

Generally, natural sciences in Africa are represented by the largest group of R&D scientists and engineers (37% in total). Agriculture accounts for 33% of the total while engineering, which is the main group required for the tasks of adaptation of technology is one of the smallest R&D groups (9%) and is mentioned in only 20 of the replies from 36 African countries.

The higher education sector is the most important employer of R&D scientists and engineers in African countries: 55% of the total stock. The productive sector employs 36% and the general service sector only 9%.

The ratios of technicians per R&D scientist and engineer are different in the various sectors of R&D performance. In higher education the ratio is 0.6, in the productive sector 1.6 and in the general service sector 1.5; the average for all sectors is one technician per scientist or engineer. This is a rather low ratio by international standards, thus highlighting the shortage of technicians able to lend effective support to higher R&D personnel.

(b) R&D financing

57. Only partial data on R&D financing in Africa are available:

Ten out of 20 African countries reporting on their level of expenditure for science and technology, in connexion with R&D, have reported that they have reached or surpassed 0.5% of their GNP for that purpose. It is not clear, however, whether these countries have reached the 0.5% target for R&D properly speaking incorporated by the United Nations General Assembly in the International Development Strategy for the Second Development Decade[2]. It seems probable that they are still below the 1% of GNP target proposed by

(1) Cf. World Plan of Action for the Application of Science and Technology to Development, United Nations, publication 71.II.A.18/Rev., New York, 1971, p.63. The corresponding targets proposed for Asia and Latin America were respectively 380 and 400 research workers per 1 million inhabitants. As of 1967, most European countries had 1,000 or more R&D scientists per one million population and this figure has risen considerably since.

(2) Cf. International Development Strategy for the Second United Nations Development Decade (United Nations document A/RES/2626 (XXV), para. 61).

UNACAST[1] namely 0.5% of GNP for R&D proper, plus the cost of related scientific and technological public services (STS) (another 0.5% of GNP).

In most African countries government funds constitute the main source of R&D financing, though only one country (Senegal) appears to identify R&D expenditure, in the national budget, as a separate global item (national R&D budget). In some countries, however, the productive and/or service sectors play a major if not preponderant rôle in R&D financing. On the basis of data for a small number of countries, the higher education sector, using its own resources, appears to contribute to total national R&D expenditure in widely varying degrees ranging from almost nil to a fairly sizable percentage.

African R&D expenditure per R&D scientist/engineer, also on the basis of a small sample, appears to be in the range of $9,000 to $20,000; that is, very considerably below the world average of some $30,000. Almost the totality of available funds are spent on current expenditure, thus highlighting the difficulty of African nations to meet capital costs of R&D.

58. The above considerations, and their institutional as well as numerical implications, underscore that the present situation of R&D in Africa comprises positive as well as negative factors which must be taken into account in planning for the future.

(c) R&D institutions, facilities and equipment

59. The institution-building implications of scientific and technological activity lend themselves less well to numerical treatment, than those of R&D manpower and R&D financing.

60. With a view to CASTAFRICA, however, Unesco has striven to bring together the best possible documentation on the institutional aspect, by means of a survey carried out by Unesco's Field Science Office for Africa, Nairobi, and published in 1970 under the title Survey on the scientific and technical potential of the countries of Africa (296 pages).

61. The survey comprises an inventory of the scientific and technical research institutions of 40 African countries. Individual entries are given for 722 institutions, with a total of 6,048 full-time and 5,045 part-time researchers, or 11,903 researchers in all; it can be taken that this represented, at the time of the survey, almost the whole of Africa's STP, though it should be borne in mind that certain of the institutions are local branches of foreign institutions and that these, as well as some of the national R&D institutions properly speaking, are staffed largely by foreigners (expatriates). Also, some institutions may not have been identified or did not provide the information needed for the survey.

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(1) World Plan of Action, UNACAST, pp. 56-57.

62. Because practically every one of the R&D institutions conducts research in several fields at the same time, it is somewhat difficult to provide a breakdown of the 722 above-mentioned institutions, by field of R&D work. In effect, the intensity of attention which the individual institutions give to the various scientific disciplines with which they deal, varies very considerably. Nevertheless, it is interesting to note the very large range of R&D questions already being dealt with by African institutions, as indicated below:

Principal disciplines or groups of disciplines	Number of African institutions working in the disciplines indicated (1)
Fundamental sciences	
Mathematics	34
Atomic physics and nuclear physics	18
The states of matter	20
Physics (specialization not determined)	21
Chemistry (specialization not determined)	51
Nuclear chemistry	9
Inorganic chemistry	30
Organic chemistry	73
Biochemistry, biophysics, cell biology	53
Genetics	90
General physiology	82
Plant biology (botany, taxonomy, etc.)	134
Animal biology (zoology, taxonomy, etc.)	130
Radiobiology	15
Other biological sciences (ecology, conservation, etc.)	122
Earth and space sciences	
Geomorphology, geodesy, cartography	83
Gravity, magnetism	44
Mineralogy, petrography, etc.	75
Geology, vulcanology, hydrogeology, etc.	109
Palaeontology, palaeobotany	15
Research on internal structure (seismology, etc.)	31
Meteorology, climatology	70
Hydrology	48
Astronomy, astrophysics	7
Oceanography	37
Hydrobiology	37
Other disciplines of earth and space sciences	4

(1) Taken from pages 279-281 of the Survey on the scientific and technical potential of the countries of Africa, Unesco, 1970.

Principal disciplines or groups of disciplines	Number of African institutions working in the disciplines indicated
Medical sciences	
General	177
Fundamental sciences	72
Human biology and anthropology	36
Contagious diseases and vectors	85
Chemotherapy, antibiotics, antiseptics, medical chemistry, pharmacology	61
Nutrition	54
Water, soil and air hygiene	34
Surgery	12
Other disciplines of medical sciences	46
Food and agricultural sciences	
Soil management	179
Agricultural hydrology	70
Crop production	192
Crop protection (general)	183
Crop protection: agricultural entomology	83
Crop protection: phytopathology	61
Forestry and forest products	60
Animal production and animal products	109
Animal health	84
Continental fisheries	33
Maritime fisheries	20
Human nutrition and food technology	66
Application of isotopes as tracers in agriculture	23
Fuel and power	
Power (general)	24
Thermochemical energy	20
Hydroelectric power	14
Nuclear energy	7
Solar energy	14
Electric power transmission	8

Principal disciplines or groups of disciplines	Number of African institutions working in the disciplines indicated
Industrial research	
General	94
Metallurgy: ferrous metals	13
Metallurgy: non-ferrous metals	13
Industrial chemical products	16
Textile industry	10
Mechanical engineering	8
Electromechanical engineering	6
Transport engineering	8
Telecommunications	10
Applications of automatic devices	10
Building and civil engineering	67
Building materials	57
Principal sciences applied in the building industry	22
Main building techniques	21
Economics	46
Social and human sciences	
General	46
Geography	38

63. The above information gathers meaning in the light of the distribution of the 11,093 research workers who, at the time of the survey, worked in the 722 institutions surveyed, either full-time or part-time, as follows:

	Full time research	Part time research	Total
Fundamental sciences	655	1,643	2,298
Earth and space sciences	1,410	219	1,629
Medical sciences	589	1,318	1,907
Food and agricultural sciences	2,637	1,072	3,709
Fuel and power research	87	62	149
Industrial research	375	587	962
Economics*	79	18	97
Social and human sciences*	216	126	342
TOTAL	6,048	5,045	11,093

* In specific relation to the sciences covered by the survey (see p. 19)

64. The survey provides information for each institution, on a number of questions, such as the extent of laboratories and experimental fields, library, publications, etc.

(d) Scientific and technological information

65. In connexion with the STP, CASTAFRICA might finally wish to consider the problems posed by the development of the information resources which are an indispensable input to the formulation and application of science and technology policies.

66. The important question of required international co-operation in this field is discussed at some length in Chapter III, in connexion with the "World Scientific and Technical Information System" (UNISIST). In the national context, CASTAFRICA might wish to consider needs for the development of scientific and technological information and documentation services which are the point of entry for the transfer of information resources from abroad. These services are, at the present time, very little developed in Africa, though they are an indispensable part of the national scientific and technological infrastructure.

5. Objectives of science and technology policy

67. Earlier science policy concepts somewhat optimistically assumed that if sufficient resources were devoted to building up and staffing scientific institutions, these would have an almost automatic modernizing effect on industry and agriculture, and on society generally. It is now evident that this is simply not so. While in the deliberate application of science and technology to development we are still hampered by our inadequate knowledge of just how the system works, it is already apparent that the provision of scientific institutions does not in itself ensure an automatic contribution to development. "Science for policy" as a logical counterpart to "policy for science" was thus conceived.

68. But even this concept is inadequate unless the picture is completed with the addition of technological innovation, the mechanism through which science and technology make their impact on economic development. In past centuries science and technology have evolved almost independently of one another - old technology gave birth to new technology, while old science gave birth to new science. More recently a much closer interaction has been developing, though even now the relationship is not strictly sequential - scientific discoveries do not necessarily lead immediately to new technology, and technology improvements are most often based on long-known science or on advances in other fields of technology. But while science and technology cannot be considered a unity, they are evidently closely interrelated, and without doubt scientific knowledge can and must be used to improve technology, which in turn is an important input to the production of goods and services.

69. In other words science and technology policy - in short often referred to simply as science policy - needs to cover the whole chain of research, experimental development, and technological innovation (including technology import and adaptation). While the process is theoretically divisible, in operational terms the different elements are tightly interlinked and virtually impossible

to treat separately. Science and technology policy is in fact an integral part of overall national policy - that part which consists in improving the resources available to science and in promoting technological innovation to attain national goals.

70. Alternatively, the application of science and technology to development can be viewed as a supply and demand situation through which the requirements of industry, or other sectors of national activity such as agriculture and medicine, are translated into a need for new knowledge, and the output of the R&D system is translated into possible economically or socially oriented applications. In this process demands are placed on the scientific community for new knowledge in applicable form, and for certain scientific and technical services. Policy-making in science and technology then consists in influencing the demands which the production system places on the R&D system. Science and technology policy in toto must concern itself with both sides of the equation and with the interconnecting links.

71. Thus the range of interests covered under science and technology policy includes the build-up of a suitable network of institutions to carry out R&D and to offer supporting scientific and technical services (STS) as well as the problems involved in putting these institutions to effective use. The design of such a network - or the rationalization of an existing network - requires decisions on the rôles which the various units thereof are expected to play in relation to national problems, and vis-à-vis each other. Decisions will have to be made on the allocation of financial and human resources to longer range work, and the opportunities this may potentially offer, as against the immediate and pressing need to solve production and adaptation problems.

72. On the other side, the demand within productive sectors of the economy for new science or improved technology with a view to produce more and better goods or services at lower costs depends greatly on the political climate and the functioning of the economic system generally. In a market economy it also depends on the degree to which entrepreneurs make use of science and technology to their competitive advantage. Given the right climate, demand can be stimulated in a variety of ways, including the enforcement of standard specifications, and the promotion of productivity improvement centres and consultancy services. Various incentive schemes, such as tax allowances, have been used to encourage the use of local research services. Significant price differentials for quality can stimulate the use of improved technology in agriculture. These aspects are a necessary part of science policy-making and planning, with the aim of promoting both the use of scientific knowledge and technological know-how by the productive sectors and the development of science and technology tailored to the needs of the productive sector of the economy.

73. Particularly in developing countries the linkage mechanisms between the R&D system and the users of research results are weak, and these vital linkages have to be deliberately developed to ensure adequate two-way communications. The fostering of these mechanisms and ensuring that they work effectively is one of the major concerns of science and technology policy. Examples of these mechanisms are agricultural or medical extension services, which in a developing country may need to be matched by corresponding industrial extension services.

74. Also of direct concern to science policy-making and planning is the education system, which provides inputs to both producers and users of science and technology, and which therefore receives demands for skilled people from each side. Here again, science policy is concerned not only with the supply and training of research scientists, but also with the much broader problems relating to the training and distribution of scientists, technologists, engineers and technicians in production, marketing, and public administration, and most particularly the development of technologically-minded managers and entrepreneurs. The general level of vocational training and the scientific awareness of the population as a whole are also highly relevant factors in making use of modern science or technology.

75. Thus science policy and education policy are closely interrelated, ideally representing two specific aspects of one single coherent development programme. Unless a nation has an adequate scientific and technological potential, arising from a well-conducted and persistent policy for science, it cannot reach the point where it can usefully apply a science for policy.

76. The heart of the problem of building up of the national scientific and technological potential is that of tracing pathways which will allow a country to develop them in such a way that it can yield the greatest possible benefits as seen from many standpoints - essentially, that of pursuing an expansion of knowledge from a purely scientific point of view, or that of finding new solutions to more earthy and material issues which the nation must perforce face (pursuit of socio-economic "missions").

77. For either of these tasks, nations must possess tools, and CASTAFRICA may wish to dwell on the need for the African nations to perfect, as soon as possible and urgently, their means of maintaining permanent surveys of the national scientific and technological potential, in such a way that they can be used for the proper conduct of the national science and technology policy in the context of the national overall development effort(1).

6. Government structures for science and technology planning and policy-making - The national R&D system

78. Having cleared some of the main issues which have led governments to establish formal (and sometimes even rather informal) structures for science and technology policy-making and planning, CASTAFRICA might take up the question of the extent to which institutions for this purpose now exist in Africa, and seek to draw conclusions as to the present situation and desirable future trends in this field.

79. As has been pointed out, it is only in recent years, and generally not before their accession to independence, that the subject of science policy has received serious attention in the African countries. Not surprisingly, therefore, the institutions and mechanisms for the planning of science policy and the management of R&D are found to be mostly in an evolutionary stage, often of a

(1) Attention is again drawn in this connexion to the Manual for Surveying the National Scientific and Technical Potential, op. cit.

tentative nature, or even in some cases totally lacking. This would certainly be expected, bearing in mind the organic relations between the science policy suitable for any particular country, and the political, social and economic conditions prevailing in that country at a given stage.

80. However, even those African countries where the science policy structure appears weakest have expressed keen appreciation(1) of the potential significance of science and technology for their economic development as well as the great value of a purposeful science policy for co-ordinating their national research activities and for guiding them into those projects most likely to accelerate socio-economic development. The scarcity of resources - human, financial, institutional and informational - devoted to scientific and technological activities, which is common to most of these countries, and explicitly deplored by them, is a factor which intensifies the necessity of using efficiently all available resources, thereby avoiding undue overlap or serious gaps in their national R&D efforts.

81. The above remarks make the information in Table I all the more impressive and meaningful. In a very brief span of time - barely the one decade that has elapsed since the Lagos Conference - by far the majority of independent African nations have moved to create policy-making bodies for science and technology, and others have announced their intention to follow suit.

82. CASTAFRICA will doubtless wish to consider, in some detail, the real meaning of the information contained in the Table. Are these institutions effective? In the affirmative, how? If not, why? What can be done to improve the present situation? The discussion of these problems might well be facilitated by considering the results of a survey conducted by Unesco over the period of the First United Nations Development Decade (1960-1970) on the operational characteristics of the principal national science policy-making bodies existing in the Member States of the Organization.

83. As a result of this survey it became possible to conceive the national science policy structures as comprising the following four levels:

84. A <u>first</u>, top level at which planning and decision-making are undertaken on a comprehensive national scale and are co-ordinated inter-ministerially. This level normally takes concrete form in the shape of a separate ministry (e.g. the Ministry of Scientific Research in Guinea and in the Ivory Coast), and/or a special council closely related to one of the highest government offices such as the Prime Minister or the President of the Republic as the case may be.

85. The <u>second</u> level includes bodies which promote, finance and co-ordinate R&D within various sectors of the national activity. Typical amongst the bodies found at this level are Research Councils dealing respectively with sectors such as agriculture or medicine, and including among their members representatives from the spheres of science, government and industry.

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(1) Cf. The National Summaries in Unesco document SPS No. 31.

TABLE I

POLICY-MAKING BODIES FOR SCIENCE AND TECHNOLOGY IN AFRICAN COUNTRIES (MAY 1973)

COUNTRY	Ministry of Science or ministerial science policy committee	Science planning body - general	Multisectoral body for co-ordinating scientific research	Co-ordinating bodies for scientific research					
				Natural sciences research	Agricultural research	Medical research	Nuclear research	Industrial research	Environmental research
Algeria	X(3)		X(1)					X(2)	
Burundi									
Cameroon		X	X		X	X		X	
Central African Republic			X						
Chad			X						
Congo			X						
Dahomey			X		X	X		X	X
Egypt	X		X	X	X	X		X	X
Ethiopia			X	X(4)	X	X(4)		X(4)	
Gabon			X(4)						
Ghana		X(?)	X						
Guinea	X		X(?)						
Ivory Coast	X		X		X(?)				
Kenya(8)									
Lesotho									
Liberia		X							
Libya									
Madagascar			X						X
Malawi					X				
Mali(5)		X			X				
Mauritania									
Mauritius									
Morocco					X		X		
Niger		X(?)	X		X				
Nigeria		X	X	X	X	X		X	
Rwanda									
Senegal		X	X						
Sierra Leone									
Somalia									
Sudan		X(6)	X(6)		X	X		X	
Tanzania(8)		X	X						
Togo									
Tunisia	X(7)	X							
Uganda(8)		X(?)	X						
Upper Volta					X				
Zaire		X	X		X(?)		X(?)		
Zambia		X(?)	X		X	X	X(?)	X	

(?) Situation not altogether clear

(1) Provisional (2) Government Department of Mining and Geology (3) Ministry of Higher Education and Scientific Research

(4) Projected (5) There is a Natural Resources Research Committee which undertakes co-ordination

(6) National Council for Research (7) Ministry of Planning cover science policy and R&D

(8) Note close relations with the scientific bodies of the East African Community.

86. The third level is that at which R&D is actually executed, thus covering a network of research institutions, special schools at universities, and centres of various kinds, the extent of this network normally increasing as the socio-economic development of the particular country proceeds.

87. The fourth level is that of the scientific and technological services required for the execution of R&D and for the production of goods and services (for instance, meteorological services, geographical services, etc.).

88. A mere comparison of the extent to which institutions exist at the above-mentioned four levels in each African country, is not likely to provide an accurate impression either of the efficiency of the institutions concerned (measured in exclusively scientific terms) or their effectiveness (measured as their contribution to the achievement of national goals). These institutions must therefore be looked at and their performance evaluated in a systematic and operational manner.

89. Beyond the governmental structures just referred to in a static way there is, of course, the national R&D system as such, the dynamic characteristics of which CASTAFRICA may wish to consider, as they apply to the African nations.

90. This system can be cybernetically described in terms of "black boxes" and interconnexions, as shown in Diagram C which can be used as a basis for assessing the information contained in the National Summaries.

91. It will be observed that, within Zone I of the diagram, the national development plan and State budget determine, in close collaboration with the national science policy body, the means or resources at the disposal of the national research institutions.

92. Once approved by the government, these resources are fed into the R&D system as "energy", mainly in the form of manpower, funds and scientific information. The general objectives of the national research efforts are determined and endorsed by the government in the same way, and are then injected into the R&D system as "directives", in the form of instructions or recommendations. These "directives" are transmitted for execution:

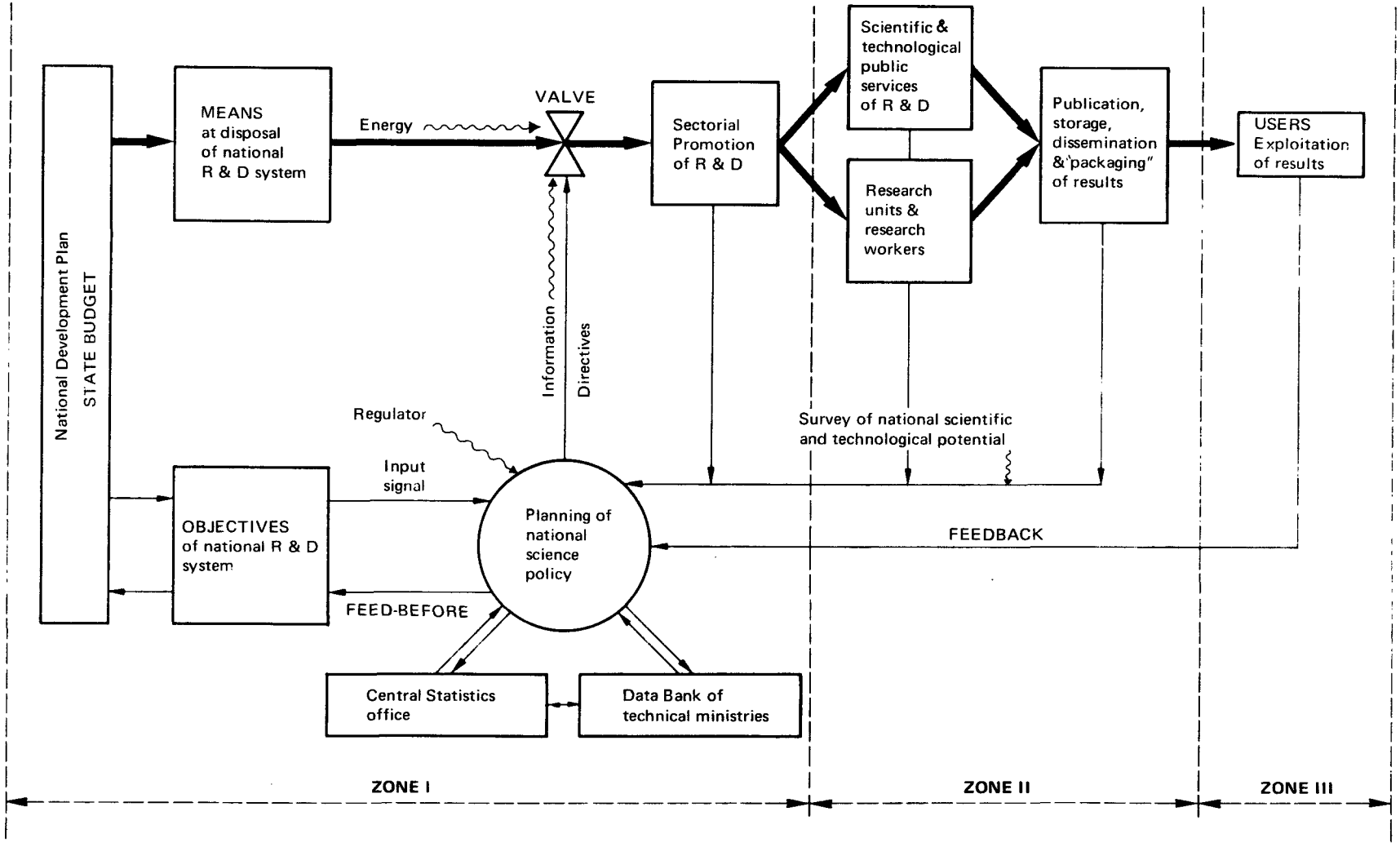
to the authorities responsible for making resources available; and

to the institutions responsible for sectoral promotion of R&D, for performing R&D, and for providing services for R&D.

93. This "transmission and clutch" constitute valve V in the cybernetic diagram. If the valve jams, the whole science policy operation remains a dead letter. This is exactly what happens in certain African countries when the government's financial and budgetary machine is not yet sufficiently run in and where, as a result, the ministry of finance (or the comptroller of the budget) arrogates to itself, on "technical grounds", the right to block the execution of science policy decisions taken by the government as a whole.

Diagram C

CYBERNETIC MODEL OF NATIONAL R & D SYSTEM



94. Zone II in Diagram C covers both the work of the national research units and research workers, as well as the work of scientific and technological public services which lend support to R&D. Also included in this zone is the publication, storage and dissemination of research results, including their "packaging" in a form ready for immediate practical application.

95. Zone III comprises the users of R&D results, both scientific and technological; this is where the new knowledge is applied in practice and where it can be seen whether the national R&D system is ultimately justified and its effectiveness gauged.

96. Mention should also be made here of an aspect of salient interest to developing countries - that of "transfer of technology" - since they are so highly dependent on the production of technology in the industrialized countries. The mere importation of technology may be termed "horizontal transfer of technology", as opposed to the "vertical transfer of technology" which comprises the transfer of scientific and technological knowledge through the whole - or part of - the chain of operations that go from fundamental research to the actual production of goods or services, as depicted in Diagram C. The situation, as it applies to developing countries, comprises two channels of transferring foreign knowledge to a country, which can respectively be labelled "packaged", and "unpackaged". Whereas packaged transfer goes directly to the users (for instance, in the form of "turn-key" industries), the unpackaged transfer enters the national system through national research units which analyse, assess and - if need be - adapt the imported knowledge to local conditions.

97. It is important to note that "feedback" from the users to the purveyors of scientific and technological knowledge should take place both at the national level (for locally developed knowledge), and at the international level (for imported knowledge). It would be normal to expect users dependent on "packaged" transfer to address their feedback mainly to the foreign purveyors in order to allow them to further improve their technology so as to fit better the local conditions and needs of developing countries.

98. A concluding observation is that - in Africa - Zones I and II in Diagram C predominantly cover research, rather than experimental development, primarily because of the fact that technology is admittedly incipient in the region, while Zone III is mainly dependent on "horizontal transfer of technology". This is an important aspect in the African context which should be borne in mind during the analysis of national R&D systems.

7. Efficiency and effectiveness of R&D

99. On the basis of the foregoing considerations, CASTAFRICA may wish to devote a part of its time to discussion of a further important and related question: that of the efficiency of the African research units and the effectiveness of the R&D system as a whole, in terms of application of the results which it produces. These concepts have particular relevance in a developing country, where the government and the public are entitled to know whether their limited resources are being properly used. Although African scientific and technological potential

has been growing rapidly and is already reasonably strong, the available resources are still far below those in other parts of the world. This drives home the importance of using them to best advantage.

100. However, much discrimination is called for in applying the notion of efficiency to research. While R&D and the related scientific activities have become of national importance, especially in relation to economic development, R&D cannot be placed on the same footing with the production of goods and services, since the results of scientific activities are, by their very nature, subject to a long-term uncertainty inherent in the exploration of the unknown. Furthermore, such activities do not lend themselves to an assessment of input-output ratio, whether qualitative or quantitative. Input can be measured easily enough; but measurement of R&D output is likely to defy econometric calculations for some time to come.

101. By the "efficiency" of the R&D system is meant the ratio of the new scientific or technical knowledge actually produced by the system and that which might theoretically be expected of it, given the resources employed. Although this concept does not take into account the users of the new knowledge thus acquired, it is by far the most interesting aspect to the scientist at the bench,

102. The "effectiveness", on the other hand, is concerned with the "benefits" which may be expected from investment in the national R&D system. At least three criteria are relevant to its assessment:

(a) the cost/benefit ratio of research and the application of its results;

(b) the social benefits (including security and quality of life) that may be derived from application of the results;

(c) the scientific and technological value of the results, which can be roughly appraised by the citation index of publications and by purchases of patents and licences.

103. The results of fundamental research do not constitute "prorietary knowledge"; but governments and public consider that the pay-off in terms of scientific and cultural prestige redounding to the whole nation is amply satisfying when important discoveries are made in the country and recognized at international level by the award of prizes or honours.

104. These concepts can be applied not only to national R&D systems, but to individual organizations within the system. The system's efficiency and effectiveness are evidently bound up with the proper working of these institutions and of the services responsible for the dissemination and utilization of the results. At the research unit level a key issue is the quality of research management. Research leaders even in industrial laboratories tend to be highly science-oriented and have a limited awareness of the economic factors affecting the industry they are intended to serve, such as for example price-quality-market relationships. Under these circumstances research programming can be rather arbitrary. Without attempting to fetter research leaders, it is useful to develop management systems whereby senior research personnel are obliged to go more

or less thoroughly through the discipline of defining their objectives, justifying their requests for budget allocations, and accounting for their subsequent performance. It may also be advisable to bring research staff into closer personal contact with their industrial clients or potential clients, as through joint management training courses or liaison officers attached to research units. In many ways this problem can be regarded as a special case of the more general management problem discussed below.

105. CASTAFRICA may wish to consider recommendations for action likely to propagate, in Africa, the concepts of efficiency and effectiveness in science and technology. A clarification of these notions, as they apply to the management of R&D on the continent, might first be sought through appropriate workshops, symposia or other meetings.

8. National scientific and technological public services (STS)

106. Before attempting to round up some of the social, cultural and economic constraints to scientific development in Africa, the present section draws the attention of CASTAFRICA to the basic importance of national scientific and technological public services (STS).

107. During the first phase of industrialization a key rôle falls to these supporting services, which form the essential infrastructure for modern activities. They include mapping and surveying facilities, indispensable for formulating cogent national plans, scientific information and document services, vital for horizontal technology transfer, and testing and analytical services, standardization and metrology. Industrialization is impossible without this supporting infrastructure, yet it often receives inadequate attention(1).

108. It is apparent that much remains to be learnt in general terms about the operation of the scientific and technological public services in Africa, and in particular about their functioning in a particular socio-cultural-economic environment.

109. It would seem obvious that CASTAFRICA, after considering the importance of the STS, will wish to examine possible measures for their strengthening and development in Africa. This aspect is more closely related to necessary inter-African co-operation, than to the building up of national R&D systems, because the data and information which must be gathered and diffused by the services often extends beyond the national frontiers (e.g. meteorology). The question is therefore also dealt with in some detail in Chapter III of the present document, which deals specifically with inter-country and international co-operation.

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(1) An illustrative list of these services is given in the World Plan of Action for the Application of Science and Technology to Development, United Nations, New York, 1971 (pages 90 and 91).

9. Social, cultural, economic and management constraints

110. In conclusion, CASTAFRICA might consider some of the constraints which Africa faces in its scientific and technological development effort. Development has been appropriately described as the result of two simultaneous processes, growth and change, either of which can be decisively influenced by the application of science and technology(1). While in the process of economic growth, science and technology contribute mainly through increases in efficiency and improved productivity, perhaps the most important and far-reaching effects of science and technology are to be found in the change component of development.

111. In most developing countries, lack of scientific knowledge and technological know-how are rarely the key critical limiting factors - the main obstacles to change are economic and social, including education and general level of skills, communications between different social groups, the acceptability of new ideas, administrative effectiveness, entrepreneurial spirit of industry and political leadership. Social, cultural and religious traditions are often powerful and positive barriers to change, and sustained economic growth may require extensive and intensive changes in human value systems and attitudes, as well as in social and political structures. Only within this broader context of development can science and technology make a really effective contribution.

112. Evidently much will depend on the development goals which a country sets for itself. Most countries are increasingly - and understandibly - concerned with clarifying and preserving their social and cultural identity, and with protecting and improving the quality of life of their inhabitants. African countries are clearly not likely to be content to become faceless imitations of other societies, and they will each individually have to come to terms with the social impact of modernization. Whether in terms of technology or international relations. However, as a common denominator most countries usually seek improvements in material living conditions, through increases in the production of goods and services per head of population. Economic growth is still a primary, if not the primary objective of most governments in Africa. The problem is to find an acceptable compromise between economic and social change, seen not as a static situation, but one which is inevitably in a continuous state of flux.

113. Economic and social change in Africa depends primarily on the actions of the various constituent countries themselves, and in particular on their peoples and their governments. The successful achievement of the conditions for speedy overall development is possible only if this is accepted as a priority objective, and if governments pursued stable policies directed towards this end. In any event science and technology alone can make little contribution without the will to progress, and the opportunity and organization to use them.

114. Speaking more generally still, it seems unlikely that development can be achieved and social change accepted without building up a certain minimum of scientific culture. This may involve fostering a wider and deeper undertanding of scientific methods and their applications at the adult level, through adequate provisions within the educational system.

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(1) Ref. CASTASIA, Science in Asian Development, p. 99 et seq.).

115. The level of scientific literacy of the future adult population will depend largely on early exposure to science. The immediate impact of science on a society is manifested as a change in technology. Technological change affects the way men make their living, their social habits, their whole way of life, and is inevitably therefore disruptive of established attitudes and practices. All societies tend to resist this change and preserve the status quo. The capacity of a society to assimilate new technology depends on both its capacity to adapt the technology to its own conditions and its capacity to adapt itself to the needs of technology.

116. Though the situation is slowly changing, at this stage of African development most of the new technologies will come from abroad. The obstacles to the transfer of technology from one culture to another, and specifically from an industrialized developed country to a less developed country, are as yet little understood, as equally are the best means to overcome them.

117. Although the process of technology transfer itself[1] is nowadays better understood and in no ways different in essence according to the regions considered, it remains to the Africans themselves to determine how technology must be tailored to suit their own set of social and cultural conditions, or, alternatively how these local conditions must be changed to allow new technologies to be assimilated. Unless the Africans can create a capability for technological assessment; that is, analysing the social and cultural implications of technological development, they will be in a very vulnerable position, with serious potential consequences.

118. The social climate will have a strong determining effect on the direct proponents of technological change: the scientists and technologists. The supply and the quality of scientists and technologists will depend not only on the educational system, but also on social attitudes towards their work. Status, social as well as scientific, may be critical and special incentives and rewards may be needed to attract the most able people into these careers. The factors which affect the productivity of expensively-trained scientists and technologists, and the preferences they exhibit for particular fields of work, may also merit close examination. A better understanding of these matters might help to induce the ideal situation, whereby scientists are motivated to work in fields which coincide with the national interest, and above all, to stay in their country instead of succumbing to the temptations of international brain-drain.

119. Among the economic constraints, CASTAFRICA may wish to examine in the first place some of the problems posed by the existing economic structures which may severely restrict the scope for exploiting modern science and technology in practice. It is not easy to induce technological change in a context of subsistence farming, small indigenous workshops and large expatriate trading/manufacturing concerns. It may well be that the full potential for increased production and improved productivity which technological change allows can be properly exploited

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(1) The greater part of Chapter II below is devoted to the technical aspects of technology transfer and to the barriers that hamper such transfer in Africa, in connexion with the implantation of new technologies.

only in the context of structural changes in the economy and modified economic policies. These questions are so important that Unesco has deemed it necessary to request the Organization of African Unity to prepare a special study on "The propagation of new technologies in Africa" which is submitted to the Conference as document SC/CASTAFRICA/Ref.3.

120. In terms of the two main production sectors, agriculture and industry, structural changes may be required both within and between the sectors. Agricultural production needs to move from subsistence or semi-subsistence farming to a more flexible, market-oriented, increasingly specialized organization, with increased yields from land and labour, which will be able to meet the widening nutritional needs of a growing population, increasingly urban, to provide raw materials for industry and a market for industrial products, and to contribute to foreign exchange earnings through exports and increased local value added. In industry, expansion must be accompanied by productive employment and growing incomes, with an ability to supply domestic demand but also to move into international competitive markets. To these ends structural change and technological change must move in unison.

121. Similarly, there is a whole array of government policies - labour, fiscal, financial, trade, etc. which should ideally be harmonized with science and technology policies. In practice there is often a failure, in advanced countries as well as developing countries, to take into account the implications of economic and other policies, usually adopted for other purposes, on the viability and direction of the science and technology effort. It is a task of the science policy makers to publicize these implications because the economic system does not only affect the possibilities for the application of science and technology, but it also largely determines the structure of the R&D system.

122. In developing countries, where the local private sector is not yet motivated nor equipped to do research, the governments have necessarily a rôle to play, building up an adequate network of research institutions, with supporting technical and scientific services, almost entirely government financed (though there are notable exceptions) based both on bilateral and international financing. In this connexion, the United Nations Advisory Committee on the Application of Science and Technology has requested Unesco to assist the developing countries on their request, to determine their institutional needs in science and technology as they relate to the national socio-economic development objectives(1). An analysis of the first results of these surveys, carried out in 20 African countries over the years 1971-1973, will be made available to CASTAFRICA as a conference room document.

123. Finally, in connexion with constraints, CASTAFRICA may wish to discuss some of the managerial barriers which stand in the way of a more extensive application of science and technology in Africa. It is nowadays recognized that the proper application of modern management techniques may have more far-reaching effects than the application of the natural sciences. It has been said that high

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(1) Cf. World Plan of Action for the Application of Science and Technology to Development, United Nations, New York, page 71-72.

quality management is a sine qua non for an effective science and technology policy, the examples of the Federal Republic of Germany and Japan, where the R&D investment was proportionally less than in many other market-economy countries while their rate of development remained substantially higher in the same period, have done much to focus attention on the need for high quality management.

124. Yet for a wide range of social, cultural, historical and other reasons, the key rôle of management is still not sufficiently recognized in Africa. The socio-cultural constraints affecting the attitudes to management and the attitudes of management are worthy of serious study. Management techniques may need to be adapted to suit particular African circumstances just as any other form of imported technology. Long-term improvements in management practices in the field of science and technology and their application to development needs to be supported by systematic research on the management process, managerial behaviour and training methods.

125. At the same time, it is also important to encourage the development of entrepreneurs able to recognize the possibilities offered by a new idea or new techniques, and on this basis to set up a new enterprise, public or private. An entrepreneurial spirit is probably not something which can altogether be taught, but latent abilities can be brought out and strengthened by various training methods, and by measures to induce a more favourable environment.

II. QUANTITATIVE TARGETS

126. Whereas Part I of this Chapter has attempted to provide a conceptual basis for CASTAFRICA discussions under item 7 of the Provisional Annotated Agenda, the present Part turns squarely to the question of whether the Conference is in a position to attempt to establish some basic targets which might guide governments in their efforts to promote national scientific and technological development. While the targets are, of necessity, quantitative, they do have direct institutional implications which are implied in what has been said in Chapter I and should be kept very much in the forefront of thinking about the justification for the setting of targets.

127. In going about this work, CASTAFRICA may wish to split its debate into five parts dealing respectively with (a) financial resources for R&D, (b) human resources for R&D, (c) ratio of technicians to R&D scientists/engineers, (d) scientific and technological equipment, and (e) general financial implications. These are but five facets of the many which intervene in R&D development, but, if it should be possible to establish numerical points of reference for their future evolution, the institutional and other implications will be at least tangentially covered.

1. Financial resources for R&D

128. It is well to consider the financial aspect first because, in theory at least, money is the one thing that governments could overnight decide to allocate for a particular purpose.

129. In practice, the African nations, as all developing nations, have to face extremely grave financial constraints, and stringencies and the question which CASTAFRICA might ask itself therefore is: At the present juncture, what is a reasonable level of national expenditure on R&D, as measured against the national GNP, on the one hand, and against the national budget, on the other?(1)

130. The answer to the first and second parts of this question present quite different facets which merit consideration.

131. In so far as expenditure expressed as a percentage of GNP is concerned, it should be recalled that the GNP is made up of contributions emanating from all sectors of national activity, including foreign-owned or directed enterprises which may have little or no connexions with national development planning or government. This explains, in part, (Cf. paras. 57-58 of this Chapter) the fact that 10 out of 20 African reporting countries have indicated that they are now spending 0.5% or more of their GNP for R&D and STS. Furthermore, it is perfectly clear, from the analysis which has been made of the situation of higher education for Africans, that R&D work in Africa, financed from abroad, cannot be dispensed with. CASTAFRICA may even wish to consider the drawing up of recommendations for an expansion of such valuable outside inputs. But, if it does so, it should also try to recommend a proper dosing of the indigenous effort as compared with inputs received from the outside.

132. This last aspect is related, of course, to the possibility for the CASTAFRICA Conference to draw up recommendations as to the extent to which the national budget should make room for R&D financing and incentives. It is known(2) that, in most African countries, government funds provide over 50% of R&D financing, but there are a number of exceptions and the likely consequences of a shirking of government responsibility in this connexion might be usefully discussed by the Conference. One course, following the example of certain of the industrialized countries, might be to recommend that all funds allocated by governments in the national budget be grouped under a special, separate heading, thus constituting the "national R&D budget", which should represent a certain minimum percentage of the total national budget.

133. A further related question, in the context of R&D funding within the national budget, is that of the funding of R&D undertaken by the national universities. Data on this aspect is unfortunately not available, except for the five countries cited below, for which the percentage of R&D expenditure (both total and current), accounted for by higher education was as follows:

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(1) Such data as are available on R&D financing in Africa are analysed in paras. 208-214 of the Introduction to document SPS No. 31.

(2) Cf. document SC/CASTAFRICA/REF.1, para. 73.

TABLE II

	Higher education R&D expressed as a percentage of total national R&D expenditure
Ivory Coast	23.8
Kenya	9.0
Madagascar	2.2
Mauritius	1.9
Nigeria	17.6

134. The question would appear to merit consideration because of the very rapid growth of African higher education during the last decade. The likelihood that citizen pressure for easy access to universities will remain very high in the foreseeable future, may make it ever more difficult for universities to find room for R&D activities within the funds allocated to them "for the purposes of higher education". While the undertaking of research by university professors is admitedly one of the main ways of upgrading their professional level and validity as teachers, is it not better for the State to take, at the political level, a global decision as to the "national R&D budget" and then, through appropriate mechanisms - such as National R&D Funds or Sectoral Research Councils - to allocate funds selectively for university research on a grant basis? A parallel question which CASTAFRICA might consider is whether such a system, as opposed to the global allocation of funds to universities for teaching and for R&D work, might not facilitate team research, as opposed to individual research, within the universities, through the allocation of subventions or the conclusion of contracts for specific R&D work related to national development programmes. Such arrangements might, for instance, include the provision that senior students work directly with government agencies or private industrial enterprises, thus making their education more practical and valuable to the nation.

135. Another aspect alluded to earlier but on the basis of the data available for 5 countries only, is that it would seem that the "productive sector" distinguished in Unesco statistics from the "higher education sector" and the "general service sector" appears to be carrying out (and financing) a sizable proportion of national R&D. For Ivory Coast, Kenya, Madagascar and Mauritius the range is from 67.3% minimum to 88.8% maximum of current R&D expenditure, and from 67.3% minimum to 91% maximum of total R&D expenditure(1). It is difficult to draw general conclusions from such a small sample, but the figures do suggest the advisability that CASTAFRICA consider the relationship between R&D undertaken by the higher education sector, and that undertaken by other sectors. Is it true to say that, at present, there is little connexion between the university R&D and the needs of the productive sector? Would National R&D Funds or Research Council

(1) Cf. document SC/CASTAFRICA/REF.1, para.70.

Funds of the type previously mentioned not provide an opportunity to spur links of high economic yield between the universities and the productive sector? It must be recalled that for R&D research in the productive sector there would appear to be no a priori reason why universities could not be rather easily associated with so-called "branch research institutions" which serve the productive enterprises of a whole economic sector. It might finally be remarked that there might well exist a situation, in certain countries, where such indigenous African R&D personnel as is available is mainly concentrated in the universities, whereas the productive sector - and research institutes maintained in Africa by foreign nations - relies mainly on foreign (expatriate) researchers. In such instances, much could be said for bringing together scientific researchers from the two sectors.

2. Human resources for R&D

136. Needless to say, even if funds for R&D were made available by governmental or private entities, no valid and useful research could be carried out unless high-level R&D personnel, and the required technical staff, were also available.

137. Whereas R&D financing statistics tend to be flimsy in Africa, R&D manpower data are more solid, and the figures and facts already mentioned strikingly show Africa's vulnerability in this regard, possibly with the sole exception of Egypt.

138. Yet, within a historical context the situation is far from being discouraging, in the sense that much progress has been made during the past decade. The Lagos Conference (1964) recommended that African nations fix as a target to be attained by 1980 a ratio of 200 scientists per 1 million population, this figure to include engineers and "senior officers of Ph.D. level, graduate scientists in all sectors and all university teachers"(1).

139. Although the Conference stressed that the target was "very low by international standards"(1) that it should be retained for the moment only, and that it should be revised after 1970 in the light of further studies, it is nevertheless to be remarked, as shown in the table below, that the ratio has long been surpassed by many African nations on the one hand, but is still valid as a target for the least developed amongst the African countries, on the other.

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(1) Final Report of the Lagos Conference, page 54.

TABLE III

Country	Year	Total Number of scientists and engineers	Number of scientists and engineers per million inhabitants	1970 GDP per capita (1970 US$)	Ratio of scientists/ engineers per million inhabitants for every 1 US$ of per capita GDP
(1)	(2)	(3)	(4)	(5)	(6)
Ghana	1970	6,897(1)	795	311.2	2.5
Mauritius	1967	554	720	237.7	3.0
Tunisia	1968	+ 2,228	450	259.8	1.7
Nigeria	1970/71	19,885	360	131.1	2.7
Tanzania	1968/69	4,080(2)	320	102.8	3.1
Malawi	1967	1,253	300	76.1	3.9
Congo	1966	231	270	324.0	0.8
Kenya	1970	3,000(3)	270	148.5	1.8
Togo	1971	461	230	140.5	1.6
Cameroon	1967	+ 800	145	184.0	0.8
Sudan	1965/66	1,668	120	119.1	1.0
Central Afr. Rep.	1969	124(4)	80	147.7	0.5
Somalia	1965	+ 175	70	67.5	1.0
Rwanda	1967	207	60	56.5	1.1
Upper Volta	1967	160	32	61.3	0.5

(1) Also including data for humanities, education and the arts.

(2) Data relate to persons employed in any job requiring a university degree.

(3) Not including second level science teachers.

(4) Partial data

Sources: Columns (2), (3), (4) and (5): document SC/CASTAFRICA/REF. 1, pages 1 and 2 of the Appendix.

Column (6) Figures in column (4) divided by those in column (5).

140. It is interesting to note, from the table, that despite the relatively low number of scientists and engineers in the 15 countries for which fairly consistent data are available, there exists a close relationship between the stock of scientists and engineers, and the GDP. Expressed as a ratio between (1) the number of scientists and engineers per 1 million of population and (2) per capita GDP, the ratio is about 3 for the African higher per capita income countries; 2 for the African middle-bracket per capita income countries; and 1 for the African lower per capita income countries.

141. So as to take the above fact into account, and, also, as a means of taking practical measures to implement the operative parts of United Nations General Assembly resolution 2626 (XXV) of 24 October 1970, which calls for a special effort on behalf of the least developed amongst the developing countries, CASTAFRICA might wish to consider updating the Lagos target for the number of scientists/engineers per million population, according to a "sliding-scale" corresponding to the three main levels of per capita economic development within Africa. In doing this it might wish to choose, for each of the three levels, between a "high" target, a "medium" target and a "low" target, of which the latter might correspond to the least developed amongst the developing African countries.

142. In so far as the "high" target is concerned, it is obvious that it will have to very far exceed the tentative Lagos target of a minimum of 200 scientists/engineers per million population by 1980. As indicated in the table, Ghana (by 1970) and Mauritius (by 1967) were already at the level of 795 and 720 scientists/engineers per million population, respectively. Internationally speaking this is nevertheless still a very low level. If improved at a rate of 15% annually, it would mean a doubling of the ratio in the brief space of 5 years, while at a rate of 12% increase annually, which would seem minimal under the circumstances, the ratio would double in eight years. At 6%, barely the rate presumed for the increase of per capita income, the number of scientists and engineers per million inhabitants for Mauritius would pass from 720 in 1967 to about 2,000 in 1980.

143. A realistic <u>minimal</u> "high" target for the relatively high-income African countries would therefore be of the order of 2,000 scientists/engineers per million population, by 1980.

144. On the basis of the fairly solid data contained in the table, the minimal "medium" target might be set at roughly two-thirds of the "high" target or in round numbers, 1,400 scientists/engineers per million population, by 1980.

145. Still on the basis of the data contained in the table, the minimal "low" target might be set at roughly one-third of 2,000 or 666. Taking into account the spirit of United Nations General Assembly resolution 2626 (XXV) of 24 October 1970, already referred to, one might be tempted to push this minimal target upwards somewhat, if only as a direct invitation for increased assistance to the countries concerned (in Africa, 16 countries(1)), either for the training

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(1) Botswana, Burundi, Chad, Dahomey, Ethiopia, Guinea, Lesotho, Malawi, Mali, Niger, Rwanda, Somalia, Sudan, Uganda, Tanzania and Upper Volta.

of scientists/engineers or directly supplying scientists and engineers from abroad. A minimal "low" target might therefore be of the order of 666 + 50% = 999, or, in round numbers, 1,000 engineers/scientists per million population. In this connexion, attention is again drawn to the fact that, to a large extent, the African "least developed amongst the developing countries" are also land-locked (Burundi, Chad, Lesotho, Malawi, Mali, Niger, Rwanda, Uganda and Upper Volta).

146. Still a further reason for special assistance to these countries is that a number of them are in the sub-Saharan zone (band extending from west to east and comprising Guinea, Mali, Niger, Chad, Sudan, Ethiopia and Somalia), within which agricultural production is highly vulnerable to fluke variations in rainfall, as was recently the case with dramatic consequences which aroused world-wide solidarity. It would seem obvious that the development of better and more reliable techniques for farming in such areas depends on concentrated scientific research and/or experimental development, and that these efforts would need to be supplemented adequately by agricultural extention services able to propagate the newly-gained knowledge among the farmers. Yet, because of their limited national resources, the least developed among the developing countries of Africa will not be able to ensure the self-financing of the required expansion of R&D and of agricultural extension services. The achievement of the tentative targets mentioned above therefore depends not on domestic effort alone, but on the nature and degree of aid granted from outside.

147. The preceding paragraph raises, of course, the question of the extent to which the available stock of scientists/engineers should be used for R&D work (e.g. creation of new knowledge; innovation), rather than for the application of existing knowledge.

148. There fortunately is, in this regard, a sound statistical criterion to which reference can be made: in Africa, as elsewhere, the ratio between the national number of R&D scientists and engineers, and the total national stocks of scientists and engineers, is about 1:10, or, in other terms, 10%(1). There appears to be no valid reason for assuming that this ratio will not be operative in the future and, on that basis, CASTAFRICA might also wish to consider the establishment of a sub-target, for the three above-mentioned groups of countries, in regard to R&D scientists and engineers per million population, thus completing the table of possible minimum targets as follows:

(1) Cf. Table 13 of the Introduction to document SPS No. 31.

TABLE IV

POSSIBLE TARGETS TO BE ACHIEVED BY 1980

Countries in alphabetical order	Number of scientists/ engineers per million population (1)	Number of R&D scientists/engineers per million population (10% of figures in column (1)) (2)
"High" target countries (bracket of US$ 200 + per capita GDP in 1970):		
Algeria Congo Egypt Equatorial Guinea Gabon Ghana Ivory Coast Libya Mauritius Morocco Senegal Swaziland Tunisia Zambia	2,000	200(1)
"Medium" target countries (bracket of US$ 100 to 200 per capita GDP in 1970):		
Botswana Cameroon Central Afr. Rep. Gambia Guinea Kenya Madagascar Mauritania Niger Nigeria Sierra Leone Sudan Tanzania Togo Uganda	1,400	140

(1) This target, of 200 R&D scientists/engineers per million population, is the one retained in the UNACAST World Plan of Action for the Application of Science and Technology to Development, for Africa (United Nations document 71.II.A.18, page 63). It should be recalled that the figure retained for Asia is 380/million, and the one for Latin America 400/million. The "High" target for Africa would therefore still be far below that for other developing regions.

	(1)	(2)
"Low" target countries (bracket of US$ 100 or less per capita GDP in 1970):		
Burundi Chad Dahomey Ethiopia Lesotho Malawi Mali Rwanda Somalia Upper Volta Zaire	1,000	100

149. It is again stressed that the above targets would include both the building up of the stock of African scientists and engineers, and the obtention of the services of foreign (expatriate) scientists and engineers. The assumption is that the African nations would make a maximum effort to develop their systems of higher education so that they might provide the required numbers of scientists/engineers, or send Africans to obtain such training abroad; and that any deficit would be made up either by the negotiation of foreign technical assistance or by the hiring of foreign staff.

3. Ratio of technicians to scientists/engineers

150. A further aspect which lends itself to mathematical relationships is that of the desirable ratio of technicians per scientist/engineers.

151. CASTAFRICA may wish to consider this question in the light of the Lagos Conference recommendation that the following ratio be maintained:

1: experienced senior scientist,

to 3 : younger university-trained scientists/engineers,

to 2: technicians who are not university trained but who have received some special training in science and technology over a period of years(1).

152. The above ratio can also be expressed as 4 scientists/engineers to 2 technicians and thus corresponds to the ratio of scientists/engineers to technicians within R&D activities in Africa which exists at the present time.

(1) Final Report of the Lagos Conference, pages 42 and 48.

153. There would appear to be no specific reason to query this recommendation of the Lagos Conference.

4. Scientific and technological equipment

154. CASTAFRICA is fortunate in having received a document submitted to it by the United Nations Economic Commission for Africa, entitled "Trends of African imports and exports of scientific and technological equipment" (document SC/CASTAFRICA/REF.5), which enables it to also make precise recommendations in connexion with this important question.

155. The specific aspects to which the Conference might address itself are: (i) the need to develop the local production of scientific and technological equipment for science teaching, R&D and productive economic activity, (ii) the place which governments should give to imports of such equipment within their national policies for the allocation of foreign currency, (iii) special measures which might be taken by governments to facilitate the passage, through customs, of scientific and technological equipment generally(1), and, more particularly, of delicate physical standards or of equipment which must be imported temporarily for the execution of specific R&D tasks (but the permanent purchase of which is uneconomic); (iv) the need to earmark a certain minimum percentage of the national R&D budget for the purchase of equipment as a part of sound R&D management, and (v) the advisability of developing various national public services where specialized equipment is made available for the specific purposes (e.g. metrological services, bureaux of standards, material testing laboratories or equipment maintenance and repair services). Document SC/CASTAFRICA/REF.5 draws the attention to specific aspects which might be considered the subject of CASTAFRICA recommendations.

5. Financial implications

156. In conclusion on this question of mathematical analysis of certain parameters of scientific and technological development, which CASTAFRICA might attempt to carry out, it might be well to conclude with comments as to the financial implications of the four points discussed under (a), (b), (c) and (d) above and which are, of course, interrelated in the sense that they all imply expenditure.

157. Indeed, if the African nations accept the tenets of the UNACAST World Plan of Action or of the Regional Plan of Action, which form a part of the Conference's documentation, it follows that they will need to take special measures to either finance or obtain the financing for the carrying out of the various tasks at hand.

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(1) The following Unesco-sponsored international instruments relate to this question: Agreement on the Importation of Educational, Scientific and Cultural Materials - known as the Florence 1950 Agreement - Annex D; Arrangement for the Safe and Expeditious Transit of Delicate Physical Standards; and Convention on the Temporary Importation of Scientific Equipment, sponsored jointly by Unesco and the Customs Co-operation Council.

158. Doubtless, the financial effort is considerable, and it will be up to individual nations to decide on whether they are willing to pay the price. It is estimated that, of a total world expenditure of perhaps $65,000,000,000 annually on R&D, of which somewhere from $2,000,000,000 to $2,500,000,000 in the developing countries of the world as a whole, Unesco African Member States are at present contributing around $270,000,000[1], that is, barely 0.4% of the total world effort. This figure is abnormally low, by all counts, and certainly does not reflect the place of Africa within the world's economy. Because the situation arises from an anomalous past, the needed corrective action cannot but be drastic, and there would seem to be little virtue in adopting timid targets likely to be rapidly overtaken by the endogenous and exogenous forces at work in Africa as was the case for the Lagos targets.

159. Attention is thus here drawn to three considerations which enter into the setting of targets for scientific and technological development mentioned previously.

160. Firstly, the present situation is as described in the table below:

TABLE V

Number of R&D scientists and engineers per million inhabitants, in 1970[2]	Number of countries falling within the bracket
6 - 10	4
11 - 30	13
31 - 60	12
61 - 90	6
91 - 120	0
121 - 137	1

(1) A further $100,000,000 is believed to be spent on R&D in Southern Africa.

(2) Includes R&D scientists in the fields of economics, the social sciences and humanities.

Excludes Ph.D. degree holders and university professors not engaged in R&D.

Excludes technicians.

161. Second, CASTAFRICA participants might wish to compare the above figures, and the proposed targets ranging from 100 to 200 R&D scientists and engineers per 1 million inhabitants, with the corresponding figures for the industrialized countries given below:

TABLE VI

	Number of scientists and engineers engaged in R&D (expressed as Full-Time Equivalent) per million inhabitants, in 1967
Belgium	940
Bulgaria	1,330
Canada	1,000
Czechoslovakia	2,850
Finland	450
France	1,020
Fed. Rep. of Germany	1,080
Hungary	1,020
Ireland	420
Italy	380
Netherlands	1,250
Norway	930
Poland	1,410
Romania	1,000
Sweden	830
United States of America	2,600
Yugoslavia (1966)	590

(Source: National Science Policies in Europe, Unesco document SPS No. 17, page 45.)

162. By 1980, the above levels will have been surpassed by far. Attainment of the envisaged minimum targets for Africa would thus be but a modest step forward, if the wealth gap between Africa and the industrialized world is to be noticeably narrowed.

163. Finally, CASTAFRICA may wish to take into account the financial implications of the R&D scientist/engineer targets. The situation as it now stands in Africa in that regard is as follows:

TABLE VII

	Expenditure per R&D scientist or engineer (latest available year)
	US $
Ivory Coast	17,000
Malawi	15,000
Mauritius	9,000
Tunisia	20,000
Upper Volta	18,500

(Source: Science Policies in Africa, Unesco document SPS No. 31, Introduction, Table 11)

164. An average expenditure of $30,000 per R&D scientist/engineer was until 1970 accepted as an international standard, and it is reasonable to presume that the standard should now be increased somewhat - say about 15% - to take into account the devaluation of the dollar and rising costs. The figures cited above are therefore in line with world averages, although it is known that they represent current expenditure (as compared with capital investment in R&D equipment and buildings) in a much larger proportion than is the case in Europe or Northern America. CASTAFRICA may therefore wish to consider a recommendation to the effect that, to the extent that governments finance research, an average budget of $35,000 per year and per R&D scientist/engineer should be provided within the "national R&D budget".

165. The financial implications of R&D financing can be determined, in relative terms, that is, per million population, by reference to two tables: on the one hand, the total aggregate GNP at various levels of per capita GNP income (Table VIII) and, on the other, the total annual expenditure on R&D for given ratios of R&D scientists/engineers per million population (Table IX).

TABLE VIII

Aggregate GNP, per million population, at various levels of per capita GNP

Level of per Capita GNP	Aggregate total GNP per million population
$	$
100	100,000,000
200	200,000,000
300	300,000,000
400	400,000,000
500	500,000,000
600	600,000,000
700	700,000,000
800	800,000,000
900	900,000,000
1,000	1,000,000,000
2,000	2,000,000,000
3,000	3,000,000,000
4,000	4,000,000,000
5,000	5,000,000,000

TABLE IX

Theoretical annual expenditure on R&D at different levels of development (capital and current costs)

Number of R&D scientists/ engineers per million population	Total annual expenditure on R&D, per million population, at $35,000 per R&D scientist/engineer(1)
persons	$
100	3,500,000
110	3,850,000
120	4,200,000
130	4,550,000
140	4,900,000
150	5,250,000
160	5,600,000
170	5,950,000
180	6,300,000
190	6,650,000
200	7,000,000
500	17,500,000
1,000	35,000,000
1,500	52,500,000
2,000	70,000,000
2,500	87,500,000
3,000	105,000,000

(1) Current national R&D expenditure includes wages and salaries and all related elements of labour, including such "fringe benefits" as bonuses, holiday pay, contributions to pension funds, payroll taxes, etc. Also included are all expendable supplies and minor equipment and other supporting costs including share of overheads, for example: rent, maintenance and repair of buildings, replacement of office furniture, water, gas, electricity, administrative expenses such as expenses for security, janitorial and maintenance personnel engaged in general housekeeping activities.

Capital expenditure includes actual expenditure or investment in land, buildings and major equipment (during the year of reference). Actual expenditure should be shown if possible. If this is not possible, the pro rata share of common facilities should be given. Any depreciation, e.g. on major instruments, equipment and buildings, should be excluded.

166. A comparison of the data in the two tables enables a country to assess, fairly easily, the costs of its R&D activity objectives, in comparison with its available national resources and with the situation in other countries. This comparison might be made, in the first instance, against the figures for the United States of America, because these are the highest for any individual nation. The U.S.A., in 1970, spent $26,700,000,000 on R&D, for a GNP of $974,100,000,000, or an expenditure on R&D of 2.73% of the GNP(1). The mid-1970 population of the U.S.A. being 204,800,000, and the number of R&D scientists/engineers per million population in 1970 being 2,700 (full time equivalent)(2), it can be calculated that average expenditure on R&D, for each R&D scientist/engineer, was of the order of $48,300.

167. If, in comparison, a developing country with, say, $200 per capita GNP (which is often the case in Africa)(3) were to strive to reach, solely using resources from its GNP, a level of 200 R&D scientists/engineers per million population (that is, a level only 1/13th of the U.S.A. level in 1970), and if it were to decide to allocate only $35,000 per R&D scientist/engineer (that is, less than 3/4 of the average U.S.A. expenditure for the same purpose), the relative financial effort in this instance would be of the order of

$$\frac{\$7,000,000 \text{ for R\&D}}{\$200,000,000 \text{ GNP}} = 3.5\% \text{ of GNP for R\&D}$$

168. Although the execution of R&D within the national boundaries is essential to the development of African nations, it is thus evident that, for many African nations, the attainment of the minimum targets mentioned in Table III would represent considerable effort if the required expenditure were to be met from national resources alone. Yet, the required amounts are not, in international terms, of very great magnitude, and international or bilateral aid could go a long way in alleviating the burden - which Africa must perforce bear - of seeking knowledge so as to produce wealth.

169. CASTAFRICA may wish to draw up recommendations on the above questions, including that of desirable levels of aid to Africa for the execution of essential R&D. In doing so, it may wish to take into account the views, expressed by UNACAST in the "World Plan of Action", concerning levels of R&D expenditure:

> "Experience suggests that a doubling in five years of the national expenditure for science and technology (at fairly constant prices and an inflation rate of no more than 3% to 4% a year) cannot be exceeded in countries that have reached or exceeded the figure of 0.2% of GDP devoted to science and technology. This five-year doubling time corresponds to an annual growth rate of 15%, which, if exceeded, may lead to waste, either because the infrastructure of research institutions cannot be built and organized in time, or because the education and training of scientific workers does not keep pace with the increase of the financial

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(1) Source: Science Indicators, 1972, National Science Board, National Science Foundation, U.S. Government Printing Office, 1973, page 102.

(2) Ibid, page 103.

(3) Cf. Table IV of this Chapter.

resources devoted to science and technology, or for both reasons. A limitation to the financial target might thus be that developing countries devoting more than 0.2 of their GDP to science and technology should not, as a general rule, increase their national expenditure for science and technology by more than 15% a year at constant prices"(1).

170. In connexion with "aid for the direct support of science and technology" (scientific and technological services as well as research and development) in the less developed countries during the Second United Nations Development Decade, UNACAST recommended that:

> "highly developed countries should continue to increase their aid" for the above purpose "to reach an average level equivalent to 0.05% of their GNP. This corresponds to 5% of the total foreign aid if the latter reaches the target of 1% of the GNP of highly developed countries"(2).

171. The question of the balance between the level of indigenous effort on behalf of R&D, and the amount of aid received from outside is therefore one of equilibrium and balance, with a view to the obtention of optimal results while taking into account the absorptive capacity of the specific countries concerned, within which conditions may vary considerably.

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(1) UNACAST, World Plan of Action, page 57.

(2) Ibid, page 58.

CHAPTER II

POSSIBILITIES FOR DEVELOPMENT AND APPLICATION OF NEW TECHNOLOGIES IN AFRICA

TABLE OF CONTENTS

INTRODUCTION

1. On examining the development of modern societies one is inevitably led first to the obvious fact that science and technology, as they have evolved over the last three centuries, have played a predominant part in this development in the sense that they have been one of the prerequisites (but not the only one!) of the very forms assumed by those societies. Whether their influence was immediate or whether it took several decades to become apparent, it was at all events an undisputed fact.

2. Beyond that fact we are unfortunately at a loss to explain the process of their influence scientifically. We find ourselves bogged down in theories dealing with all aspects of development. So we cannot claim in a brief paper to shed any light on the question as to whether technology is a cause or an effect of the progress of societies. We shall assume that it is partly cause and partly effect.

3. Nevertheless, it is generally agreed that technological progress has been a determining factor in the evolution of human societies. Development has rightly been defined as the result of two simultaneous processes - growth and change. While the applications of science and technology can undoubtedly influence growth - in particular, by increasing the productivity of labour and capital - it is the process of change which is the most deeply and lastingly influenced.

4. So at the root of any government policy in the African countries is the conviction that development is not only possible but essential and urgent.

5. It was through the process of technology transfer[1] that societies were able to benefit from evolutionary development, that is, the growth resulting from technological innovation. This transfer may be made from science to production by means of the country's research efforts. It is then a "vertical" transfer resulting in an original technological innovation. Or again the transfer may be a "horizontal" one; in other words, a new technology may be invented in one country and then spread elsewhere.

6. One consequence of the ease with which peoples can communicate today is the technological unification of the world. In any national economy we find that innovation by international transfer of technology tends to predominate over original technological innovation, that is, innovation due to research conducted in the country itself.

7. In this chapter we shall consider the practical conclusions which can be drawn from the foregoing in so far as the aims, means and methods of the transfer of technology and the obstacles encountered in the African region are concerned and in the light of specific examples of new technologies selected by the Unesco Secretariat on the basis of a Delphi-type international survey.

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(1) In this paper the term technology transfer is to be understood in the wider sense, meaning the passage from one place to another of the capacity for carrying on a particular activity and/or the means of doing so.

8. The CASTAFRICA Conference will perhaps deduce the practical steps which the African countries might take to promote their own technological progress in their own way, each preserving its identity, customs and culture while making the concessions necessary to adapt itself to a world of which it is willy-nilly, an integral part.

I. AFRICA IN THE FACE OF TECHNOLOGICAL PROGRESS

1. The nature of technological progress

9. It might be as well for a start to see what the fundamental components of technological progress are. By this we mean the basic concepts which make it possible to understand and explain the systematic "know-how" of societies (to put in a nutshell what we mean by technology), it being understood that this "know-how" can be codified, reduced to logical and often even concrete terms and consequently passed on, in particular by the educational system(1).

10. Technological progress, seen broadly in the light of history, seems in the last resort to be based on Man's capacity to master two classes of phenomena: energy and information. Close study of the various manifestations of what we call technological progress, without ever stopping to define it, will inevitably bring us back to these two basic concepts.

11. Without wishing to take the comparison too far, we might say that the mastery of energy (which requires information) has enabled Man over the centuries to minimize his efforts in obtaining a given result, that is, to enhance the material value of his action; and that the mastery of information (which requires energy) has enabled him, also over the centuries (for let us recognize that before the data-processing revolution, there was the invention of writing, then of alphabets, and there was Gutenberg, and others...!), to develop his intellectual potential, that is, to reach a higher stage of evolution in terms of mental adaptability or freedom, comparable to the stage reached in terms of physical freedom.

12. When reading this chapter it will be worth while bearing in mind these two frames of reference without which technological progress may well seem to be a concession to a passing fashion, and from the African standpoint an invitation to copy historical models from alien societies. The importance of technological progress to development then stands out as relatively independent of the various cultures and political philosophies of the societies concerned.

13. When reviewing the possibilities of new technologies in Africa and the conditions in which they can be applied, we must also remember that these technologies become available as a result of two basic mechanisms: on the one hand, Africa's invention of its own "know-how" and, on the other, its physical and cultural assimilation of technologies invented elsewhere. It is realized that a society cannot preserve its identity and its roots if it does not invent

(1) According to W.H. Gruber and D.G. Marquis in Research on the Human Factor in Transfer of Technology, M.I.T. Press, Cambridge, Massachusetts.

at least a part of its own technology, but it is also realized that no society can live in absolute independence today, whether technological or otherwise. So an extremely delicate balance peculiar to each society must be achieved in development programmes between national research (the deliberate, organized collective form of invention) and international technology transfer (the assimilation of methods of production and organization alien to the conditions of the country concerned). We shall revert to this in Section IV of this chapter.

14. Furthermore, efforts - in the political sphere, for instance - designed to promote, direct, organize and control technological progress must be based on a long-term view. For technological progress seems to follow its own laws of evolution and its dynamics usually involves long periods, that is, periods of ten years or more.

15. Finally, while technological progress influences ways of life, its effects are delayed, and frequently unexpected, not to say unpredictable. The developed countries have quite recently begun to worry about this aspect and a number of studies and surveys have been made with a view to anticipating future developments and following them closely from their inception. In this way it is hoped that their social, economic and even political consequences can be foreseen, as also their impact on the physical environment. So we must adopt a prospective approach to technological progress.

2. Aspects of technological progress peculiar to Africa

16. Science and above all technology are products of developed societies. To a certain extent they answered needs as they were felt by those societies in their particular economic and social situation. Here we put our finger on the difficulty of treating technologies applicable to Africa when, as a rule, those technologies have been, or are about to be, acquired in other continents. This acquisition can, however, be turned to advantage on the express condition that the specific problems of the African continent which these technologies are supposed to help solve are constantly borne in mind.

So any recommendation concerning the launching of research work and studies aimed at implanting new technologies in Africa should take into account a whole series of factors relating to the appropriateness of the "technological solution". A few examples are given below.

17. The first set of factors concerns the eventual beneficiaries of the technological implantation. In the developed countries urban populations predominate; in most of the African countries rural populations predominate. As the ultimate aim of science in the service of Man is to serve the majority of the population, and particularly those whose need is greatest, it would seem advisable to sift technologies according to the types of population which they will affect in the long run and which will benefit therefrom directly or indirectly.

18. In the second place, as we know, the African countries form a considerable reserve of manpower. This manpower is demanding employment, if possible without being displaced or having its way of life too radically altered. So technologies requiring heavy investment and little manpower are, all other things

being equal, unsuitable. It is sometimes said that the economic growth brought about by these technologies is a sufficient justification in itself, for it provides a point of take-off. Need we be reminded, however, that there are millions of unemployed in the world, passive and uprooted, mere spectators of this flying start in which they do not really take part, and that the social and human problems this entails are of such magnitude that they are beginning to disturb the most obdurate partisans of (economic) growth at all costs.

19. The implantation of a technology is, moreover, a cultural phenomenon. It has to make the most of individual resources such as attention to detail, turn of mind. sensitivity to certain modes of oral or visual expression, and so on. The degree of sophistication of a technology will have to be measured by the level of technical knowledge of those who will be called upon to use it. In some cases the latter will have to be "acculturized" by means of adequate training programmes. Some countries, because they cannot recognize what may seem obvious perhaps, are allowing themselves to be dependent on technical assistance for years, with all the constraints that this implies.

20. Well-known economic considerations, also come into play. The optimal utilization of human or natural resources can of course lead a country to envisage developing a local technology rather than importing a foreign one, almost always designed to suit the specific resources of the country that produced it. In this connexion, it has constantly been observed that the use of local materials in certain types of manufacture often demands the development of a new technology and not just a slight adaptation of processes which have been imported, e.g. through licensing. Development of the national scientific and technological potential is then dictated by government policy decisions of a strictly economic character.

21. For some years now, increasing attention has been devoted to the environment, especially by the developed countries. Unquestionably, the problem of protecting the environment primarily concerns those who are ruining it and it might be thought that the countries which are not yet industrialized on a large scale are not immediately concerned. It would be dangerous, however, not to recognize the direct effects of technological progress on the environment. We have only to imagine how the course of urban history would have been changed if engineers at the beginning of this century had concentrated on producing an electric motor instead of the internal combustion engine which equips the hundreds of millions of vehicles coursing through towns today. Any technology can be regarded as directly or indirectly affecting Man's physical environment. The effects of a technology are never neutral. To this extent, then, the choices made in Africa today, especially the patterns of technological development chosen, will in the long run have repercussions on its fauna, flora, countrysides and towns.

22. Finally, the impact of certain technologies on social customs and individual behaviour patterns is probably the most important factor to be considered and also the most difficult to assess. To quote a simple example, the habits and attitudes of people accustomed to public transport will certainly differ radically from those of people accustomed to using their own cars. The difficulties encountered by birth-control programmes as a result of beliefs and habits and the

futility of technological solutions in certain cases (we shall revert to this later) are well known. Consequently if we do not take the human factor into account, with its infinite individual variations, we are likely to provoke opposition, or else psychological and social mutations which we have underestimated and regret when it is too late.

23. The foregoing considerations show how complex the choices are and may be regarded as criteria which should be borne in mind when it is decided to implant technologies, to import them or to develop them through national research.

3. Choosing v. submitting to technological progress

24. In very general terms, the question put to the CASTAFRICA Conference here might be formulated as follows:

> "The development of the African countries in all its aspects is likely to be facilitated by the implantation of a series of technologies now being evolved or already fully fledged. As Africa cannot undertake everything at once, which technologies should it select, develop and implant first?"

25. That, in short, is the choice to be made, and it is for the Africans to make it. In this connexion, the Conference could usefully consider the orientations of research and/or international technology transfer programmes to be undertaken selectively in the foreseeable future.

26. In order that the Conference might be able to discuss the question with full knowledge of what was involved, the Unesco Secretariat consulted a wide range of eminent scientists and engineers, Africans and non-Africans, asking them more or less the fundamental question posed above.

27. This consultation was carried out in the form of a Delphi survey, a method developed by Olaf Helmer in the United States of America in the 1960s and widely applied since then by futurologists and research planners in most of the developed countries in both East and West. This survey has enabled the Secretariat to supply the Conference with views worth heading which may help it to form an opinion. They are set out in detail in the reference document SC/CASTAFRICA/REF.2.

II. TECHNOLOGICALLY FEASIBLE FUTURES FOR AFRICA - THE DELPHI SURVEY

1. The frame of reference of the Delphi survey

28. It must first be borne in mind that Africa's economic and technical possibilities are limited for the time being; that the leeway it has to make up, though sometimes estimated on the basis of dubious criteria, is great; and that its needs are all urgent. From this some people infer that it should confine itself to making the most of past achievements, that is, to applying techniques which have proved satisfactory elsewhere. In their view, the developing countries ought not to serve as a testing-ground for daring new experiments which may or may not yield results.

29. But another point of view was adopted on the occasion of the CASTAFRICA Conference. This was that if a society confines itself perpetually to adapting what others invent, that society will perpetually lag behind the others. Consequently, if leeway is to be made up where it occurs, we must realistically and imaginatively set about building hypothetical and, in the main, utopian situations from which will perhaps emerge the revolutionary solutions alone capable of rapidly changing a pattern of relationships which is not for the moment in Africa's favour.

30. Furthermore, it did not seem advisable to repeat to no purpose the effort made by the United Nations system as a whole, and by the Economic Commission for Africa in particular, with a view to establishing the "African Regional Plan for the Application of Science and Technology to Development"(1). As we know, this plan is an exhaustive directory to all the spheres of African life, in all its aspects, in which a specifically scientific and technological effort is required. Current economic, social and technical problems are described, illustrating the aims of the action to be taken and, in some cases, the research to be carried out.

31. The point of view adopted for the Delphi survey conducted by Unesco was appreciably different, although complementary. Whereas the African Regional Plan, starting from the problems, actually draws up a programme of work for researchers and scientists in general, who will have the task of finding different technical approaches and judging of their respective merits, the Unesco survey was aimed at identifying technologies in the course of development and roughly assessing their respective merits with reference to the problems which they might be used to solve.

32. It is in this light that a series of technological advances, considered of definite interest, in some degree or other, to the African countries, are explored for the benefit of the participants in this Conference.

2. <u>The survey method - Summary of findings</u>

33. In order to investigate the possibilities for the development and application of new technologies in Africa with authority, the Unesco Secretariat approached the African and international scientific communities. For no one is in a better position than they to give an opinion on the developments anticipated in years to come, and at the same time to discern those likely to promote economic and social progress in Africa, having regard to the special characteristics of that continent, whatever their nature.

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(1) "African Regional Plan for the Application of Science and Technology to Development", United Nations Economic Commission for Africa, document E/CN.14/579, Addis Ababa, 1973. Submitted to the CASTAFRICA Conference with the reference number Unesco/CASTAFRICA/4.

34. Thus, a preliminary consultation of some two hundred well-known figures in the world of science and technology enabled the Secretariat to draw up a list of more than 130 technologies likely to interest Africa in the long run, and a list of 85 barriers of all kinds - scientific, technical, educational, economic, social, political, cultural, administrative, etc. - which the implantation of these technologies might come up against. (For details see the reference document SC/CASTAFRICA/REF.2). The experts subsequently eliminated technologies which seemed of minor interest and barriers which seemed of minor importance, thus reducing the lists to one of 44 technologies and one of 25 barriers, which are given in Tables I and II below:

TABLE I

List of 44 technologies

TRANSPORT:	Helium-filled airship; hovercraft, "all terrain" vehicles; "air cushion" vehicles; transportation of mineral and agricultural products by pipelines; vertical take-off and landing system.
COMMUNICATIONS:	Telecommunications based on the satellite; laser links; microwave links.
POWER:	Small self-contained power sources for use in remote areas; new techniques for harnessing the wind; solar energy devices; desalination with solar energy; use of solar energy in air conditioning; desalination of sea-water with nuclear energy; thermo-nuclear power system; fuel cells.
INDUSTRY:	New materials and techniques for road surfacing; improved methods (e.g. biological leaching) for working low-grade ores; iron-ore reduction process by natural gas; pulp and paper plants (allowing the utilization of mixed deciduous forests; desalination with permeable membranes; self-propelled hole-borer for mining and hydrological use.
EDUCATION:	Automated teaching techniques (e.g. programmed learning); educational techniques for home use.
HEALTH:	Birth control techniques; use of African herbs in pharmaceuticals; helicopter-transported operating theatres.
BUILDING AND COMMUNITY DEVELOPMENT:	Environmental-controlled communities under plastic domes; use of rice husks, bamboo and other materials in the building trade.
FOOD:	Edible proteins from petroleum; production of leaf protein; use of chlorella for milk substitutes; food preservation by freeze-drying.

AGRICULTURE AND ALLIED INDUSTRIES:	Fertilizers - nitrogen fixation by enzymes; production of nitrogenous or compound fertilizers from by-products of oil refineries; synthetic sources of nitrogen. Crop-growing - glandless cotton seed varieties suitable for Africa; storage facilities for peanut products which prevent the development of aflatoxin; developed No. 2 opaque corn suitable for Africa. Insect and disease control - genetic manipulation to control diseases and produce selected plant varieties; non-polluting pesticides.
MISCELLANEOUS:	Weather control over large areas, artificial rainfalls; the "nuplex", a nuclear-powered agro-industrial complex.

TABLE II

List of 25 barriers

Technical barriers due to lack of scientific knowledge connected with a specific technology:

Basic knowledge not yet acquired (more research needed)

Know-how not yet developed (more development needed)

Technology too sophisticated to be developed on the basis of the African R&D capability only.

Technical barriers due to lack of scientific development in general:

World R&D effort not oriented towards African problems

Inadequate communication between African scientists and colleagues elsewhere

Too few highly qualified scientists and engineers in Africa

Inadequate scientific development budgets in African countries

Unsophisticated markets (lack of knowledge on the part of potential users)

Lack of scientifically trained middle-grade government officials

Lack of involvement of scientists in government planning

Lack of co-ordination between science policies of African countries

Lack of communication between African research laboratories

Technology too sophisticated to be used on a broad scale.

Economic barriers:

Inadequate communication and transportational infrastructure

Inadequate industrial infrastructure

Shortage of venture capital

Capital sources unacquainted with the technological possibility

The widely dispersed market

Lack of capital at low-interest rates

Lack of continuity in the policies pursued, lack of effective planning

General economic conditions not favouring industrialization.

Socio-cultural barriers:

Lack of basic education of the masses, illiteracy

Lack of public awareness of possible technological benefits

Cultural inertia resisting change (taboos and mores)

Awareness that human progress does not necessarily result from improvement of technologies.

35. A second survey, of the Delphi variety, was carried out by means of three questionnaires sent to some sixty experts (23 African and 38 international), all eminent scientists or engineers, and yielded data showing group opinion on the stage of development of each technology, the geographical areas in which it might be applied (for great differences actually exist among what is collectively referred to as "African countries"!), the nature of the major barriers, the estimated cost of implantation and potential benefits (chiefly economic, but also social and cultural), the length of time it might be expected to take to implant and the anticipated effect of an appropriate science policy on reducing that time.

36. Here we must mention two striking facts which lend weight to the collective opinion of those who were consulted.

(i) The first is that on most of the aspects dealt with in the survey a consensus was very quickly reached (right from the first questionnaire) and was subsequently confirmed.

(ii) The second was the absence of serious differences of opinion, on the whole, between the African group and the international group, as distinct groups.

37. On the basis of the authoritative opinion of the panel of experts we can therefore make a preliminary selection by eliminating from the short list contained in Table I those technologies which:

would be of value to only a very few African countries;

would cost what is considered too much to develop or propagate;

would have economic or social and cultural benefits considered at best only mediocre.

38. In this way a first selection of technologies can be made including those which, all things considered, seem particularly worth while. These are dealt with in the following section.

3. Analysis of the findings of the Delphi survey

(a) Particularly worth-while technologies

39. In this main working paper of the CASTAFRICA Conference only a very few technologies can be dealt with: those which seem to offer the greatest benefits[1] in the opinion of the panel of experts consulted in the Delphi survey.

40. They are as follows (see also Table III):

(1) Helium-filled airship

(2) "All terrain" vehicles

(5) Transportation of mineral and agricultural products by pipelines

(7) Telecommunications based on the satellite

(10) Small self-contained power sources for use in remote areas

(14) Use of solar energy in air conditioning

(18) New materials and techniques for road surfacing

(21) Pulp and paper plants allowing the utilization of mixed deciduous forests

(25) Educational techniques for home use

(26) Birth control techniques

(27) Use of African herbs in pharmaceuticals

(32) Production of leaf protein

(33) Use of chlorella for milk substitutes

(37) Synthetic sources of nitrogen

(38) Glandless cotton seed varieties suitable for Africa

(39) Storage facilities for peanut products which prevent the development of aflatoxin

(40) Developed No. 2 opaque corn suitable for Africa

(41) Genetic manipulation to control diseases and produce selected plant varieties

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(1) Other technologies, which are less advantageous, all things considered, are described in detail in the full report on the survey (document SC/CASTAFRICA/REF.2)

(42) Non-polluting pesticides.

The numbers in brackets are the numbers under which the 44 technologies are listed in the detailed report of the survey (SC/CASTAFRICA/REF.2), to which the reader is referred for supplementary information.

TABLE III

List of particularly worth-while technologies

TRANSPORT:	Helium-filled airship; "all terrain" vehicles; transportation of mineral and agricultural products by pipelines.
COMMUNICATIONS:	Telecommunications based on the satellite.
POWER:	Small self-contained power sources for use in remote areas; use of solar energy in air conditioning.
INDUSTRY:	New materials and techniques for road surfacing; pulp and paper plants allowing the utilization of mixed deciduous forests.
EDUCATION:	Educational techniques for home use.
HEALTH:	Birth control techniques; use of African herbs in pharmaceuticals.
FOOD:	Production of leaf protein; use of chlorella for milk substitutes.
AGRICULTURE AND ALLIED INDUSTRIES:	Synthetic sources of nitrogen; glandless cotton seed varieties suitable for Africa; storage facilities for peanut products which prevent the development of aflatoxin; developed No. 2 opaque corn suitable for Africa; genetic manipulation to control diseases and produce selected plant varieties; non-polluting pesticides.

41. As will be seen, the range available is fairly wide despite the very strict selection. Almost all the important aspects of social and economic life are represented: transport, communications, power, industry (building, paper), education, health, population, food and agriculture. It should be noted that nearly half the technologies (8 out of 19) come under the last head, whereas in the original list only 12 out of 44, i.e. less than one-third, of the technologies related to food and agriculture. The selection criteria were less strict for these technologies than for the others, precisely in view of the importance of agriculture as a problem and of solving that problem through technology. The selection therefore appears not only varied but fairly well balanced.

42. With few exceptions these technologies are at a sufficiently advanced stage, even in R&D, for it to be possible to contemplate implanting them in Africa within periods ranging from 5 to 10 years. Even shorter periods are envisaged for implanting the small self-contained power sources for use in remote areas. On the other hand, longer periods, ranging from 10 to 25 years, are envisaged for the use of solar energy in air conditioning, the production of leaf protein and of non-polluting pesticides.

43. In almost all cases, these technologies could benefit a fairly large number of countries equally, which enhances their value, for inevitably, in almost all cases too, the cost of developing, adapting and propagating the technology would necessitate a joint effort on the part of several countries. This cost, in no case prohibitive, is estimated as considerable none the less, although acceptable for the African economies as a whole. In some cases the costs are even estimated as low - technologies Nos. 10, 39, 40, 41 and 42 above.

44. The benefits anticipated from the implanting of each of the technologies selected are held to be very great, whether they be of an economic or a social and cultural nature.

45. Certain technologies have the advantage of making it possible to turn the natural resources of the continent to account (paper plants allowing the utilization of mixed deciduous forests, medicinal herbs, leaf proteins, etc.).

46. Others are of a nature to contribute greatly to the large-scale educational effort undertaken in Africa (telecommunications based on the satellite, educational techniques).

47. Still others constitute valuable alternatives to current practices, if consideration is given to the protection of the environment, as, for example, helium-filled airships, transportation by pipelines, and non-polluting pesticides.

48. Finally, certain technologies are distinguished by the mobility and independence which they allow their users ("all terrain" vehicles, small self-contained power sources, air conditioning by solar energy, educational techniques for home use). This aspect is worth stressing, for one of the disadvantages of certain technologies, which is coming to be recognized more and more, is that they form an integral part of a system and are interdependent (for example, standard electricity distribution networks, a breakdown of which can plunge millions of people into darkness and have a whole chain of repercussions in different sectors). Generally speaking, these "integrated systems" require enormous infrastructures and are like a "corset" which society must try to fit into, economically, socially and psychologically, instead of its being the other way around.

(b) Foreseeable barriers

49. The barriers to the implantation of the technologies mentioned above are obviously of many different kinds. Only a few will be mentioned here - those considered the most important, looking at the question from the standpoint of the whole series of technologies.

50. In almost all cases the basic knowledge has been acquired but the processes for applying the technology have to be developed, necessitating studies and research.

51. Such research is already under way, in several cases, in the developed countries, where technological variants are worked out to meet the needs of those countries, their climates, their technical specifications, etc. One major barrier to Africa's conducting such research is the lack of qualified personnel for research and experimental development, partly owing to the slenderness of national R&D budgets.

52. Another major barrier is the potential users' lack of information, which means that they do not represent a demand capable of providing a market. Obviously the level of scientific or technical knowledge of the population plays a predominant part in the scientific and technological development of Africa.

53. Major economic barriers will be encountered. Most of the technologies mentioned above will demand a much more considerable infrastructure than is available at present. The shortage of capital to invest in industrial firms will make the undertaking difficult, especially as those who possess the little capital available are generally uninformed of the attractive possibilities of technological investments in the medium or long term.

54. Furthermore, any effective planning is subordinated to a certain continuity in the policies adopted. If this important factor is lacking, any directed and controlled technological development, that is, development deliberately undertaken, is precluded, for when the period involved extends over ten years, and often much longer, constant, unwavering and coherent efforts are required.

55. In the following section we shall see what types of policy are most likely to bring about the development and implantation of the technologies reviewed here, having regard to the barriers we have referred to.

56. It is also worth while identifying the barriers listed in Table II which, in the opinion of the panel of experts, seem to be the most widespread and therefore the most considerable, that is, which would be most frequently encountered, whatever the technology involved. For the technologies listed in Table I as a whole, the survey results show that on the average the processes for applying them have not yet been developed or that the technology is far too sophisticated for Africa's present research capacity.

57. Among the technical barriers due to lack of scientific development in general, the most considerable appear to be the shortage of highly qualified engineers and scientists and the lack of information on the part of the potential African users.

58. The inadequacy of the industrial infrastructure and the shortage of capital for investment in industry are the major economic barriers. By far the most widespread and formidable social and cultural barrier is the fact that the population is not sufficiently aware of the benefits it can derive from technology.

59. It may be said that there is nothing very new, let alone revolutionary, in this analysis of the barriers. However, it is well to realize that this analysis is based on the opinions of a panel of experts specializing in various branches and that these opinions relate to a relatively diverse series of technologies concerned with almost all the social and economic problems. Consequently any policy aimed at developing really new technologies would run a very great risk of failure if it did not at first address itself to clearing away these barriers, so much are they universally deep-rooted obstacles.

III. POLICIES FOR TECHNOLOGICAL PROGRESS

60. The specific technologies considered in the preceding section point to very different policies for technological progress, according to the case.

61. As a rule, the implantation of a technology will demand a complex and varied set of measures coming under several policies. However, an attempt must be made to identify their main features. It will be enough to determine the nature of the major barriers standing in the way of a given technology. Fortunately the Delphi survey has enabled us to do this, since the experts were asked to give their opinions on the relative importance of the different barriers in the case of each technology.

62. The great majority of the most useful technologies (Table III) call for a research and experimental development (R&D) policy designed to develop the technology in question or to adapt it when it is imported, or can be imported.

This is the case, for example, with the following technologies: helium-filled airships, "all terrain" vehicles, small self-contained power sources for remote areas, use of solar energy in air conditioning, new materials and techniques for road surfacing, pulp and paper plants allowing the utilization of mixed deciduous forests, educational techniques for home use, African herbs in pharmaceuticals, the production of leaf protein, the use of chlorella for milk substitutes, glandless cotton seed varieties suited to Africa, storage facilities for peanut products which prevent the development of aflatoxin, No. 2 opaque corn suited to African conditions, and non-polluting pesticides.

63. However, in some cases the technologies have already been developed and spread in several countries, but not yet in Africa. The policies designed to implant them should stress the organization of means of overcoming barriers of a different nature.

For instance, the development of the technology of the transportation of mineral and agricultural products by pipelines demands the corresponding personnel, which Africa lacks. Telecommunications technology is already available, but its implantation is conditioned, in the main, by an information policy and an education policy. Wide-scale application of the various birth control techniques, which conflict with African traditions and customs, depends on a public health or population policy. Finally, the transfer to Africa and application of the technology of synthetic sources of nitrogen, which has reached the stage of commercial distribution in other countries, will be conditioned chiefly by an appropriate economic and agricultural policy.

64. The policies framed for science and technology must of course be supported by complementary policies. Table IV (see following page) gives a comprehensive view of the different policies which it might be found advisable in some degree to apply for each of the 19 technologies listed in Table III and indicates the time it would probably take to implant them. It is considered that, in most cases, an effective policy for science and technology would shorten by a few years the period required for implantation, which is in all cases between 5 and 10 years.

IV. THE TRANSFER OF NEW TECHNOLOGIES AND THEIR IMPLANTATION IN AFRICA

1. Topics for discussion

65. In Africa, as elsewhere, the transfer and implantation of new technologies raises a series of questions which the CASTAFRICA Conference will no doubt wish to broach in order to get a proper grasp of the problem as a whole.

With this in view, the Secretariat of Unesco has selected the following topics for discussion so as to facilitate the discussions of the Conference:

Choice of broad national goals

Rôle of science and technology in economic growth

The two types of technology transfer

Scientific preparation of decisions - practical examples

Examination of the horizontal transfer process

Forms and channels of horizontal transfer

Examination of vertical transfer; rôle of R&D

Comparative costs of the two types of transfer

Optimization of profits

Implantation policies for new technologies

The firm establishment of newly implanted technologies

Evaluation and corrective mechanisms of technology transfer

Transfer of scientific and technological information

Possibilities for African regional co-operation in the transfer of technologies.

2. Choice of broad national goals

66. In choosing a "civilization blueprint", nations and governments face what is, in theory at least, a relatively simple problem: to achieve survival and progress.

TABLE IV

Technologies of particular interest to Africa

	Title of Technology	Number of years it would probably take to implant the technology	Type of policy on which the technology is dependent			
			Scientific and technological policy		Economic or social and cultural policy	
			A	B	C	D
1.	Helium-filled airship	5-10	xxx	xx	x	
3.	"All terrain" vehicles	5-10	xxx	xx	x	
5.	Transportation of mineral and agricultural products by pipelines	5-10	xx	xxx	x	
7.	Telecommunications based on the satellite	5-10	xx		x	xxx
10.	Small self-contained power sources for use in remote areas	Less than 5	xxx	x	xx	
14.	Use of solar energy in air conditioning	10-25	xxx			
18.	New materials and techniques for road surfacing	5-10	xxx		xx	
21.	Pulp and paper plants allowing the utilization of mixed deciduous forest	5-10	xxx		xx	
25.	Educational techniques for home use	5-10	xxx		x	xx
26.	Birth control techniques	5-10	xx			xxx
27.	Use of African herbs in pharmaceuticals	5-10	xxx		xx	
32.	Production of leaf protein	10-25	xxx		xx	
33.	Use of chlorella for milk substitutes	5-25	xxx		xx	
37.	Synthetic sources of nitrogen	5-10	x		xxx	
38.	Glandless cotton seed varieties suitable for Africa	5-10	xxx		xx	
39.	Storage facilities for peanut products which prevent the development of aflatoxin	5-10	xxx		xx	
40.	Developed No. 2 opaque corn suitable for Africa	5-10	xxx		xx	
41.	Genetic manipulation to control diseases and produce selective plant varieties	5-10	xx		xxx	
42.	Non-polluting pesticides	10-25	xxx		xx	

A: Science policy relating to a specific technology
B: Science policy for scientific development in general
C: Economic development policy
D: Development policy of a social and cultural nature

xxx : Policy of paramount importance
xx : Important policy
x : Policy of appreciable importance

67. But over the past few decades more complex and ambitious civilization patterns have emerged, comprising in particular the building of a different society through the deliberate speeding up of the "development" process, through raising the individual and collective "quality of life", or else through the attempt to establish international relations based on co-operation instead of rivalry between peoples.

68. So all governments, under pressure from unfulfilled popular aspirations, are being induced to follow a "blueprint for civilization" and gradually to specify its aims as well as the means chosen to achieve them.

69. In fact, the general public has become aware of the vast possibilities latent in the scientific approach, which takes experimentally verifiable knowledge as its starting-point and results in the creation of a tool, a model or a method, and subsequently puts the means thereby created into practice according to plan.

70. Even when natural disasters are in question, such as drought, which has a stranglehold on a large part of Africa, governments can no longer put such things down to fate alone, as they once used to do.

71. Those in power must therefore equip themselves with the means of action directed towards clearly formulated development objectives, and with a national plan for attaining them.

3. Rôle of science and technology in economic growth

72. Economic growth usually heads the list of objectives in the African countries' national development plans. So it is appropriate to specify the conditions for the effective use of science and technology in a general economic development policy.

73. In this connexion, the traditional kind of economic growth strategy, based solely on the extension of existing activities or on a better organization of these, is unlikely to be of great interest to the CASTAFRICA Conference.

74. Conversely, economic growth strategies based on technological innovation - either original or imported - as well as on the propagation of innovations, should be the focal point of the Conference's discussions. It should be made clear that technological innovation, taken in the broad sense which is ascribed to it nowadays, can cover the practical application of an invention, work aimed at making a radical change in the technology of an existing type of production, or even launching the manufacture of a known product by means of techniques already being used abroad.

75. In fact, any development plan which aims to put a new procedure into practical application or to manufacture a new product must include not only the acquisition of a profounder knowledge of the object of the action (be this the natural environment, man or society) but also the introduction of new tools and new methods for the action itself.

76. Clearly, therefore, science and technology must provide two essential components in such a development plan: knowledge of the object of the action, and creation of the means of carrying it out.

4. The two types of technology transfer[1]

77. According to the kind of implantation process adopted for a new technology, a distinction may be drawn between two types of technology transfers, namely:

horizontal transfer, whereby the technological innovation:

(i) is propagated gradually within a country or from one country to another;

(ii) extends from one use to another, one branch of industry to another and from one economic sector to another, within a country, or from one country to another;

and vertical transfer, in which a flow of knowledge and know-how follows the sequence "research - experimental development - technological innovation".

78. The main link between horizontal and vertical technology transfers derives from the fact that technologies must often be adapted, and sometimes even radically adapted, when they are transferred. And to the extent that adaptation is necessary, the two processes are very likely to be interdependent. The judicious composition of the "mix" seems, moreover, to be one of the most important requirements for the technological development of the less advanced countries[2].

79. It is constantly observed that a certain domestic research potential is absolutely essential for a full awareness, understanding and assimilation of the technological innovations of others. That is why, even while innovation by technology transfer is almost everywhere outstripping innovation resulting from research carried out on home ground, nations must keep up active research laboratories. They thus secure an effective technology transfer for themselves, and this also enables them to participate to some extent in the world-wide process of original technological innovation.

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(1) Cf. Y. NAYUDAMA, Director-General, Scientific and Industrial Research, in the proceedings of the International Symposium on Technology Transfer (Technology transfer - Analysis and imperatives for developing countries), Council of Scientific and Industrial Research, New Delhi, India, February 1973.

(2) Cf. Recommendation No. 13 of the Inter-regional Group of Experts on the transfer of operative technology at the enterprise level (meeting in New York, June 1971) in the publication entitled "Transfer of Operative Technology at the Enterprise Level", United Nations, New York, 1972 (Sales No.: E.72.II.A.1).

5. Scientific preparation of decisions - practical examples

80. Whatever the choice of development strategy, whether based on domestic scientific research or on the importation of foreign technologies, scientific preparation of decisions is of truly crucial importance.

81. This work consists in collecting and scientifically processing - often by computer - the data which form a basis for the decisions to be taken at government level.

82. In this connexion, the CASTAFRICA Conference will no doubt wish to examine the factors which come into play when the new technologies are evaluated a priori(1), in terms of their repercussions on the economy, as well as on the technological capacity, social structures and general well-being of the African countries (see also paragraph 123) below for the a posteriori evaluation).

83. For example, the decision to implant a new technology in a given country requires a preliminary study of the following points(2):

(a) The socio-economic characteristics of the technology used locally, or, if appropriate, the reasons why the activity in question has not so far been embarked upon. What are the advantages of the new technology? What are its disadvantages? Should compensation be made for the latter?

(b) The various technologies existing abroad to meet the needs under review. Which of these are the most advanced from a technological and economic point of view?

(c) Among the technologies of interest, which ones seem best suited to the conditions of the country in which they are to be implanted, particularly from the point of view of the amount of labour and capital required?(3)

(d) Are the conditions for the importation of technology, in the form of patents, licences, unbundled or packaged technologies, acceptable? Is their cost reasonable? Are they hedged about with restrictive clauses? Which ones?

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(1) Cf. C.V.S. RATNAM in the Proceedings of the International Symposium on Technology Transfer (Transfer of technology from research laboratory to industry), Council of Scientific and Industrial Research and UNIDO, New Delhi, India, February 1973.

(2) This question has been gone into thoroughly in document SC/CASTAFRICA/REF.3 entitled "Propagation of New Technologies in Africa" submitted to the Conference by the Secretariat of the Organization of African Unity.

(3) Cf. the Report published by the United Nations Advisory Committee on the Application of Science and Technology to Development, entitled "Appropriate Technology and Research for Industrial Development", United Nations Publication, New York 1972. (Sales No.: E.72.II.A.3).

(e) If foreign technology is not wholly suited to the conditions of the country, is it possible to adapt it (locally or elsewhere)? What would that cost?

(f) If this is not possible, should research and development work be undertaken to solve the problem? In the country itself? Abroad?

(g) What is the cost/benefit relationship of the implantation of the new technology from the point of view of economic returns? And as regards social utility?

(h) What is the most advantageous solution from the point of view of the country's foreign currency reserves? At the time of implantation? Later?

(i) How many staff are required for the local "absorption" of the technology in question and what should be their qualifications (and adaptability)? Can they be trained on the spot? Abroad?

(j) Are the necessary funds available for the implantation of the technology, or can they be mobilized? In the country? Through international or foreign loans? On what terms?

(k) Do the "peripheral technologies" necessary for the running and maintenance of the new technology exist in the country? For example, certain semi-products, or high pressure or low temperature technology, inert gas, welding, etc. - should plans be made for their gradual introduction into the country?

(l) What are the most efficient means of ensuring the propagation of the new technology in the country?

84. Lastly, the preliminary studies must also give consideration to purely political matters such as national or foreign ownership of the means of production and the degree of technological dependence (not to say colonialism) from which the country is suffering.

6. Examination of the horizontal transfer process

85. In general, it is apparent that countries wishing to master the horizontal technological transfer process must above all acquire the ability to do the following:

make a wholly independent choice from among the various technological possibilities open to them;

adapt imported technologies to local conditions;

participate increasingly in the world movement of original technological innovation;

ensure the management and running of the technologies implanted.

86. In this connexion there can be no ignoring the fact that international technology transfer is first and foremost a communication process, whose broad outlines may be traced as follows:

a supplier (a company, institution or individual);

a message (advice, patent or any other sort of information, including information embodied in machines, equipment or plant designed along new lines);

an organized circuit for transmission of the message (trade, transport, information and documentation services, technical assistance, consultants);

a user (a company, institution or individual) who has often requested the technological message, while being aware that it will have to adapt the technology received, or who realizes on receiving it that it will have to be adapted;

a feedback from the user to the supplier, which may, if necessary, include an evaluation of the technological, economic and socio-cultural effects of the transfer.

This process is set in motion and conditioned by continuous or chance contact, following organized or random channels between actual or potential suppliers and users of the technological message, and vice versa.

87. It must be admitted that the sometimes complex mechanisms involved in international technology transfer have not been investigated thoroughly enough, and that their workings are not entirely understood. This last remark is particularly true of transfers between developing countries, the advantages of which are acknowledged, and which will no doubt make a considerable leap forward during the Second Development Decade.

88. Since "technology" is primarily a matter of "know-how" (training and information), its international transfer is basically a "people process". This does not, of course, mean that machines are less important, but that man's rôle is predominant. Men and machines together form operational technology. In the last analysis, there can be no technology transfer unless man himself is capable of effecting it.

7. Forms and channels of horizontal transfer

89. In the field of contractual agreements(1) for horizontal technology transfer, an assessment should be made of the comparative efficiency of the main types used at present:

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(1) On this subject see the joint publication by the United Nations and the Regional Economic Commission for Europe entitled "Guide for use in drawing up contracts relating to the international transfer of know-how in the engineering industry", UN/ECE, 1970 (Sales No.: I.70.II.E.15).

acquisition of machinery and equipment;

procuring of paid services in the form of technical assistance supplied by specialized design and engineering consultants;

purchase or barter of licences and patents;

establishment of branches of foreign enterprises;

launching of joint enterprises;

purchase of turn-key factories.

90. These various types of horizontal technology transfer may take a number of channels, of which those most commonly used are:

non-commercial transfers (including the activities of some intergovernmental organizations);

transfers assisted by international aid "projects" such as those supported by UNIDO;

bilateral co-operation arrangements between governments;

transfers on a purely commercial basis.

91. Most of the problems which have led to legal disputes, particularly between developing countries and industrialized countries, have arisen over the past few years in the last category of channels. Thus the trend of the 1970s is towards transfer channels of a multiple, and hence more complex, nature; greater efforts in investigation and negotiation are needed for these, but on the other hand they provide the countries receiving international technology transfer with fuller guarantees.

8. Examination of vertical transfer; rôle of R&D

92. Could not the African countries base the development of the modern sector of their economy solely on horizontal technology transfer? In other words, could they not abandon vertical technology transfer, whose backbone is the chain constituted by research, experimental development and technological innovation?

93. The reply which the CASTAFRICA Conference gives to the question of the relations between science and technology in Africa will make it possible to clarify the position of R&D in the science and technology policies of the African States.

94. Expert opinion on this question may be summed up as follows: participation by developing countries in original technical innovation, thanks to those countries' building up of a potential for appropriate scientific and technical

research, is a necessary condition for their progress, and should have a front-ranking place in any national development plan[1].

95. Setting aside the political implications of the scientific autonomy, dignity, national prestige and cultural development of the African countries, experts most often put forward the following justifications in support of their opinion[2]:

(a) Horizontal technology transfer alone cannot provide a satisfactory solution to either the agricultural problems peculiar to the climate, the soil and the local water balance, or the mining problems resulting from the countries' geological formation; a domestic R&D drive in favour of vertical technology transfer in these fields is always indispensable;

(b) In view of its "communication" aspect, horizontal technology transfer requires the supplier and the user to be "on the same wave-length". So in the receiving country there must be teams of scientists and engineers whose research activity keeps them abreast of the science or technology in question. It is obvious that these teams can attain and maintain this position only if they themselves participate in orginal technological innovation;

(c) Horizontal technology transfer is carried out on more favourable terms when it is possible to combine barter and purchase. Countries which are able to offer in exchange the results obtained in their own public or private laboratories will have access to the best foreign licences and to the most advanced foreign know-how;

(d) Each stage of development must be a stepping-stone to the subsequent stages. In its first industrialization phase, a country must therefore prepare the vantage points from which it will tackle the following phase. So, from the outset, it must have a potential for original technological innovation in a few well-chosen areas;

(e) Public scientific and technological services, which have an essential part to play during the first phases of industrialization, cannot attain and maintain a high standard of quality, nor can they fulfil their educational rôle in the country, without conducting significant research activities.

96. The foregoing considerations will perhaps encourage the CASTAFRICA Conference to discuss the relationship, in various socio-economic contexts, and for different fields of application, between R&D and international technology transfer.

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(1) Cf. G.S. RAMASWAMY and D. BANERJEE in the Proceedings of the Joint Government of India/UNIDO Inter-regional Seminar on Technology Transfer, New Delhi, December 1972.

(2) Cf. "Science for Development" by J. SPAEY et al., Paris, Unesco, 1971.

9. Comparative costs of the two types of transfer

97. It may perhaps be objected that the pursuit of scientific and technological research on home territory is an expensive undertaking which is beyond the present financial means of the African countries. This cannot be gainsaid.

98. Even so, these expenses must be compared with the extremely high costs of horizontal technology transfer.

These costs may, broadly speaking, be split into direct and indirect costs of transfer(1).

99. Direct costs are those that represent payments for which specific provision is made in the contractual agreement (see above, paragraph 89) i.e.:

(i) purchase costs of patents, licences, know-how and trademarks;

(ii) expenses incurred in acquiring the necessary technical knowledge and know-how at the pre-investment, investment and operational stages.

100. Indirect costs cover a wider area, but they may be subdivided as follows:

(iii) expenses resulting from overpricing imports of intermediary products, spare parts and equipment indispensable to the implantation and operation of the technology in question;

(iv) expenses and outlay of foreign currency because of profits due to the foreign share of the firm; it may, for example, be a matter of repatriation of funds, which in part represent the purchasing country's payment for the technology transferred;

(v) other forms of indirect costs arising in particular from restrictive clauses in the contract, such as prohibition to export, or from accounting manipulations in the case of branches of foreign firms, enabling them to avoid paying local taxes or customs duty;

(vi) Lessened scientific and technological acculturation, owing to the fact that branches of foreign companies tend to have all research and experimental development necessary for the launching, maintenance and modernization of production carried out by the parent company. As a result, in the countries receiving the technology career prospects are not bright for research scientists and engineers, and for nationals who have undergone such training there is often no alternative but to join the brain-drain.

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(1) On this subject see: (i) the very interesting publication entitled "Guidelines for the study of the transfer of technology to developing countries - a study by the UNCTAD Secretariat", New York, United Nations, 1972. (Sales No.: E.72.II.D.19); (ii) the Report of the UNCTAD Secretariat on the "Transfer of Technology", document TD/106, of 10 November 1971, prepared for the third session of UNCTAD (Santiago, Chile, April 1972).

101. Stringent analysis of the scope and variety of the costs of horizontal technology transfer, which are nowadays spread over the whole range of industries from the primary to the tertiary sector, has led a number of people to say, with some degree of truth, that this form of transfer tends to generate or perpetuate some of the features of underdevelopment. Some countries have taken such drastic measures in this field that international co-operation and technical assistance have been jeopardized, if not paralysed, as a result.

10. Optimization of profits

102. Generally speaking, it might be said that the economic, scientific and technological policies of African countries should be planned in such a way as to optimize the profits of all kinds which may be reaped from a wise combination of horizontal and vertical technical transfer processes, i.e. combining imported foreign know-how with a national drive towards original technological innovation.

103. The CASTAFRICA Conference will no doubt seek a way of directing this optimization process in accordance with the African countries' best interests. Such an investigation could be carried out in a concrete fashion into those new technologies - identified by Unesco by means of the Delphi survey mentioned at the beginning of this chapter - which have proved to be of particular interest to Africa.

11. Implantation policies for new technologies

104. The implantation of new technologies in developing countries is not a spontaneous process which may be left to the interplay of uncontrolled forces. On the contrary, this implantation requires determination on the part of the governments and industries concerned(1).

105. In the case of vertical technology transfer, i.e. the progression of technology from a science to the finished product, the trend is towards the organization of domestic R&D by "vertical integration"; in other words, all research relevant to the transfer concerned is brought together in a "mission-oriented" institution, whatever the type of research carried out there (whether fundamental, applied, or experimental development).

106. This form of organization may be contrasted with "horizontal integration" of research according to scientific disciplines or technologies, which is to be found chiefly in traditional universities and polytechnics. This kind of research is described as "discipline-oriented".

107. Naturally, the discipline/mission dichotomy introduced above, is a gross oversimplification, things are never so clear-cut, since all R&D establishments are somewhat ambivalent on this point. For instance, faculties of medicine and agronomy in many universities are familiar with a high degree of vertical organization; in addition, universities and polytechnics are able to provide

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(1) Cf. Z. MADEJ "The Strategy of Technology Transfer" in the Proceedings of Unesco's Symposium on "International Aspects of Technological Innovation", document SPS No. 26, Paris, Unesco, 1972.

common ground for reflection and contact between a great many development "missions", thanks to the very flexible ad hoc combinations which they are able to make among their various discipline-oriented research units.

108. Here we run up against the problem of organizing higher education establishments for R&D. This is a really crucial problem for the national science and technology policies of the African countries, and the CASTAFRICA Conference will probably wish to discuss it under item 7 of its agenda.

109. In the case of horizontal technology transfer from one country to another, it is worth while to examine the types of measure which governments in partnership may adopt in order to ease the transfer. Here are a few examples:

110. Among other things, the government of the receiving country may:

(a) Grant loans at a low rate of interest to the domestic industry which embarks upon innovation, following the guidelines of the national development plan;

(b) Grant special tax exemption to this new industry;

(c) Give high priority to training abroad for qualified staff who will work in this industry;

(d) Give preferential treatment to foreign experts specializing in this industry.

111. The government of the developed country may facilitate the transfer abroad of its national technologies by adopting such measures as:

(a) Selective tax relief for firms which agree to set up plants in developing countries, in order to assist the economic development of the latter;

(b) Complete takeover (with or without assistance of a multi-national kind) of the training of qualified staff from the receiving country to work in this new industry;

(c) Total or partial coverage by the donor country's government of the risks to which its industries are exposed when embarking on technological aid operations abroad;

(d) Payment by the government of the donor country of at least part of the direct cost of the transfer (see paragraph 99 above).

112. It would be unrealistic not to mention here the very large - and growing - rôle of "multi-national" companies. Some observers estimated in 1970 that they were responsible for approximately one quarter of the world's production[1].

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(1) Cf. "An analysis of technology transfer", report by the Nomura Research Institute of Technology and Economics, Tokyo and New York, July 1971.

113. Indeed, these companies are heavily committed to horizontal technology transfer to developing countries, and as such may claim the support of the governments of the developed countries to which they belong.

114. Why these companies settle in developing countries is of little importance; such a step, after all, corresponds to their ultimate aim and inner driving force, which is a tendency always to increase their hold on the market and maximize their own profit margins.

115. However, the governments of the lost countries have recently taken exception to some of these companies' practices; for example:

(a) The attempt to obtain a monopoly and then a monopsony on the national market;

(b) The concentration of all genuinely creative work (R&D, for example) in the parent company, which is nearly always situated in a highly industrialized country;

(c) Scattering part manufacture among several countries in order to avoid the threat of nationalization;

(d) The practice of "closed door" manufacture in order to ensure that the very advanced technologies which they use can neither be absorbed into the host country nor be propagated within it.

116. The CASTAFRICA Conference may wish to examine the measures which might be planned by the governments of developed and developing countries alike, concerning concrete examples of horizontal technology transfer taken from the Delphi survey carried out by Unesco in Africa.

12. The firm establishment of newly implanted technologies

117. A new technology, once implanted usually passes through several stages of "establishment" before it is wholly assimilated by the receiving country.

118. In this connexion it is useful to distinguish between the following stages[1] which make it possible to assess the degree of assimulation attained by each technology:

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(1) Cf. "An Analysis of Technology Transfer", report by the Nomura Research Institute of Technology and Economics, Tokyo and New York, July 1961.

Stages by which a newly implanted technology establishes itself	Criteria of Assessment
1	Use of machinery and utilization of imported products
2	Maintenance, check-ups and quality control services
3	Repair workshops
4	On-the-spot assembly line production
5	Local production of individual parts, geared to on-the-spot assembly
6	Local production of major components, geared to on-the-spot assembly
7	Manufacturing engineering (fitting up of machinery and organization of production)
8	Design engineering (machinery and products)
9	Experimental development of prototypes and pilot factories

119. Similarly, when the horizontal transfer of a new technology is carried out, it is necessary to plan at which stages of establishment the technology will be imported, and to plan its progression (up to stage 9) in accordance with a pre-established schedule.

120. Here again, the CASTAFRICA Conference might discuss this matter in concrete terms with reference to the new technologies identified by the Delphi survey carried out by Unesco in Africa.

13. Evaluation and corrective mechanisms of technology transfer

121. Next comes the stage of feedback from the user of the technology to the supplier, which is, as a rule, based on an evaluation of the technological, economic, socio-cultural and political effects of the transfer.

(a) Among the technological effects, good note will be taken of the increase of the country's productive capacity and the improvement in its general standard of technological competence;

(b) Economic effects will be measured chiefly in terms of the per capita increase in the GNP, the creation of new jobs, the fall in prices of products and services, and the freedom of access to new products;

(c) Among the socio-cultural effects are included the general improvement in the standard of living, the drift of the rural population into the towns (with its sometimes detrimental consequences) as well as the change in outlook which is wrought by industrialization, and which in turn increases a country's capacity for technological assimilation, etc.

(d) Political effects are closely linked to a country's technological independence and its power and prestige in the world.

14. Transfer of scientific and technological information

122. Lastly, at all stages of the process of implanting new technologies, whether this is done through domestic R&D or by importation from abroad, there a arises the fundamental question of transfer of scientific and technological information. The overriding need is for the African countries to secure access to scientific and technological information published throughout the world. This is one of the principal aims of the world information system set up by Unesco under the acronym UNISIST. This matter, among other things, is the subject of the last chapter relating to item 9 of the CASTAFRICA Conference Agenda, which deals with international co-operation.

123. There is, however, a further point to be taken into consideration when implanting a new technology, namely: is the information recent? Is it relevant? It is henceforth beyond a doubt that in order to obtain relevant scientific and technical information with the least possible delay, interpersonal contacts constitute by far the most important channel of communication, although the usefulness of heuristic systems of information storage and retrieval by computer is not called into question.

124. The problem is that of the geographical mobility of scientific and technical staff. Just as in the case of R&D (see paragraphs 105 and 106 above), study tours for scientific and technical staff should be the target of a positive policy in the African countries(1) and a judicious balance should be struck between mission-oriented and discipline-oriented mobility. The CASTAFRICA Conference will certainly wish to bear this in mind when discussing item 9 of its agenda.

15. Possibilities for African regional co-operation in technology transfer

125. To end this chapter, the CASTAFRICA Conference might, in view of the technologies identified by Unesco's Delphi survey, discuss the possibility of African countries' pooling their potential for the study and scientific preparation of decisions in order systematically to trace new technological courses open to Africa. It might perhaps be expedient for multilateral institutions with a regional or sub-regional African vocation, a study of which was recommended by

(1) See on this subject "Bilateral institutional links in science and technology", document SPS No. 13, Paris, Unesco, 1969.

by the third session of UNCTAD[1], to be given express responsibility for this task of periodic consultation with the world scientific and technological community, and - taking advantage of UNISIST, the world scientific and technological information system - the task of going systematically through the scientific or technological literature which is of some practical interest to the development of Africa.

126. The key responsibility of such multilateral institutions would be to supply a flow of information to the government authorities in charge of the science and technology policies of the African countries which they would be called upon to serve, so that these countries might take new technological possibilities into account when preparing their medium- and long-term development plans.

127. One of these institutions' first tasks, in close collaboration with Unesco's science offices in Africa, would be to gauge the amount of effort needed and the capacity already present in Africa for the new technologies which the CASTAFRICA Conference selects as promising for the future of Africa. In order to do this , they would have to carry out individual surveys for each technology on the number and the quality of specialists available in all the African countries, existing equipment, specialized laboratories, etc. They would then have to assemble the necessary documentation on the technology in question, go to visit foreign laboratories, etc. - in short, with the support of UNISIST in particular, they would have to be responsible for carrying through the transfer of scientific and technological information, for which purpose they would have been established.

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(1) Cf. Resolution 39 (III) on transfer of technology, adopted without opposition by UNCTAD at its third session, which was held in Santiago, Chile, in April-May 1972; see in particular the operative paragraph II 8/b (document TD/III/RES/39), the text of which reads as follows:

"8. Decides that UNCTAD should co-operate with other bodies in the United Nations system, and with other competent international organizations, including the World Intellectual Property Organization, so as, in conformity with Part II of the Programme of Work, to supplement their activities in order to:

(a) ...

(b) Explore the possibility of setting up multilateral institutions such as technology transfer centres, patent banks and technological information centres".

CHAPTER III

SCIENTIFIC AND TECHNOLOGICAL CO-OPERATION IN AFRICA

TABLE OF CONTENTS

INTRODUCTION

1. The present Chapter is intended to facilitate discussion, by CASTAFRICA, of item 9 on its Provisional Agenda, which comprises four sub-items, as follows:

(a) co-operation in scientific research and experimental development;

(b) co-operation in the provision of scientific and technological services;

(c) co-operation in the field of scientific and technical documentation and information;

(d) making more effective the mobility of scientific and technological personnel.

2. From what has been stated in Chapter I it will be apparent that the minimal national institutional and conceptual basis for inter-country co-operation in science and technology now exists in Africa.

3. At the same time there exists an awareness, in Africa, that inter-country co-operation in science and technology is not likely to bear fruit, to the fullest extent possible, unless nations investigate possible joint action according to a jointly agreed terminology and methodology.

4. Members of the scientific community, and national planners are in fact convinced that the time has passed when a few persons from a number of countries could get together in a rather informal way to create and sustain truly operational inter-country co-operation schemes in the field of science and technology. International scientific co-operation has now become one of the major topics of national science policies. It is for this reason that in Europe, for instance, many countries:

(i) have set - sometimes implicitly - a ceiling to their international financial commitments in R&D (it is known that, on the average, Western European countries devote between 10% and 15% of their national R&D science budgets to international scientific co-operation and this, of course, has repercussions on these efforts);

(ii) are in the process of integrating into their national science policy the network of their bilateral and multilateral agreements and programmes in the field of science and technology.

Moreover, many industrialized countries:

(iii) have established temporary or permanent policy and management groups for their international scientific activities.

5. The above does not mean, of course, that all is now perfect in international co-operation in science and technology, even amongst the economically advanced countries. On the contrary, those countries have taken unco-ordinated steps towards scientific integration in many ways and at various levels. The

present situation in Europe, for instance, which is the inheritance of a complex past, presents two characteristics:

(a) attempts to integrate isolated research efforts have sometimes been successful within specific disciplines such as experimental zoology, oceanography or astronomy;

(b) however, without minimizing the worth or results of some of these attempts advanced nations have been perforce compelled to establish means of assessing, on a continuing basis, their overall participation and commitments in the present chaotic network of bilateral and multilateral, governmental and non-governmental agreements for scientific and technological co-operation. This, with a view to optimizing their interests within this network.

6. Turning to the African context, the general question which CASTAFRICA may wish to consider under item 9 of its Provisional Agenda is: What options are open to African nations, to optimize both their individual and collective involvement in the intra-African and international co-operative efforts in science and technology?

7. Should CASTAFRICA answer this question, it will make a salient contribution to African development. Indeed, most African countries cannot possibly hope to cover alone the whole range of research and scientific services relevant to their developmental problems in the foreseeable future. In its attempt to answer the above question CASTAFRICA might resolve that each nation interested in exploring possible co-operation with other nations in the field of science and technology should determine for itself however provisionally:

(i) the areas, and items for which inter-country co-operation in science and technology appears to be most urgently warranted, from their national standpoint;

(ii) the countries with which it would wish to start bilateral and/or multilateral negotiations with a view to inter-country co-operation;

(iii) for each item, the order of priority of the co-operative ventures envisaged with each other country;

(iv) for each item, the modalities of co-operation which it is ready to consider.

8. By way of introductory remarks to this chapter it might finally be pointed out that the examination of the main areas in which such co-operation is most urgently warranted is here purposely restricted to scientific and technological activity properly speaking, that is: the production, ordering, adaptation and application of knowledge, as distinguished from other fields of possible co-operation, such as transmission of knowledge through higher education in the various scientific and technological disciplines, or the questions specifically related to the international transfer of technology, the intricacies of which have been discussed under Chapter II, Section IV.

9. Scientific Research and Experimental Development (R&D) obviously qualify as subjects for discussion from the above-mentioned point of view, as well as the scientific and/or technological services (STS).

I. IDENTIFICATION OF FIELDS FOR SCIENTIFIC AND TECHNOLOGICAL CO-OPERATION

1. The global and regional approaches

10. Inter-country co-operation in science and technology requires special modalities and arrangements for the allocation, by the countries concerned, of the financial and manpower resources that must be mobilized in order to make joint action effective. The identification of fields of co-operation and the conclusion of arrangements judged to be mutually advantageous must therefore of necessity involve bilateral and multilateral negotiations around very specific considerations, both as regards the substance of the proposed co-operation, and the modality (technical, financial, administrative) for its execution.

11. The latter aspect - that of modality - has to do with form rather than content and is therefore discussed towards the end of this chapter.

12. The present section is thus concerned solely with the subject-matter of the proposed international co-operation, abstraction being made of the fact that the co-operation may be implemented by formal or informal means, and may require large-scale or modest individual inputs from the various participants.

13. That having been said, it seems clear that the identification of fields for scientific and technological co-operation which is tantamount to the selection of fields and the establishment of priorities can be approached from two mutually opposed standpoints: (i) the "global" or "regional" approach seeks to grasp the issue in terms of world situations, trying to discern the truth and to delineate problem areas from a "bird's eye" view; (ii) the "specific" approach seeks to identify the resources which are readily available in the countries directly concerned and can be translated into concrete action at short notice and with a minimum of effort.

14. CASTAFRICA might, in the light of the above considerations, wish to consider the subject of inter-country co-operation by first looking into the more general aspects of the question, and then turning to the particular ones.

15. For an examination of the general aspects, CASTAFRICA is fortunate in having before it the World Plan of Action for the Application of Science and Technology to Development, prepared by the United Nations Advisory Committee on the Application of Science and Technology to Development (UNACAST), over a period of several years(1).

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(1) World Plan of Action for the Application of Science and Technology to Development, United Nations, New York, 1971, 286 pages. Sales No. 71.II.A.18. Copies of the World Plan will be made available to CASTAFRICA delegations, in Dakar.

16. The objective of the World Plan of Action is to provide a framework for the United Nations and its Specialized 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.

17. The World Plan is composed of a Global Plan, on the one hand; and three Regional Plans, respectively for Africa, Asia and Latin America, on the other. The Global Plan and the African Regional Plan are discussed below, in so far as they are related to item 9 on the CASTAFRICA Provisional Agenda.

(a) The UNACAST Global Plan

18. The Global Plan was completed by the United Nations Advisory Committee on the Application of Science and Technology (UNACAST) early in 1970. Published in several languages, it is now being considered by Member States.

19. The Global Plan comprises two parts, of which Part Two comprises Chapters VI to XV, as follows:

VI. Science and technology policies and institutions

VII. Science and technology education

VIII. Natural resources

IX. Food and agriculture

X. Industry

XI. Transport and communications

XII. Housing, building and urban development

XIII. Health

XIV. Population

XV. Relevance and application of new technologies

20. The above chapters comprise material selected by UNACAST from contributions made by various organizations of the United Nations system, including, in so far as Chapters VI, VII and VIII are concerned, Unesco. Part Two was reviewed by the Sub-Committee on Science and Technology of the United Nations Administrative Committee on Co-ordination (ACC) and its final text thus is a consensus.

21. Part One of the Global Plan was prepared by the Committee itself. It is the part of the World Plan which can best assist discussions under CASTAFRICA Provisional Agenda item 9, if only because of its relative briefness (pages 3 to 41 of the English-language edition) and the fact that it lists priority scientific and technological areas the potential importance of which to individual developing countries is greatest.

22. The degree to which each subject which has merited a high global priority interests a given country must, of course, be determined on a country-by-country basis, and this aspect is discussed later on in the present chapter. It is also possible that, for specific reasons, a subject which is not on the global priority list is of considerable interest to one particular country.

23. The priority areas for further R&D identified in the Global Plan are:

A. High-yielding varieties of staple foods

B. Edible protein

C. Fish

D. Pest and vector control

E. Tropical hardwoods and fibres

F. Ground water

G. Desalination

H. Arid land

I. Natural disaster warning systems:
   (1) Volcanic eruptions
   (2) Earthquakes
   (3) Hurricanes, cyclones, typhoons
   (4) Floods and tidal bores

J. Indigenous building and construction materials

K. Industrial design and research:
   (1) Metallurgical processing
   (2) Industrial chemicals
   (3) Processing of natural fibres
   (4) Plant and equipment design
   (5) Small-scale and cottage industries
   (6) Industrial research
   (7) Appropriate technology

L. Schistosomiasis

M. Human fertility.

24. The Global Plan also identifies priority areas for the application of existing knowledge, as follows

A. Storage and preservation of agricultural products

B. Control of livestock diseases

C. Human disease control:

(1) Trypanosomiasis

(2) Smallpox

(3) Leprosy

(4) Cholera

D. Housing construction methods

E. Glass and ceramics

F. Improvement and strengthening of science teaching in secondary schools

G. Industrial extension and advisory services

H. Natural resources assessment and management

25. In considering the subject of possible areas for regional co-operation, CASTAFRICA will doubtless wish to bear in mind the above global UNACAST analysis, particularly since it offers the advantage of making a clear distinction between the need for further R&D, on the one hand, and immediate salient opportunities for the application of already existing scientific and technological knowledge, on the other. There exists a relationship between these two aspects, because application of existing knowledge often requires a certain amount of additional, supporting research and/or experimental development, for the purposes of adaptation so as to make the conditions and effects of application more consonant with local socio-economic constraints and objectives(1).

26. A second major step towards the pinpointing of scientific sectors relevant to Africa was the preparation by the African Group of UNACAST of the African Regional Plan for the Application of Science and Technology to Development. This United Nations Economic and Social Council document (E/CN.14/L.407 of 28 June 1972) is presented to CASTAFRICA as document SC/CASTAFRICA/4 submitted by the United Nations Economic Commission for Africa.

(b) The African Regional Plan(2)

27. The African Regional Plan is divided into ten chapters, each of which deals with one of the ten sectors listed below, though not exactly in the same sequence as the ten sectors mentioned in the Global Plan (cf. para. 19 above):

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(1) These questions are discussed in detail in Chapter I, paras. 24-33 of the present document, and also in Chapter II, paras. 65-128.

(2) UNACAST World Plan of Action: African Regional Plan, United Nations ECOSOC document E/CN.14/L.407 of 28 June 1972, forming a part of CASTAFRICA documentation as document SC/CASTAFRICA/4.

I. General development of scientific and technological capacity / Science and technology policies and institutions (1st on both Global and Regional lists)

II. Natural resources (3rd on the Global list)

III. Food and agriculture (4th on the Global list)

IV. Industrial design, research and development (5th on the Global list)

V. Transport and telecommunications (6th on the Global list)

VI. Housing and urban development (7th on the Global list)

VII. Health and sanitation (8th on the Global list)

VIII. Science and technology education (2nd on the Global list)

IX. Population (9th on the Global list)

X. Transfer of commercial technology (related to relevance and application of new technologies, which appears 10th on the Global list).

28. As will be noted, the only substantive change in sequence is that of science and technology education, which appears in 2nd place on the Global list, and 8th on the Regional list. It is difficult, however, to read any particular meaning into this, because the sequence does not necessarily imply an order of relative importance: the health and sanitation sector, for instance, is as important as the food and agriculture sector. Yet, for the purposes of any general discussion which CASTAFRICA might wish to devote to these two UNACAST Plans, it is perhaps appropriate to point out that science and technology education is but an extremely important facet of the general development of a nation's scientific and technological potential (STP). This fundamental point has already been discussed in Chapter I, paras. 48-53.

29. The Regional Plan, for each one of the ten above-mentioned sectors:

(i) states the general situation in an Introduction,

(ii) defines objectives for the sector, and

(iii) proposes a series of concrete programmes of varying scope and nature, without attempting to separate out, however, those which might best be the object of action at the exclusively national level, from those which might require inter-country co-operation. Also, the programmes do not attempt to differentiate (i) projects the main purpose of which is to increase knowledge in a given area (discipline-oriented R&D), from (ii) projects aiming mainly at facilitating the attainment of specific socio-economic objectives (mission-oriented R&D), or from (iii) the development of scientific and technological public

services (STS). Complementary and more detailed surveys and analysis were thus required to further identify priority fields of scientific and technological activity and appropriate modes of action.

2. The Unesco/UNACAST survey of institutional needs of African countries in the field of science and technology

30. A first activity undertaken by Unesco as a complement to the Global and Regional Plans has been the undertaking, at the request of UNACAST(1), of a survey of institutional needs of developing countries in the field of science and technology.

31. The survey has required the development, by Unesco, of a specially-designed methodology. Its aim is to provide a first approximation (subject to future refinement and review at periodic intervals) to the determination of national needs in the field of science and technology, measured against specific national requirements arising from socio-economic objectives, situations and constraints as outlined primarily in the respective National Development Plans.

32. The survey is conducted on a country-by-country basis. In each country, a panel of experts composed of scientists, engineers, economists, etc. from research institutions and universities on the one hand, and from ministries of planning and other ministries on the other, is asked to rate the relative importance (relevance) of sciences to development objectives, using a commonly agreed scale of assessment, a conventional nomenclature of scientific and technological disciplines and as concrete as possible a statement of development objectives and programmes, properly weighted.

33. As of October 1973, such surveys had been completed, with the help and advice of the Unesco Field Science Office in Nairobi, in twenty African countries: Botswana, Burundi, Cameroon, Central African Republic, Chad, Congo, Ethiopia, Gabon, Gambia, Lesotho, Liberia, Malawi, Mauritania, Mauritius, Nigeria, Senegal, Sierra Leone, Somali, Upper Volta, Zambia. (The exercise has also been carried out in Egypt, but results there are preliminary and cannot yet been released.)

34. A comparative analysis of the results from the 20 countries covered reveals many interesting features(2).

35. At the most aggregate level, the average share of importance (relevance) of 8 groups of disciplines emerged as follows:

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(1) Cf. World Plan of Action for the Application of Science and Technology to Development, United Nations, New York, 1971, pages 71 and 72.

(2) Cf. document Unesco NS/ROU/296: "Results of a Unesco/UNACAST survey of institutional needs of African countries in the field of science and technology".

GROUP	Column 1 Average relevance for group (%)	Column 2 Number of disciplines in the group	Column 3 Average relevance per discipline in the group (%)
Agricultural sciences	17	13	1.3
Engineering sciences (technology)	23	26	0.9
Medical sciences	9	15	0.6
Environmental sciences	18	14	1.3
Biological sciences	9	11	0.8
Chemical sciences	5	5	1.0
Physical sciences	8	16	0.5
Mathematical sciences	10	12	0.8

36. The figures in the first column are significant only in relation to each other, the absolute magnitude of the scale (in this instance, 100) being arbitrary, and chosen only for practical purposes. These figures represent the averages of the relevance marks obtained in the 20 countries.

37. One expects these relevance marks to vary, since development objectives are specific to each country, and since different panels were used for each survey. To the extent however that the countries covered have many features in common, such as overall level of development, and more specifically similar levels of education, health, industrialization, etc., one would expect these common traits, provided that the assessments of the panelists can be considered as reliable, to be reflected in a non-random distribution of values for the relevance marks. This is indeed obtained, the mean deviation of the distributions ranging from 20% to 38% (a purely random distribution would have a mean deviation of 58%). The figures in the first column might therefore be considered as reliable. They give an indication of the relative importance of 8 groups of disciplines, on the average, for the variety of development objectives found in 20 African countries. They can be used, with care and flexibility, as guideposts in working out the scale of effort by broad field of research and training, either nationally or regionally.

38. It should be observed that the magnitude of the relevance mark for a given group is the result of two compounded factors, the number of disciplines in the group, and the average relevance per discipline, shown in the third column above. It is seen that, on a disciplinary basis, agricultural and environmental sciences come out as the most relevant on the average, the share of engineering sciences, that is technology, being greater by virtue simply of the fact that the breadth of knowledge coming under "engineering sciences" is greater. This reflects the objective fact that if a broader field such as technology is to be covered as comprehensively as a narrow field (e.g. mathematics), then a greater number of specialists will be required in the broader one and this will be reflected in greater budgets, for instance, to train them.

39. The individual surveys furthermore provide fine profiles of relevance, showing the relative importance of each individual discipline in each country(1). On the average, 25 disciplines only out of a total of approximately 115 account for more than one-half of the total relevance, which means that "relevant science" for present-day Africa is rather concentrated. This is a welcome finding, for it means that the effort does not have to be spread thin over the entire spectrum of scientific knowledge. However, it points to the criticality of the selection, thereby shifting the burden to the planning stage, when priorities are set.

40. On the other hand, it is interesting to know which disciplines are, globally, the most relevant for the countries covered. A global ranking procedure has been applied, which averages the rank of the discipline over the countries. The top ten disciplines thus come out as:

Rank	Discipline
1	Hydrology
2	Civil engineering
3	Crop production and protection
4	Agronomy
5	Mechanical engineering
6	Climatology
7	Applied mathematics
8	Construction engineering
9	Pedology
10	Ecology

41. Next to this top group are found such disciplines as: public health, cartography, statistics, analytical chemistry, entomology, instrumentation and control engineering, electrical engineering, animal health, etc.

42. These results indicate that national and regional efforts in building up the scientific potential and organizing co-operation should be concentrated, as a matter of priority, in the above areas of training and research.

43. For each country surveyed, a comparison was made between the top disciplines contributing to 50% of the relevance and the fields of specializations of its research and training institutions (as listed in the publication Survey on the scientific and technical potential of the countries of Africa, Unesco, 1970). Thus were identified those disciplines for which no institution seemed to exist (in 1968-1969) that could undertake research or training in the corresponding field. By summing over all the countries covered, one finds that from 2/3 to 1/3 of the countries had no institution possessing an R&D capability in the following disciplines (listed in decreasing order of the gap): Mechanical engineering, Civil engineering, Construction engineering, Climatology, Electrical engineering, Hydraulic engineering, Instrumentation and control engineering, Ecology, Public health, Applied mathematics, Agricultural engineering, Transportation engineering, Statistics.

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(1) Ibid.

44. If this result is compared with the list of the most (globally) relevant disciplines mentioned above, it is seen that an urgent and important task lies ahead in Africa in institutional build-up in the following areas: civil, mechanical, construction, electrical, instrumentation and control engineering; climatology and ecology; public health; applied mathematics and statistics.

45. Finally, the method applied permits the identification of those development objectives and programmes which are more critically dependent on science and technology inputs (simply by summing up, for each objective, the relevance marks contributed by each discipline). The problem still arises of working out a common nomenclature of development goals which can accommodate the specific goals stated in each country. This was fortunately found to be possible, at a sufficiently aggregate level as shown in the list below. By considering for each country the top third of the goals with the greatest dependence index, (5 of them on the average) reallocating these goals among the various headings shown in the list, and summing up over the 20 countries, an idea can be obtained of those types of goals which are more widely recognized as being more science and technology dependent. The result was the following list of objectives, arranged in decreasing order of the number of countries in which they were among the top third of the most ST-dependent:

19	Agriculture
16	Health
12	Animal breeding
11	Water
10	Mines
8	Industry
8	Communication (incl. Transport)
6	Energy
5	Environment
4	Education
3	Manpower (and other social)
2	Construction
1	Post and telecommunications

46. Once again, this list provides some indication of the most widespread types of development objectives and programmes which are likely to benefit greatest from the application of science and technology.

3. The CASTAFRICA Matrix survey for the identification of areas for African inter-country co-operation in science and technology

47. A second complementary activity launched by Unesco, not only in pursuit of the general objectives of the Global and Regional Plans, but also in direct preparation of CASTAFRICA's consideration of sub-items 9 (a) and 9 (b) of its Provisional Agenda, was a survey conducted on the basis of a document entitled "A Matrix Methodology for Identifying Areas for Inter-Country Co-operation in Science and Technology"(1).

(1) Document Unesco/NS/ROU/274 of 29 January 1973, 35 pages of text plus three sets of matrixes.

48. A detailed description of the Matrix Method will be given in an Appendix to the present document, to be issued later, and which will tabulate communications from African Member States to the Unesco Secretariat, on the subject of scientific and technological co-operation in Africa.

49. A succint analysis of the results of the survey up to 15 October 1973 is given below with the aim of facilitating discussion of this question at CASTAFRICA.

50. First of all, it should be pointed out that the underlying assumption of the Matrix Method was that those who wish to co-operate with others in scientific and/or technological ventures, are more likely to reach an understanding if they accept, as a basis for negotiations, a common terminology and methodology.

51. In establishing the Matrix Method, an initial attempt was made to establish matrixes for (i) fundamental research, (ii) applied research, (iii) experimental development and (iv) scientific and technological services. This attempt was abandoned because it was often difficult to establish clear-cut boundaries between fundamental and applied research and, perhaps more important, because the results would not provide socio-economic planners with explicit information on extent to which R&D in given disciplines is likely to have practical applications. Instead, the Matrix Method was devised with three sets of matrixes, as follows:

"A" - Discipline-oriented research and experimental development

52. This set of matrixes comprises headings familiar to scientists such as, for the Biological Sciences section: Botany, Biology (general), Biochemistry, Molecular Biology, Biophysics, Cell Biology, Entomology, Genetics, Microbiology, Physiology (general), Radiobiology and Zoology(1).

"B" - Mission-oriented research and experimental development

53. This set of matrixes uses headings familiar to socio-economic planners and, in particular, to economists, since they correspond to those used in the International Standard Industrial Classification of all Economic Activities (ISIC)(2). Thus, it is an easy task to relate the terminology used in national accounts statistics for the various sectors (primary, secondary, tertiary) which constitute the GDP, and sub-sectors. For instance, the section dealing with fuel and power industries includes entries for: Coal processing industry, Coking and gas industry, Fuel cells, Geothermal energy, Hydro-electric energy, Nuclear fueld and fuel elements and moderators, Petroleum refineries, Solar energy, Thermochemical energy (fuels and combustion), Tidal energy, Wind energy.

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(1) The complete list of the areas and items used in the Matrix Method will be given in the Appendix to the present document.

(2) Department of Economic and Social Affairs, Statistical Office of the United Nations, Statistical Papers, Series M. No. 4. Rev. 2, New York, United Nations 1969.

"C" - Scientific and technological public services (STS)

54. This set of matrixes, based on the list of services on pages 90-91 of the World Plan of Action, lists for instance, under the section entitled National resources and environment services: Astronomical services, Energy services, Cartography and photogrametry services, Biometrical services, Geological survey services, Hydrological services, Integrated land-systems surveys, Marine and fisheries services, Meteorology services, Mining services, Scientific mapping services, Soil Science services, Time services, Vulcanological services, Water supply services, Wildlife conservation services.

55. It is stressed that the above are but examples of the areas and items mentioned in the three matrixes. Matrix "A" comprises 10 group headings and 138 subject headings; Matrix "B" 17 group headings and 179 subject headings; and Matrix "C" 5 group headings and 62 subject headings. In all, the Matrix Method covers 379 subject headings with additional blank spaces provided for any further headings required by respondent countries. It is believed that the degree of detail thus covered is - by comparison with the present configuration of R&D units in Africa - an optimal one.

56. Member States were asked to fill out the prospective inter-country co-operation matrixes in detail only after making certain that, for the sub-headings in question, they had an R&D potential equivalent to at least 3 full-time researchers adequately backed by well-trained technicians, suitable premises and equipment, a reasonable budget to cover capital and recurrent expenditure of the project for its anticipated duration, etc. At an all-inclusive cost of between $30,000 and $35,000 per R&D scientist/engineer (cf. Chapter I, para. 164) this implies a minimum expenditure of approximately $100,000 per year for the duration of the project. This under optimal conditions, of course, since it is known that African expenditure per R&D scientist/engineer is at present far lower, ranging from $9,000 to $20,000 (cf. Chapter I, para. 163). The implication is that each of the participating African countries would need to receive outside assistance (United Nations; bilateral) to strengthen the financing of projects which seem to offer particularly attractive inter-country co-operation prospects. It must also be considered that average expenditure per R&D scientist/engineer is likely to be higher for inter-country than for national projects, because of greater overhead costs (staff, travel, exchange of equipment and information etc.)(1).

57. So as to ensure that the replies to the matrixes were realistic, Member States were asked to point to possible co-operation with R&D units in other African countries only if they had a solid assurance that the "likely partner

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(1) For the above purpose Member States were invited to refer to the results of (i) the inventory of their national STP survey (cf. Chapter I. para. 77), (ii) the Unesco/UNACAST survey on institutional needs (cf. Chapter III, paras. 30-46) and (iii) the Survey on the Scientific and Technical Potential of the Countries of Africa, Unesco Field Science Office for Africa, 1970, Cf. Chapter I, 59-64).

countries" had also the minimum potential for inter-country co-operation(1). In addition, Member States were requested to indicate a degree of priority (T = Top; M = Medium; or L = Low) for each prospective inter-country link. Finally Member States were asked to state the implications of their notations on the matrixes by means of explanatory notes.

58. The Unesco Secretariat was aware that the inevitably sophisticated nature of the Matrix Method would make it difficult for Member States to reply without considerable work by a team of R&D scientists in each country. The extent to which Member States replied was therefore a test both as to (i) the interest of African Member States in establishing closer co-operative links in science and technology, and (ii) their belief that CASTAFRICA offered an appropriate and timely forum for a well-informed discussion of this position and the taking of concrete action-oriented decisions.

59. The Unesco Secretariat therefore reports with satisfaction that - whilst the Matrix Survey is still in process - the results achieved thus far are positive and meaningful.

60. The first direct results of the wide interest aroused by the survey were six sub-regional consultations between the Unesco Secretariat and the CASTAFRICA National Liaison Officers which had been officially designated by governments. These consultations took place in Cairo, 2-5 October 1972; Nairobi, 4-6 December 1972; Abidjan, 22-25 January 1973; Lagos, 30 January - 1 February 1973; Yaoundé, 6-8 February 1973; and Algiers, 15-17 March 1973.

61. While the Matrix Method was accepted, during these consultations, as a valid basis for the identification of inter-country R&D co-operation possibilities, it at the same time became evident that the flow of African scientific personnel and information is very much larger towards and from Europe and North America than between the African countries themselves. The consensus arising from the consultations was that owing to the mutual ignorance of the African scientific communities with regard to one another's the analysis of the first round of replies to the matrixes were concerned, could only lead to a first approximation, which would need to be supplemented by further rounds of replies each of which would have to be based on the consideration of the analysis of replies to the preceding round.

62. At the consultations, certain participants also stated that, while they considered that the filling out of the matrixes was a valuable means of facilitating the definition - be it preliminary - of a national policy for inter-country co-operation, they doubted that their governments would wish to divulge the results of their first thoughts on the question, without first hearing what other countries had said on the matter and having an opportunity to refine their position, which might be made known during CASTAFRICA.

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(1) For this purpose, Member States were invited to refer to (i) the Survey on the Scientific and Technical Potential of the Countries of Africa, ibid; (ii) the proceedings of former African scientific conferences and meetings; (iii) the publications of national science policy and research councils of African countries; (iv) the knowledge of conditions in other African countries possessed by R&D specialists within the responding country.

63. It is thus known that a number of countries which have filled out the matrixes have not transmitted them to the Unesco Secretariat. If this fact is taken into account, one might consider that the receipt by the Secretariat of replies from 17 African countries as of 15 October 1973 is highly encouraging and suggests that the CASTAFRICA conference should strive to complete the survey and derive recommendations for its implementation before the conference disbands. Indeed, a comparable major opportunity for the drawing up of concrete all-African plans for co-operation in R&D and STS is not likely to arise for some time to come.

II. CO-OPERATION IN RESEARCH AND EXPERIMENTAL DEVELOPMENT (R&D)

1. General considerations

64. One conclusion which may be drawn from the 17 replies already received to the Matrix Survey is that, as a general rule (but with numerous and understandable exceptions) African countries give highest priority to R&D co-operation with neighbours or near-neighbours whose climatic and geographical characteristics are similar and who in their R&D work, use the same language (English or French and, to a certain extent, with particular reference to the social and human sciences, Arabic).

65. For this reason the 17 responding countries are grouped in Table I on the bases of both the United Nations sub-regional groupings and main languages used for scientific work.

66. The Unesco Secretariat may still receive further replies to the matrixes from African Member States before the opening of CASTAFRICA. In that event, an addendum will if possible be issued to the Appendix to document SC/CASTAFRICA/3, reporting on these replies and indicating their relationship to the 17 already received.

67. Meanwhile, it seems appropriate to draw attention to certain aspects of the Matrix Survey:

(i) first, it must be pointed out that the fields of possible co-operation in R&D to which attention is drawn both in the Global and African Regional Plans of Action were not only included in the matrix subject classification, but were broken down into a number of sub-fields. Moreover, by means of explanatory notes, responding States have drawn attention to aspects of particular importance to them (for instance, in the field of agriculture they have specified the crops which interested them). While the Global and Regional Plans proved extremely useful for the establishment of the Matrix Method classification, the replies to the matrixes are, because of the degree of definition attained, much more precise and, as a consequence, more à propos and realistic in operational terms;

(ii) the same holds true in connexion with the identification, by the Scientific Council of Africa of the Organization of African Unity (OAU), of certain possible areas for inter-African co-operation in science and technology, namely:

earth sciences,

applied science and engineering,

food science and technology,

water resources, planning and development,

marine science and technology,

human medicine and pharmacology,

veterinary science,

climatology and meteorology,

basic sciences (physics, chemistry, biology and mathematics),

social sciences (documentation, teaching and research).

68. While all of the above items are covered by the Unesco Matrix Survey, not only globally but with several subdivisions, the replies to the matrixes show that the interest of individual countries varies considerably when specified in detail. This, again, is partly a consequence of the fact that the Matrix Method does not seek only to identify areas of theoretical interest, but to pin-point possibilities for immediate co-operation, taking into account the existence of a minimum "critical mass" for co-operation in R&D between all prospective partners.

(iii) A further general point, also related to the above, is that there exists a relationship between the "discipline-oriented" classification used for Matrix A, and the "mission-oriented" classification for Matrix B, which is sometimes fairly clear-cut but in other instances rather subtle.

(iv) As to the relationship between the classification of R&D Matrixes "A" and "B" respectively with that of STS Matrix "C", the simple fact is that most of the scientific and technological services identified in Matrix "C" have some contribution to make to the development of each of the experimental sciences.

69. The above considerations about the premises and the results of the Matrix Survey lead to a number of points to which the conference's attention should be drawn:

(a) firstly, that the ultimate approach, by the governments concerned, to the planning of R&D inter-country co-operation, should be a multidisciplinary one; and it is in that sense that it must necessarily find its place within a consolidated national scientific and technological policy, itself integrated into the overall National Development Plan.

(b) secondly, that because scientific knowledge has been doubling every eight years, or so during the past half-century, the scientific efforts of African countries should increasingly be pooled if they are to be meaningful and effective, both taken separately or as a whole;

(c) thirdly, that Unesco is merely fulfilling its central responsibility within the United Nations system for matters relating to the planning of science and technology policies across the board by carrying out the Matrix Survey. This does not mean that the implementation of specific projects or programmes will not require the placing of responsibility squarely on the shoulders of other intergovernmental organizations; and this applies both to sister organizations of the United Nations family and to other intergovernmental bodies, according to the nature of the scientific discipline concerned, to the practical objectives of the research, and to other less technical but none the less important considerations. In other words, the fact that Unesco has convened CASTAFRICA is certainly not intended to mean that the Organization has - or should have - an exclusivity in matters of scientific and technological development in Africa; quite to the contrary;

(d) fourthly, that the work of organizations which involve co-operation between the governmental and private spheres can also benefit from the results of the Matrix Survey. One such case is that of the Consultative Group on International Agricultural Research, sponsored jointly by the International Bank for Reconstruction and Development (IBRD), FAO and the United Nations Development Programme (UNDP). This Group brings together representatives not only of international institutions but representatives or observers of the governments of industrialized countries, the African Development Bank, the International Development Research Centre (Canada), and the Ford, Rockfeller and Kellog Foundations. Unesco Member States in Africa may wish to use CASTAFRICA, through application of the Matrix Method, as a means of drawing attention to priority inter-country agricultural R&D co-operation projects which might merit assistance from the Consultative Group on International Agricultural Research;

(e) in the same way, Member States may wish to avail themselves of CASTAFRICA as a means of providing guidance to certain All-African non-governmental organizations able to contribute to the continent's scientific advancement. One such organization is the Association for the Advancement of Agricultural Sciences in Africa (AAASA), established with assistance from the United Nations Economic Commission for Africa, FAO, and the National Academy of Sciences of the United States of America (USNAS). This organization convened a Conference on Agricultural Research and Production in Africa in Addis Ababa, from 29 August to 4 September 1971. The proceedings of the conference include contributions from officials of the ECA-FAO Joint Agricultural Division, the OAU, Unesco, the World Bank, the African Development Bank, USNAS, and the International Institute of Tropical Agriculture (IITA, Ibadan, Nigeria)(1). Such conferences, placed on a scientific rather than a formal footing, though with the participation of the official bodies concerned, doubtless bring together elements which can be incorporated in a systematic analysis such as the Unesco Matrix Survey;

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(1) The proceedings of the conference were published in Vol. I, No. 2 of the Journal of the AAASA, April 1972, P.O. Box 30087, M.A., Addis Ababa, Ethiopia.

(f) finally, prominent mention must be made, by way of general comment on the Matrix Survey results, of the fact that inter-country co-operation is certainly not a new thing in Africa. More will be said about this in the context of the various sub-regions discussed below. At the outset of the present paper (cf. Chapter I, para. 11), it was stated that many of the African countries have retained close formal or informal ties with the French Community, the British Commonwealth, or Belgium. Other industrialized nations are establishing R&D ties with Africa, the assistance provided by the National Academy of Sciences of the United States of America to the AAASA being but one example. In judging the results of the Matrix Survey, CASTAFRICA delegations might therefore bear in mind these general links of African R&D activity with a growing number of industrialized countries, as well as the internal African links to which reference will be made in what follows.

2. Past and present inter-African co-operation in R&D

70. It will be realized that the purpose of the Matrix Survey was not to put in question whatever has already been done, by the African countries, by way of co-operation in the field of science and technology.

71. Quite evidently, future possibilities for inter-country co-operation will be primarily an extension of past activities simply because new co-operative ventures cannot be launched without prior building-up of the necessary scientific infrastructure.

72. In examining the origins and evolution of past R&D co-operation in Africa, it is however advisable to consider the question as it relates to the eight African sub-regions identified in Table I.

73. To facilitate the identification of existing co-operation, Member States were invited, in replying to the matrixes, to differentiate clearly the on-going projects from projects concerning possible future co-operation in new disciplines or fields. The replies which referred specifically to on-going co-operation were hence tabulated by the Unesco Secretariat in the form of cross-country matrixes, reproduced at the end of Part One of the Appendix to the present document. The comments given below on the situation of present co-operation in each sub-region are based, to a great extent, on the information contained in that set of cross-country matrixes.

TABLE I

IDENTIFICATION, ON A SUB-REGIONAL BASIS, OF THE 17 AFRICAN MEMBER STATES WHICH, BY 6 OCTOBER 1973 HAD SENT REPLIES TO THE "MATRIX METHOD FOR IDENTIFYING AREAS FOR INTER-COUNTRY CO-OPERATION IN SCIENCE AND TECHNOLOGY" 1/

(Names of responding countries are underlined)

1. Northern Africa (East) (English-language oriented)

<u>Egypt</u>
Libyan Arab Republic
<u>Sudan</u>

2. Northern Africa (West) (French-language oriented)

<u>Algeria</u>
<u>Tunisia</u>
Morocco

3. Western Africa (English-language oriented)

Gambia
Ghana
<u>Liberia</u>
Nigeria
Sierra Leone

4. Western Africa (French-language oriented)

Dahomey
Guinea
<u>Ivory Coast</u>
<u>Mali</u>
<u>Mauritania</u>
Niger
<u>Senegal</u>
<u>Togo</u>
Upper Volta

5. Middle Africa (French-language oriented)

Central African Rep.
Chad
<u>Congo</u>
Gabon
<u>Zaire</u>

Middle Africa (English/French-language oriented)

<u>Cameroon</u>

6. Eastern Africa (French-language oriented)

<u>Burundi</u>
Madagascar
Rwanda

7. Eastern Africa (English-language oriented)

<u>Ethiopia</u>
<u>Kenya</u>
Malawi
<u>Somalia</u>
Uganda
Tanzania
Zambia

Eastern Africa (English/French-language oriented)

Mauritius

8. Southern Africa (English-language oriented)

Botswana
Lesotho
Swaziland

1/ The classification of countries according to major regions is taken from the United Nations Demographic Yearbook, 1971, page 16.

(a) Northern Africa (East)

74. For some considerable time Egypt was French-language oriented in its relations with foreign countries, and although for scientific work it is now English-language oriented, it does possess a scientific potential in both languages. Its links with the Libyan Arab Republic and the long-standing contacts with the Sudan, from which it receives the river Nile, have made the relationship between these three countries particularly close.

75. It is therefore somewhat surprising to note that, judging from the replies from Member States, there does not seem to be very close R&D co-operation between Egypt and Sudan as yet. However as will be seen from the analysis which will later be made of possibilities for the future, these two countries wish to co-operate more closely with one another in many fields of science and technology. The replies to the matrixes indicate that Egyptian co-operation with other African countries has been limited mainly to contacts between services (geological surveys: Sudan, Libya and Chad) (meteorological services: Sudan, Libya, Tunisia, Algeria, Morocco).

(b) Northern Africa (West)

76. The Maghreb Permanent Consultative Committee (CPCM) comprises Algeria, Morocco, and Tunisia and involves co-operation in industrial development, transport, trade and tourism, the ultimate objective being economic union. An Industrial Studies Centre (ISC) has been set up and there is provision for the establishment of a Maghreb Development Bank and for common payments arrangements(1).

77. In its reply to the matrixes, Tunisia indicated that it is co-operating with Egypt and Libya in human and social sciences research; and with Algeria and Morocco in the establishment of libraries of science and technology, and scientific journals.

78. Algeria, for its part, indicated that it was co-operating with Guinea and Morocco in medical research; with Tunisia and Morocco in agricultural R&D; with Tunisia and Congo in the study of certain products used by materials industries; and with Tunisia for research on fertilizer production and phosphorous products.

(c) Western Africa (English-language oriented)

79. This area comprises four former British colonies (Gambia, Ghana, Nigeria and Sierra Leone) and Liberia with its historical links with the United States of America. Of these five African nations only Liberia had communicated replies to the matrixes by the closing date of the present document (15 October 1973).

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(1) African Economic Indicators 1970, United Nations, ECA, July 1972, pp.37-44.

80. The reply from Liberia indicates that this country is already co-operating with the other English-speaking Western African nations in a number of fields (mathematical sciences: Sierra Leone, Ghana and Nigeria; medical sciences: Ghana and Nigeria; soil management: Nigeria) and there is also co-operation, in connexion with various subjects, with Uganda and Kenya.

81. Before the accession to independence, the West African Regional Research Office (WARRO) had research stations in Ghana, Nigeria and Sierra Leone for cocoa and coffee (WACRI), oil palm (WAIFOR), maize (WAMRU), rice (WARRI), and stored products (WASPRI). There was also regionally based research in cotton, food crops and forestry. Although no precise information has been provided by Member States on the present state of co-operation in R&D which is still going on, it seems probable that links between the research stations have continued to exist on a less formal basis and there appears to be, indeed, considerable interest in the strengthening of present co-operation.

82. An important forum for the promotion of scientific co-operation not only in English-speaking West Africa but in several French-language West African countries is the West African Science Association (Association scientifique de l'Ouest africain), known as WASA, which has received assistance from a number of governments, from Unesco and from the International Council of Scientific Unions. The eighth biennial conference which took place in 1972 provided an opportunity for an exchange of information between West African researchers, and has probably led to co-operation ventures amongst university professors and scientists or engineers at research stations and laboratories in West Africa.

(d) Western Africa (French-language oriented)

83. Five of the nine countries in the area (cf. Table I) replied to the matrixes and the analysis of these replies (reproduced at the end of Part One of the Appendix to the present document) shows that the present state of co-operation among these countries and with other countries in the French-speaking Western African area is far from negligible. These close links are doubtless a reflection of the efforts which the countries of the area are making to tackle their common problems jointly. The Conseil de l'Entente, for instance, was established in 1959 by Dahomey, Ivory Coast, Niger and Upper Volta, and was later joined by Togo, with the aim of strengthening the solidarity of Member States through a formula for guaranteeing external loans contracted by any of its member countries. In 1966, it established a Central Aid and Loan Guaranty Fund and, in 1970, an Entente Meat Market. Training institutions in fisheries and mechanical engineering have been established, and other schemes involve co-ordination of transport and communication, industrial and tourism development, joint exploitation of hides and skins, and stabilization of grain supplies(1). The West African Economic Community covers Dahomey, Ivory Coast, Mali, Mauritania, Niger, Senegal and Upper Volta and was established in 1970 to replace the West African Customs Union. Its objectives are to improve distribution facilities, develop transport and communications, harmonize industrial development within the member countries and expand intra-African trade(2).

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(1) Ibid.

(2) Ibid.

84. The Organisation de Mise en Valeur du Fleuve Sénégal was established originally in 1963, took the legal form in 1968, and adopted its present name in 1972. Its members include Senegal, Mali, and Mauritania and it aims at promoting joint solutions to the problems of development and in particular to promoting intra-African trade and payments. It is considering the establishment of a common market in the area and the siting of basic industries(1).

85. A number of West African French-speaking countries also belong to an organization established in 1966 and now named the Afro-Mauritius Common Organization (OCAM). Its present members are: the Central African Republic, Dahomey, Gabon, the Ivory Coast, Mauritius, Niger, Rwanda, Senegal, Togo and Upper Volta. Its aim is co-operation in the development of the major sectors of economic activity, e.g. agriculture, industry and transport and communications and much emphasis is placed on intra-African trade.

(e) Middle Africa

86. As shown in Table I, this area includes 5 French-speaking African countries, together with the United Republic of Cameroon, which is bilingual. The analysis of the Matrix Survey shows that there already exists some co-operation in agricultural R&D and some fields of the earth and space sciences, engineering sciences and human and social sciences amongst the Middle African countries and the French-speaking Western African countries.

87. One of the institutional vehicles for the promotion of this co-operation has doubtless been the OCAM which has its headquarters in Yaoundé and to which all of the Middle African countries belonged in 1972(2).

(f) Eastern Africa

88. In Eastern Africa there are 3 groups of countries: (1) the East African Community countries (Kenya, Uganda and Tanzania); (2) the other English-speaking countries mentioned in Table I, some of which are considering possible membership in the East African Community; and (3) four countries with a particular geographical setting, Burundi, Madagascar, Rwanda and Mauritius (the last being bilingual).

89. As indicated in the replies to the matrixes, the East African Community is outstanding in the development of inter-country co-operation in R&D in Africa. This co-operation dates back more than 50 years(3). In the field of natural resources research, the EAC runs 4 research stations: the East African Agricultural and Forestry Research Organization (EAAFRO); the East African Veterinary Research Organization (EAVRO); the East African Freshwater Fisheries Research Organization (EAFFRO); the East African Marine Fisheries Research Organization (EAMFRO). The largest is EAAFRO, which evolved from an institute established in 1923. Industrial research work is undertaken by the East African

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(1) Ibid.

(2) Ibid.

(3) Regional co-operation in science and technology - the East African Community case, by F. Kasajja-Muwongé, paper presented to the EAC/Unesco Regional Symposium on the Utilization of Science and Technology for Development in Africa, Addis Ababa, 5-16 October 1970.

Industrial Research Organization. There are also six medical research institutes administered by the EAC and largely financed by it: the East African Institute for Medical Research at Mwanza (Tanzania); the East African Institute of Malaria and Vector-borne Diseases at Amani (Tanzania); the Tryponosomiasis Research Institute at Tororo (Uganda); the East African Virus Research Institute at Entebbe (Uganda); the East African Leprosy Research Centre at Lupe (Kenya); and the Tuberculosis Research Centre in Nairobi. Lastly, there is the East African Tropical Pesticides Research Institute (EATPRI), based in Arusha, which became an EAC institute in July 1962(1).

(g) Inter-regional co-operation

90. Finally, mention should be made of the existence, in Africa, of a number of institutions or programmes which strive to serve Africa as a whole and, which, in certain instances have international extensions. One such institution is the International Centre for Insect Physiology and Ecology (ICIPE), at Nairobi. Another is the International Institute of Tropical Agriculture (IITA), at Ibadan (Nigeria), the latter being a joint project of the Ford Foundation and the Rockefeller Foundation. Other examples are the regional intergovernmental projects such as the Inter-African-Phyto-Sanitary Council (OAU), or the regional locust control programme (FAO).

91 Also of significance is the recent creation (19 January 1973) of the Council for the Development of Economic and Social Research in Africa (CODESRIA), which supersedes the Conference of Directors of Economic and Social Research Institutions in Africa (founded in 1964). The headquarters of this organization are in Dakar.

3. Identification of areas for possible future inter-country co-operation

92. All of the countries which replied to the Matrix Survey (the names of which are underlined in Table I), with the exception of Kenya, indicated, in addition to the present state of their collaboration in the field of R&D and of STS the possibilities which seemed to them at first sight most evident for future co-operation.

93. The specific areas mentioned in the reply of each responding country are tabulated in Table II of the Appendix which accompanies the present document. Reference may therefore be made to this Table for detailed information on the fields of co-operation chosen.

94. A general analysis of replies from the various sub-regions is given below:

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(1) Further information on scientific co-operation in East Africa may be found in the National Summary for Kenya, Uganda and Tanzania in Unesco document SPS No. 31: National Science Policies in Africa.

(a) Northern Africa (see Diagrams A.1 and B.1)

95. The number of fields mentioned in the replies from the Northern African countries, in their replies to Matrix A relating to "discipline-oriented research", and "likely partners for R&D co-operation" chosen by them, are shown, in graphic form, in Diagram A.1 attached.

96. It should be noted that specific fields of scientific co-operation have intentionally not been specified in this document. It was felt that the main CASTAFRICA working document should not close the door to the incorporation of further replies from African countries to the Matrix Survey. Hence it is still possible for Member States to address communications to the Unesco Secretariat in this regard.

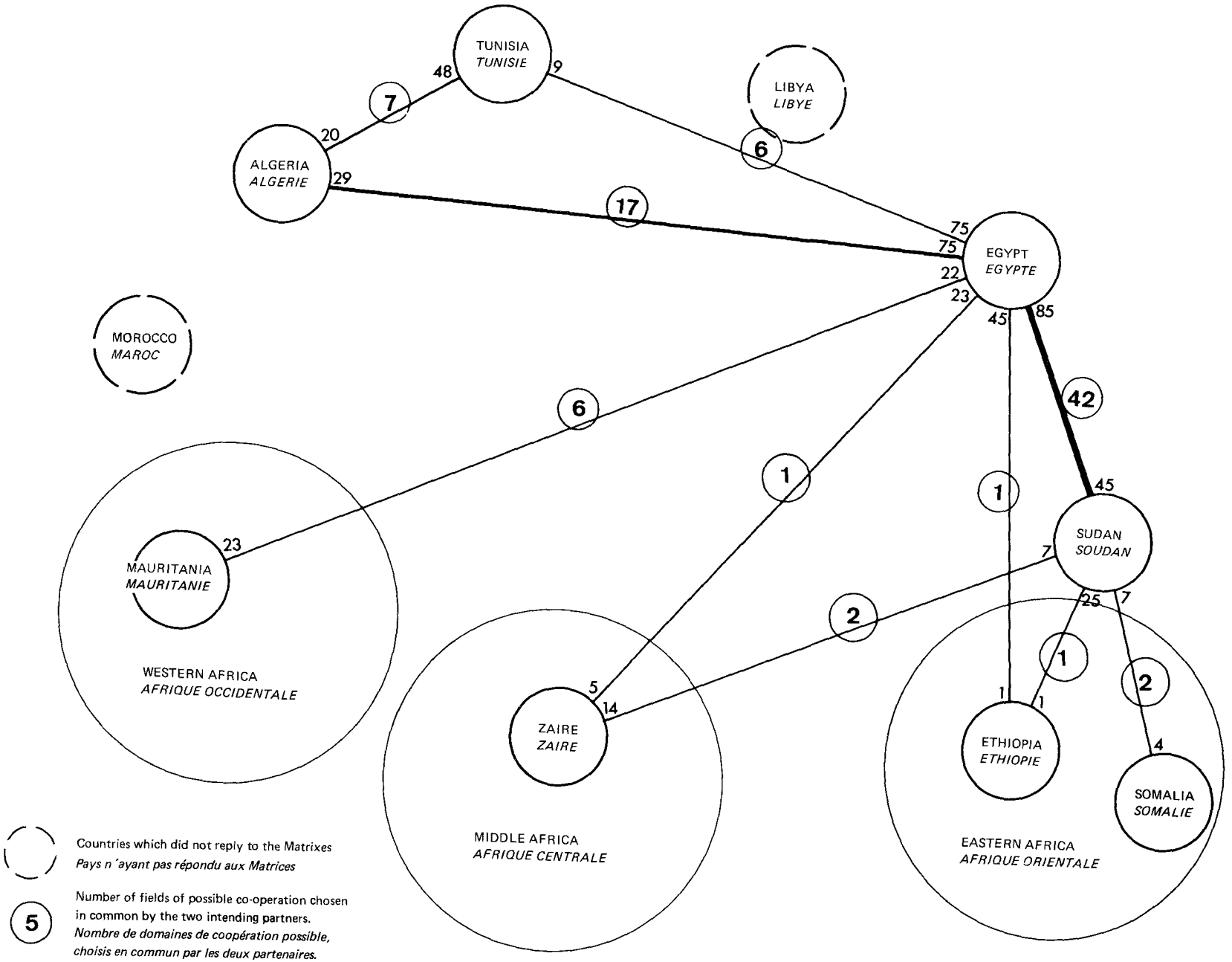
97. What is important in Diagram A.1 is, therefore, the likely flows of co-operation and their predictable magnitude rather than their modalities or the scientific fields to which they relate. The latter specifications might be established at a later date, by responding countries, after they have had the time to analyse their respective replies. It is desirable that the final choice of fields and modalities of co-operation be made by the prospective partners, taking into account the views expressed by the parties concerned.

98. Subject to this proviso, it nevertheless remains that the analysis of the flows and their magnitude yields interesting information. As shown in Diagram A.1, Egypt was the country which mentioned the largest number of possible co-operation ventures with other countries in the replies to the "discipline-oriented" Matrix A. As likely partners, it identified not only other Northern African States, but Mauritania, Zaire and Ethiopia.

99. Much the same situation arises for the replies to the "mission-oriented" Matrix B. This is doubtless a reflexion of the fact that Egypt has the most extensive scientific potential amongst all the African countries, both in terms of the absolute number of R&D scientists/engineers, and in terms of the number of scientific fields covered.

100. The very strong wish expressed by Egypt and Sudan to co-operate with one another both as regard "discipline-oriented" and "mission-oriented" research is all the more meaningful since present scientific co-operation between these two countries (cf. paras. 74-75 above) is very little developed. One major recent event which has precipitated the need for co-operation between these two countries are the consequences of the building of the Aswan dam, the headwaters of Lake Aswan extending, as is known into Sudan. In this connexion it might finally be noted that Egypt and Sudan selected 42 scientific/technological fields in which they wish to co-operate with one another, an exceptionally high figure considering that Sudan indicated, in its reply to Matrix A, that it possessed the minimum required potential for co-operating (cf. para. 56 above) in 45 fields. The second strongest possibility for co-operation lies in the possible future links between Egypt and Algeria (17 items in common for "discipline-oriented" research and 9 items for "mission-oriented" research).

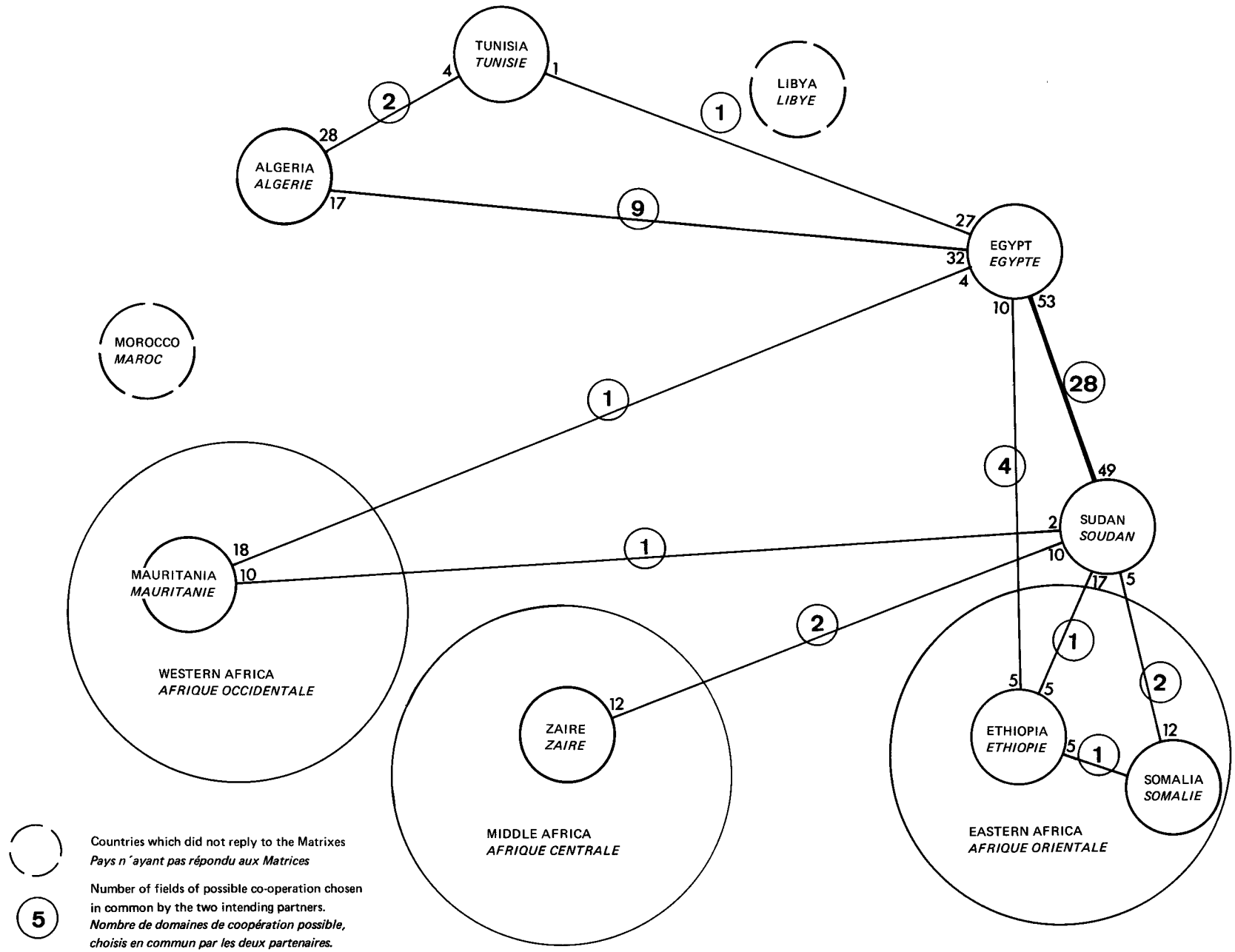
A1 POSSIBLE FUTURE COOPERATION IN DISCIPLINE-ORIENTED R & D IN NORTHERN AFRICA
COOPERATION FUTURE POSSIBLE, EN CE QUI CONCERNE LA R ET D PAR DISCIPLINES, EN AFRIQUE SEPTENTRIONALE



Countries which did not reply to the Matrixes
Pays n 'ayant pas répondu aux Matrices

5 Number of fields of possible co-operation chosen in common by the two intending partners.
Nombre de domaines de coopération possible, choisis en commun par les deux partenaires.

B1 POSSIBLE FUTURE COOPERATION IN MISSION-ORIENTED R & D IN NORTHERN AFRICA
COOPERATION FUTURE POSSIBLE EN CE QUI CONCERNE LA R ET D PAR OBJECTIFS, EN AFRIQUE SEPTENTRIONALE



101. In decreasing order of intensity, other prospective R&D co-operation movements are: for "discipline-oriented" research, Algeria-Tunisia (7 items); Tunisia-Egypt and Mauritania-Egypt (6 items each); and, in so far as possible co-operation between countries in different African sub-regions are concerned, Zaire-Sudan (2 items); and Zaire-Egypt, Ethiopia-Egypt and Ethiopia-Sudan (1 item each).

102. Summarizing, it may be said that possible future co-operation between Egypt and Sudan is by far the most important prospective movement in Northern Africa (28 items in common); however, in the Northern sub-region there are substantial differences between the "mission-oriented" approach and the "discipline-oriented" one.

103. The main divergencies are as follows: Tunisia's expression of interest for co-operation in "mission-oriented" R&D in the Northern African sub-region (with Algeria) coincides in only two areas (crop production and animal production) with the interests of her potential partners. Mauritania expresses a strong wish to co-operate on "mission-oriented" R&D with Egypt (18 items), but coincides with Egypt in only one item.

(b) Western Africa (see Diagrams A.2 and B.2)

104. As shown in Diagrams A.2 (discipline-oriented) and B.2 (mission-oriented), the replies from the Western African countries indicate a strong wish for co-operation between Senegal and the Ivory Coast, with coinciding interests in 10 items for Matrix A and 5 for Matrix B.

105. Senegal also shares a strong interest in co-operating with both Mauritania and Mali (4 and 2 items respectively, for discipline-oriented Matrix A; and 7 and 5 items for mission-oriented Matrix B). There exists, in addition, keen mutual interest in co-operation between Mauritania and Mali (5 items for discipline-oriented Matrix A and 18 items - a high figure in view of the scientific potential of the two countries - for mission-oriented Matrix B).

106. The rôle played by geographical proximity in such indications of the possible flow of co-operation is evident. Quite clearly, Mauritania considers that it shares more common interests with Mali than with any other country, because Mali faces very similar development problems. Although other countries in the South-Saha ian zone (Upper Volta, Niger and Chad) did not reply to the matrixes, it can safely be assumed that the items chosen in common by Mauritania and Mali would be of interest also to the other three countries in this zone.

107. The rôle of Mauritania as a link with other sub-regions snould also be noted: there exists a solid wish for Mauritania-Egypt co-operation in "discipline-oriented" research (6 items), but the link for the "mission-oriented" research (1 item) is understandably weaker since the two countries are respectively situated in the Tropical Atlantic and in the East Mediterranean zone which present wide geographical and ecological differences. Further south in the Western African region, the Ivory Coast (whose prospective link with Senegal was noted above) shows a rather strong interest for co-operation with a near-neighbour,

Togo, although the two countries coincide in few items (2 for Matrix A and 2 for Matrix B). This suggests that further contact and discussion is needed between the two countries in order to find specific grounds for co-operation in R&D. Certainly when two countries have separately specified (as is the case for Ivory Coast and Togo) from 7 to 15 items which each regards as being of common interest, but only 2 items appear on both lists, further discussion is needed to clarify the issue.

108. The Ivory Coast, it should be noted, is also a stepping-stone for inter-country co-operation between Western Africa and Middle Africa. Both the Ivory Coast and Togo identify "likely partners" for "discipline-oriented" R&D in Middle Africa (Cameroon, Zaire, 1 or 2 items); though, it should be noted, no co-operation between the two sub-regions is envisaged from the "mission-oriented" angle. This again is understandable in view of the different characteristics of the two climatic and geographical zones.

109. As of 15 October 1973, when the present document was closed, replies had not been received from Sierra Leone, Ghana, Dahomey and Nigeria (in addition to Niger and Upper Volta, already mentioned). Replies were subsequently received from Dahomey and Ghana.

(c) Middle Africa (see Diagrams A.3 and B.3)

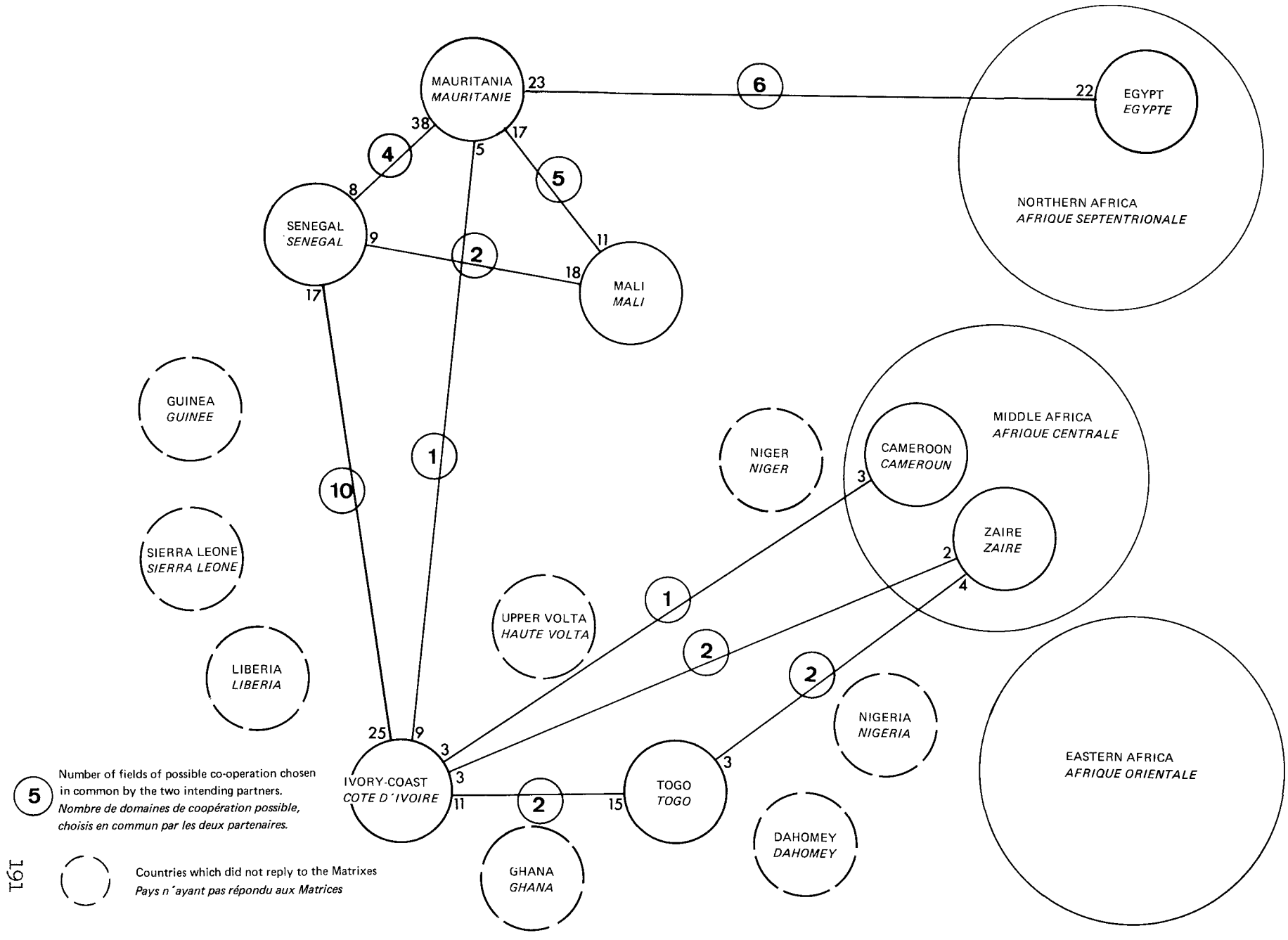
110. The same considerations apply, of course, to the Middle African sub-region, which, as shown in Diagram A.3 (discipline-oriented) and B.3 (mission-oriented) is composed of six countries, two of which completed the matrixes (Cameroon and Congo) and one of which replied in part only (Zaire). During the sub-regional consultations held in connexion with CASTAFRICA preparations, it was found that links between the scientific communities of the Middle African countries were particularly weak. Hence, it is not altogether surprising to find that the number of envisaged inter-country links noted in Diagrams A.3 and B.3 is not large. It is only natural that the co-operation movement should start on a small basis, and then gather momentum. It is also natural, as very clearly indicated by the replies from the Middle African countries, that "mission-oriented" research gives way to "discipline-oriented" research in the early stages of co-operation planning. It is, of course, easier to imagine universities and other institutions of higher learning wishing to co-operate with each other, to start with, than government departments. Nevertheless, as "discipline-oriented" co-operation develops, "mission-oriented" co-operation can be expected to follow. The time-lag for this phenomenon is probably not more than five years under normal circumstances.

(d) Eastern Africa

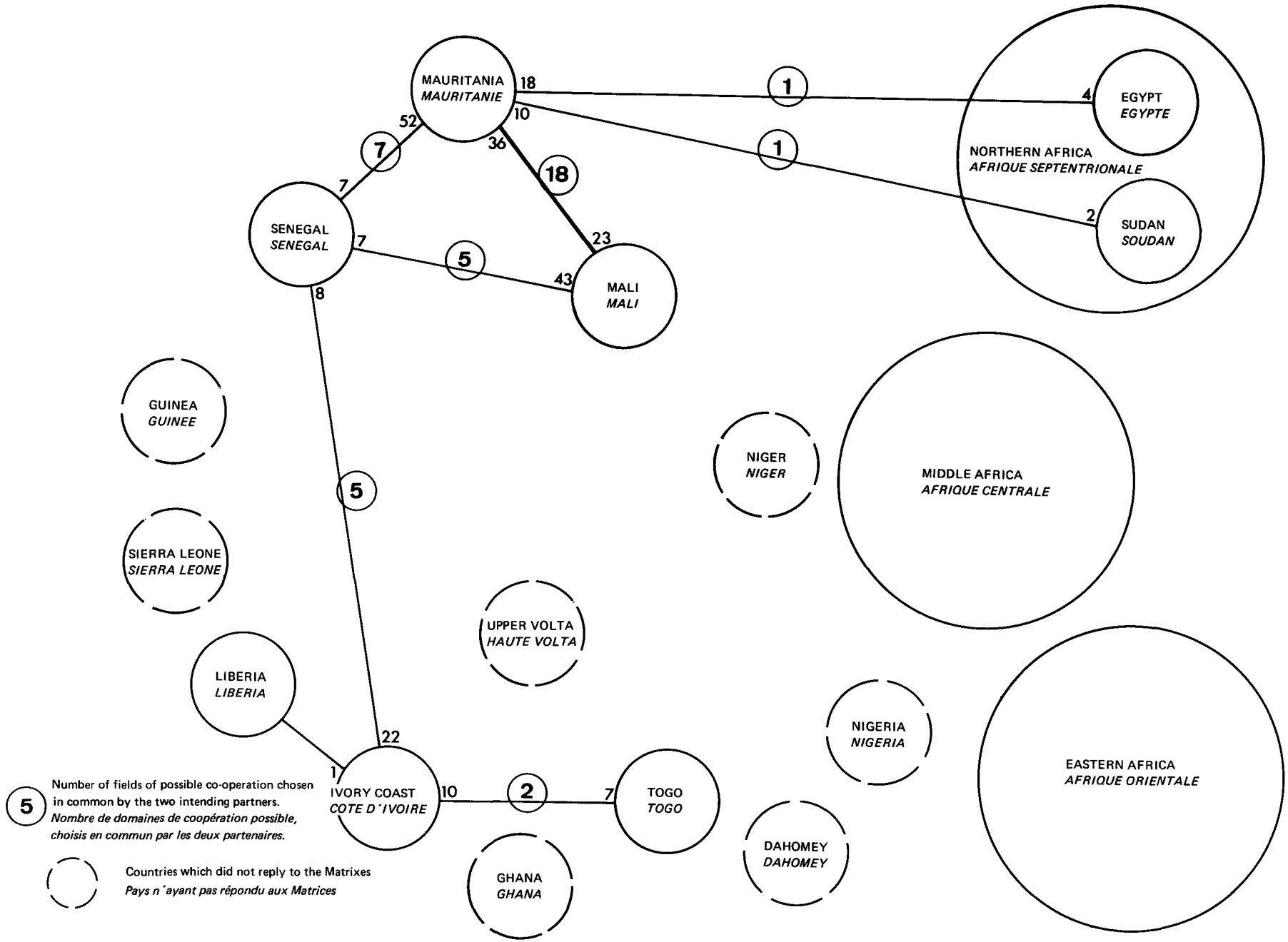
111. Finally, as regards the Eastern African region, no attempt has been made to draw up prospective co-operation diagrams because R&D co-operation in that area has already been developed extensively during 50 years, as appears from the preceding paras. 88 and 89. The identification of further fields for co-operative research in Eastern Africa would therefore require a prior in-depth assessment of present arrangements, from which guidelines for the future might be evolved.

A2 POSSIBLE FUTURE COOPERATION IN DISCIPLINE-ORIENTED R & D IN WESTERN AFRICA

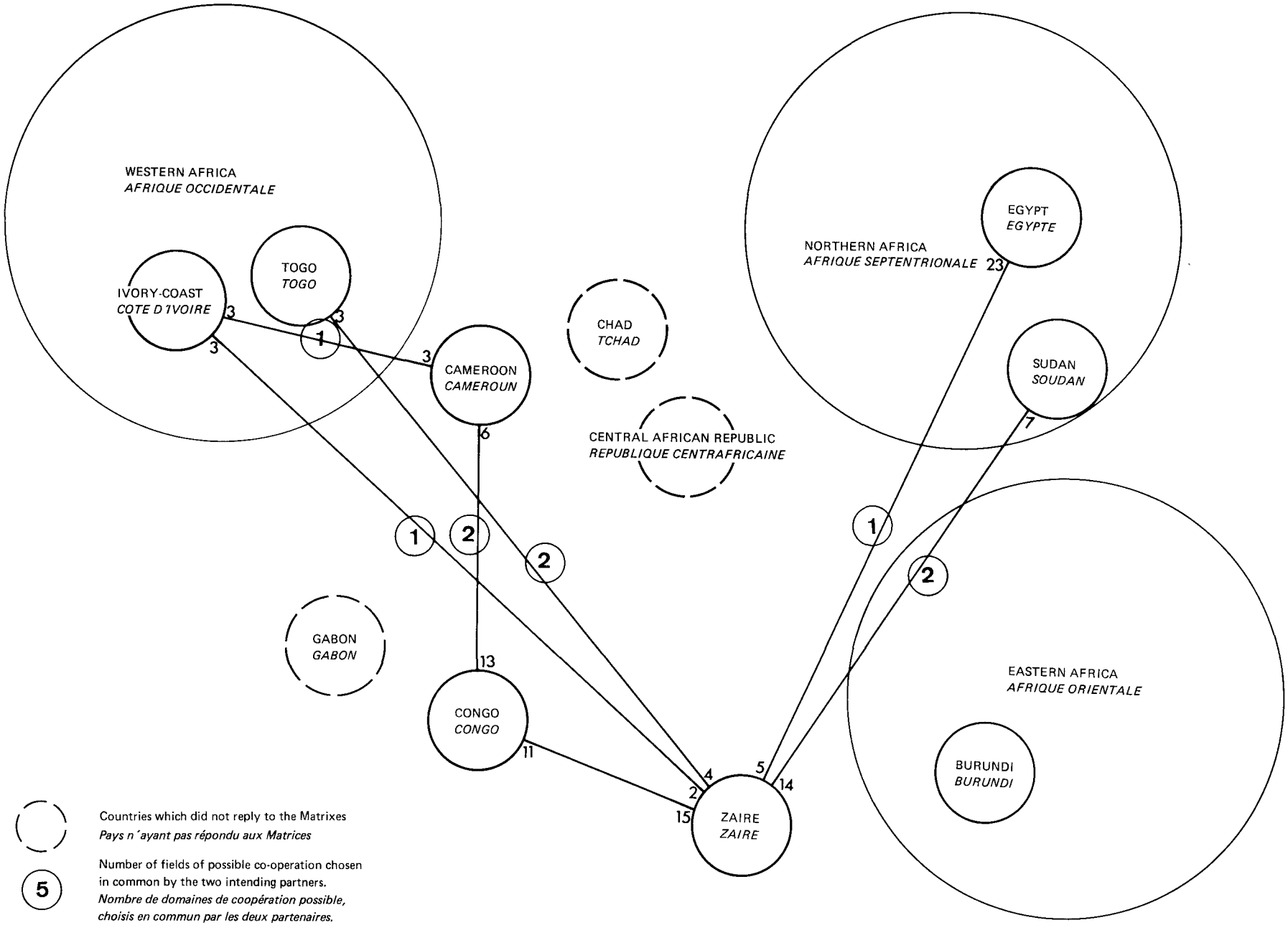
COOPERATION FUTURE POSSIBLE, EN CE QUI CONCERNE LA R ET D PAR DISCIPLINES, EN AFRIQUE OCCIDENTALE



B2 POSSIBLE FUTURE COOPERATION IN ~~MISSION-ORIENTED~~ R & D IN WESTERN AFRICA
COOPERATION FUTURE POSSIBLE, EN CE QUI CONCERNE LA R ET D PAR OBJECTIFS, EN AFRIQUE OCCIDENTALE



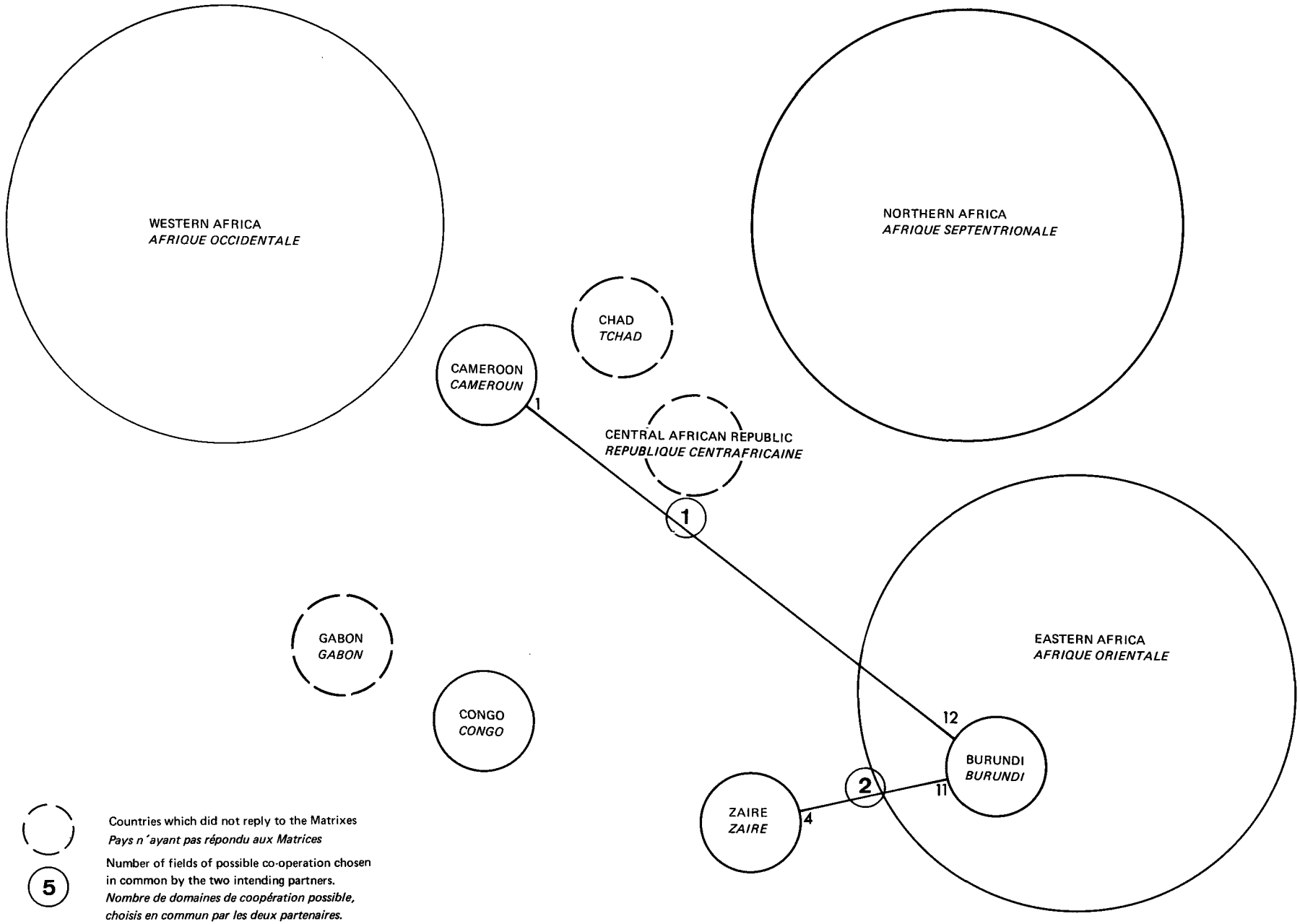
A3 POSSIBLE FUTURE COOPERATION IN DISCIPLINE-ORIENTED R & D IN MIDDLE AFRICA
COOPERATION FUTURE POSSIBLE, EN CE QUI CONCERNE LA R ET D PAR DISCIPLINES, EN AFRIQUE CENTRALE



Countries which did not reply to the Matrixes
Pays n'ayant pas répondu aux Matrices

5 Number of fields of possible co-operation chosen in common by the two intending partners.
Nombre de domaines de coopération possible, choisis en commun par les deux partenaires.

B3 POSSIBLE FUTURE COOPERATION IN MISSION-ORIENTED R & D IN MIDDLE AFRICA
COOPERATION FUTURE POSSIBLE, EN CE QUI CONCERNE LA R ET D PAR OBJECTIFS, EN AFRIQUE CENTRALE



III. CO-OPERATION IN THE PROVISION OF SCIENTIFIC AND TECHNOLOGICAL SERVICES

112. The importance of the scientific and technological services (STS) is so great in developing countries - not only for scientific research but for economic activity as well - that CASTAFRICA should give particular attention to this question when it discusses inter-country co-operation. The scientic data and information base which must be gathered, analysed, and disseminated by these services often extends beyond the national frontiers. In the African context especially, there exist groups of nations which must have complete and equal access to transnational data. This is mainly the case of the data concerning major river basins (e.g. the Nile, Niger, Senegal rivers), several major lakes (Lake Victoria, Lake Tanganyika, etc.), not to speak of more occasional data such as those relating to the drought faced by the countries bordering the Southern Sahara, or to the cross-country migrations of locusts.

113. It is seldom realized that the numerous tasks which must be accomplished by such services (STS) are painstaking and allow for no discontinuity in the gathering or processing of the data. Doubtless, a single institution can cover several fields during the initial phases of scientific development in a given country. But, in the long run, countries large or small find it necessary and useful to set up fairly complete STS facilities and to have access to similar information gathered elsewhere. Indeed, the day has now come when individual nations, however powerful, find it indispensable to exchange data on scientific observations and measurements with other nations. Furthermore, the remote-sensing satellites which are now in orbit around the world make it more pressing than ever before for the developing countries to be able to store, process and analise the data concerning their territories that are gradually becoming available in the highly advanced countries.

1. Past and present co-operation

114. When measured against considerations such as the above, Africa's STS capability appears to be quite inadequate. In effect, in replying to the "STS Matrix", Member States mentioned only a few instances in which they are already co-operating with one another. This is doubtless a consequence of the underdeveloped state of the national STS networks in Africa and it is interesting to note that such ventures of co-operation as already exist seem to have, as their driving force, close contact or links with an international or regional organization.

115. Thus, for instance, the Northern African countries indicated that they were co-operating in the field of metrological services by means of participation in the activities of the Arab Organization for Standardization and Metrology (ASMO). The countries belonging to the Organisation de Mise en Valeur du Fleuve Sénégal co-operate, as might be expected, through their hydrological, geological and soil services. The OCAM countries are working together on the question of training of data-processing technicians. Most African countries co-operate, within the ambit of the activities of the World Meteorological Organization and the Organization of African Unity, in meteorological matters. The countries belonging to the Lake Chad Commission co-operate in the production and quality

control of animal vaccines. Further information on existing co-operation is given in the notes appearing in the replies to Matrix C, dealing with the STS (see the Appendix of the present document). The point which CASTAFRICA might wish to consider, on the basis of these examples, is that inter-country co-operation between scientific and technological services invariably requires some sort of international or regional mechanism to be effective, whether this is in the form of institutions such as those mentioned, or of ad hoc vehicles for international co-operation such as the Comité Inter-Africain des Etudes Hydraulique (CIEH), mentioned in the reply from Cameroon.

116. CASTAFRICA might wish to consider recommending, as a possible post-CASTAFRICA activity, the carrying out of a survey by Unesco of the STS facilities existing in African Member States which would include indications of the existing co-operation arrangements and concrete suggestions for regional inter-country co-operation. Such a study would be an extension of the "Survey on the scientific and technical potential of the countries of Africa", geared mainly to research institutions, which was carried out by the Unesco Field Science Office for Africa, and is a part of the CASTAFRICA documentation.

2. Possible future co-operation

117. Whereas CASTAFRICA might, if it so wishes, attempt to identify priorities for R&D development in the various African sub-regions, on the basis of the replies to Matrix A (discipline-oriented R&D) and Matrix B (mission-oriented R&D), it is not certain that it would be in a position to do similar work for the STS, on the basis of the replies to Matrix C (STS Matrix) which are reproduced in the Appendix of the present document.

118. One of the factors which contribute to the difficulty of such a task is that the terminology of the STS services is not used so often and so widely as that of discipline-oriented R&D (familiar to all scientists) or of mission-oriented R&D (well known to all economists). Whereas the main scientific disciplines and economic fields have been under definition for several hundred years, STS terminology dates from only a few years back. For the purposes of the Matrix C (STS) survey, the following main headings were used(1):

C.1 Natural resources and environment services (16 sub-headings)

C.2 Scientific and technological information and documentation services (10 sub-headings)

C.3 Scientific museums and collections (9 sub-headings)

C.4 Standards, norms, instrumentation and quality control (12 sub-headings)

C.5 Extension and innovation services (15 sub-headings).

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(1) Adapted from the World Plan of Action for the Application of Science and Technology to Development, United Nations, New York, 1971, pages 89 to 91.

119. As will be seen from the tabulation of replies to Matrix C (STS) in Part Three to the Appendix of the present document, the views expressed by responding African Member States in this connexion are indeed tentative. In relation to subject C.1, only Egypt and Cameroon suggest that meteorology is a field in which all African meteorological services should co-operate, but this is doubtless of equal importance for other African States. Other sub-headings of Matrix C.1 are rather understandably mentioned by responding countries in a sub-regional context: marine and fisheries services, vulcanological services, or wildlife conservation services are examples.

120. Much the same can be said of replies to Matrix C.2 (scientific and technological information and documentation). While a number of countries stress the universality of scientific and technological information and documentation, some of them draw attention to the advisability of sub-regional action on specific questions (e.g. information-processing services).

121. Replies to Matrix C.3 (scientific museums and collections) indicate that countries consider this subject particularly suited to sub-regional rather than all-African or international co-operation. The same applies, quite understandably, to the fields included under C.4 (standards, norms, instrumentation and quality control), and under C.5 (extension and innovation services).

3. Co-operation in the field of scientific and technological documentation and information

122. Among the scientific and technological services, one of the highest priorities should be given to the national information systems and to their effective connexions with the regional and world resources of information. The importance of such information systems for the transfer of operational technology from the more developed to the less advanced countries is now well known.

123. The UNISIST programme (World Scientific and Technological Information System) aims at the creation of a flexible world network, based on the voluntary co-operation of national information services. The programme also aims at furthering the formulation and establishment of conditions required for an adequate interconnexion between information systems and the access of these systems to the world's information resources.

124. The CASTAFRICA Conference may wish to consider recommending ways and means for ensuring the effective participation of African Member States in this international programme. One of the prerequisites for such participation is the setting up in each country of a governmental (or government-chartered) agency whose main functions are to guide, stimulate, and organize the development of national information services in the perspective of regional and international co-operation.

125. Among the main principles of UNISIST is that of "compatibility", which aims at making it possible to link national documentation and information services with one another into an international network. In accordance with this principle and with the general strategy foreseen by the World Plan of Action, efforts should concentrate in the first place on the setting up or strengthening

of the necessary infrastructure for scientific and technical information in each of the developing countries in such a way that the various information modes and the various users can be merged into a genuine national information system. As a consequence, the UNISIST programme is concerned not only with ensuring the "compatibility" of the information and documentation services existing in different countries with a view to creating - step by step - an international network of such services; it is also concerned with assisting Member States to establish efficient national information systems of their own in the field of science and technology.

IV. MOBILITY OF SCIENTIFIC AND TECHNOLOGICAL PERSONNEL

1. International mobility

126. As pointed out in Chapter I, Africa suffers both from a severe shortage of highly trained scientists and engineers, and from situations inherited from the colonial epoch. As a consequence, the international flows of African research scientists and technologists are not only smaller in absolute numbers than those occurring in other regions, but their geographical distribution is even more unequal than elsewhere.

127. First, there is the language barrier which splits the African continent into two main zones as regards their spoken and printed modes of communication with the international scientific community. But no less important are the strong ties that often link African scientific institutions to similar institutions in the highly developed countries.

128. The above facts, together with the difficulties and high cost of exchanging correspondence and travelling from one African country to another, have certainly influenced, and even distorted the pattern of the international movements of African scientists and engineers towards the scientifically advanced countries of Europe and North America on the one hand, and to the African countries of the same "scientific language group" on the other.

129. At the present time, when African nations are considering the possibilities of increasing scientific co-operation within the region, CASTAFRICA may wish to discuss some of the distortions and barriers mentioned above and try to suggest means of furthering the contacts among African research scientists and technologists, short of which all efforts for increased inter-African co-operation may well be doomed to failure.

2. The "brain-drain" phenomenon

130. What has been said above is far from suggesting that increased travel opportunities are always beneficial, especially in the case of students and post-graduate students in science or technology. There was a time, fairly recent, when numerous organizations, both international and national, wrote

extensive reports on the evil effects of the "brain drain", which was blamed for the slow pace of development of scientific activity in the less developed nations(1).

131. As seen today, the brain-drain phenomenon is the result of two forces which together make up for the irreversible outflow of scientific and technological personnel. One is the so-called "pull-effect" whereby countries that are short of scientists or engineers attract foreigners; the other is the "push-effect", which compels jobless, underemployed, underpaid or politically harassed scientists to emigrate.

132. Fortunately, it can be reported that the "pull-effect" on research scientists and engineers from developing countries has considerably diminished over the last three years, thanks mainly to the fact that many of the highly developed countries are reaching a "saturation stage" in their own research efforts. The uninterrupted increase in their national expenditures for R&D, expressed as a percentage of Gross National Product, has come to a standstill, and it is not surprising that it is even decreasing in countries which were devoting more than a third of their research effort to military applications.

133. In contrast, some degree of "pull-effect" between the developing countries themselves is now being observed. This phenomenon may well tend to grow in the future as some of the developing countries start a rapid increase of their national expenditures for research, just as the highly advanced countries have been doing during the past two decades or so. There is here a potential danger for the least developed of the underdeveloped nations, many of which are located in Africa. It would perhaps be wise for CASTAFRICA to recommend some preventive action in this respect, coupled with positive measures for inter-African assistance to the least developed countries of the continent, through appropriate scientific or technological manpower transfer schemes.

134. As to the "push-effect", which drives research scientists and technologists out of their countries, experience has shown that it can be divided into structural or accidental causes. Among the structural causes one finds most frequently the lack of national openings for scientists or engineers which forces many of them to desperately frustrating underemployment situations. But worse perhaps is the countermeasure which consists in overstaffing the teaching personnel of the universities or polytechnics by forcing them to employ the near-totality of their young graduates in the field of science or technology. It has been suggested, in this respect that the higher education system of a country should engage no more than one-third and certainly no more than half of the graduates it produces in the field of science and technology on its teaching staff.

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(1) See, inter alia, the Report prepared by Unesco at the request of the United Nations Advisory Committee on the Application of Science and Technology to Development (UNACAST): "The problem of emigration of scientists and technologists - brain drain", Unesco document SC/WS/57, Paris, February 1968.

135. Remedial action in this regard generally includes the creation of a national cadre of research workers akin to a scientific civil service, which offers appropriate outlets for young research workers in fields closely related to local development problems(1). It also includes governmental promotion and support of research in the country's productive enterprises, public or private. Although CASTAFRICA may well wish to make specific recommendations to African Member States in this connexion, each country must be free to take the appropriate science-policy decisions for itself, and to follow such measures through until they are fully implemented.

136. Among the accidental causes leading to the "pushing" of research scientists out of their countries, there can be no doubt that political harassment comes first and foremost on the list. Research scientists are, by training and occupational deontology, prone to criticism and reasoned dissent. They should be understood and protected in their human rights by their respective governments for, without such protection they often have no alternative to emigration or hypocrisy in the pursuit of scientific truth.

3. Mobility at the national level

137. Developed countries are attaching growing importance to the mobility of scientific research workers from one sector of employment to another (university, government, industry) and also to mobility between scientific occupations (research, extension work, scientific services, production). Such mobility within the country seems to play an important rôle in the application of existing knowledge to development on the one hand, and in increasing the research scientists' awareness of national development problems on the other.

138. In this connexion CASTAFRICA may wish to identify some of the barriers to internal mobility which are commonly encountered by African scientists and technologists, and to recommend studies and action that should be undertaken to alleviate the undesirable effects of present employment practices in African research.

V. MODALITIES OF INTERNATIONAL CO-OPERATION IN SCIENCE AND TECHNOLOGY

139. The question of the choice, for individual R&D programmes and projects, amongst various modalities of inter-country co-operation has purposely been left for discussion towards the end of the CASTAFRICA conference. Past experience shows that ministerial conferences are usually not in a position to enter into this level of detail in the short time available during the conference itself. It is nevertheless of great importance that the conference consider the question of modalities of scientific co-operation in general terms and fully weigh the implications thereof.

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(1) See the Report of the Director-General of Unesco relating to the preparation of an international instrument on the status of scientific research workers, document SC/MD/35 of 16 August 1973.

140. While it is felt that CASTAFRICA, on the basis of the results of the Matrix Survey mentioned earlier, may be able to draw up a list of scientific fields which merit priority attention for co-operative R&D activities in Africa and in each of the major African sub-regions, it is not likely that the conference will be able to push this analysis to the point of specifying the modalities of action required for each individual case. Such an effort would have to be undertaken after CASTAFRICA, as a follow-up to that conference. This question will therefore be examined in the last section of the present document.

1. The complexity of international scientific co-operation

141. The following diagram provides an illustration of the co-operative links that may exist between the R&D systems of two countries. Taking into account the fact that there are a number of modalities of co-operation, of different types and at different levels, which can be used for each individual link, it will be seen that the launching of a series of scientific co-operation projects, even between only two partners, can lead to unexpected intricacies.

142. The increasing complexity of such a diagram, if it were extended to cover the relations of the R&D systems not of only two but of all African nations, can easily be imagined. It would moreover be necessary to add, to the exclusively intra-African dimension, the development of scientific and technological relations with:

(i) non-African nations;

(ii) organizations of the United Nations system;

(iii) intergovernmental organizations of a regional or sub-regional character not belonging to the United Nations system which have science and technology units (Organization of African Unity, League of Arab States);

(iv) other intergovernmental scientific organizations such as the International Bureau of Weights and Measures, the International Computation Centre, etc;

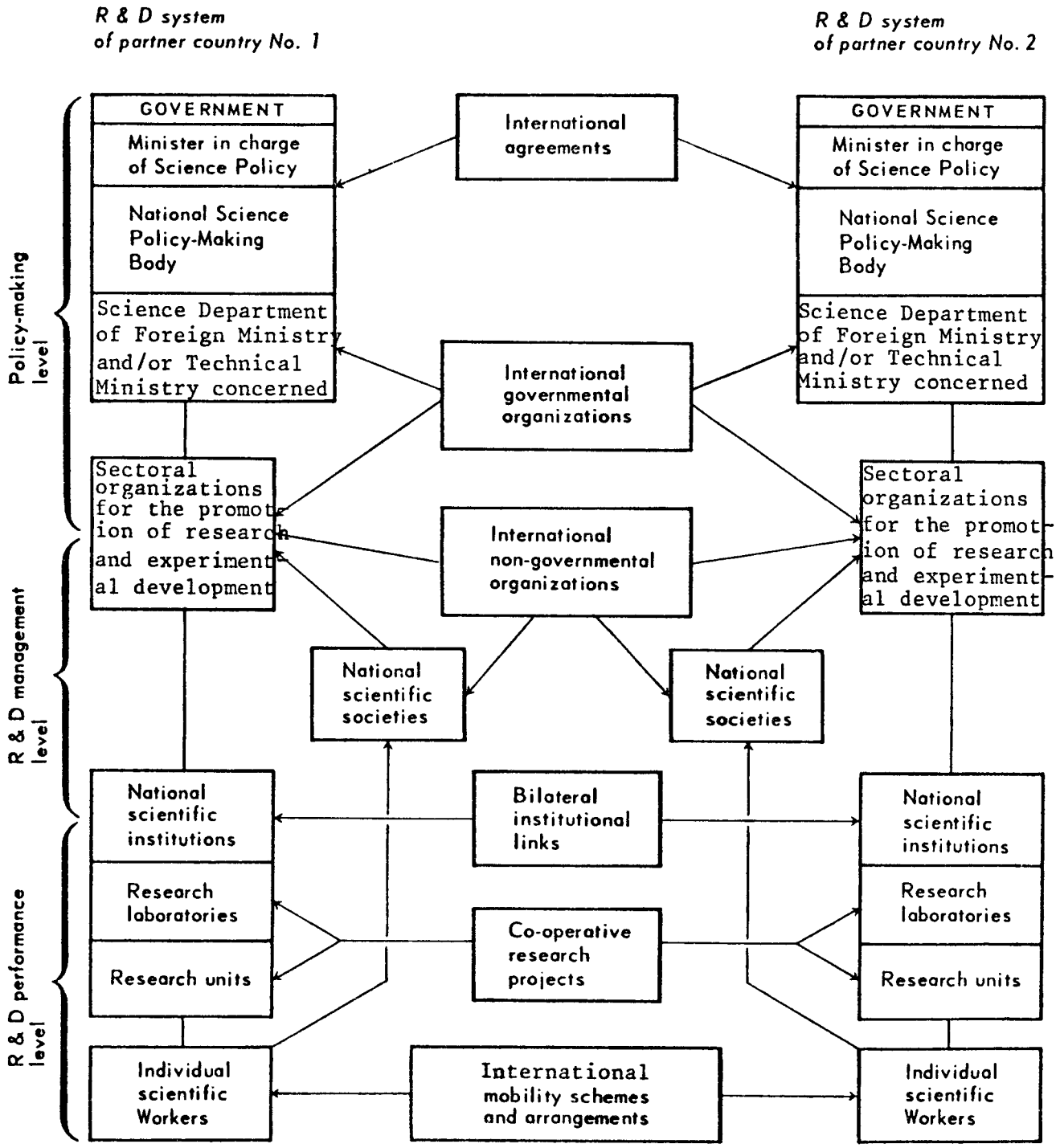
(v) non-governmental scientific organizations, which may be divided into:

federations of international scientific unions or scientific workers such as the International Council of Scientific Unions (ICSU) or the Council for International Organizations of Medical Sciences (CIOMS), the Union of International Engineering Organizations (UIED) or the World Federation of Scientific Workers;

international unions of national societies interested in a single branch of science such as the International Astronomical Union, one of the first to be created in this category, which now includes several hundreds of organizations;

beginning to emerge, along with African scientific journals.

Diagram indicating main types and levels of links between the R&D systems of two countries



2. The main types of international co-operative ventures in science and technology

143. Fortunately, and despite the intricacy of the above-mentioned situation, some concrete positive experience does exist, on the basis of which CASTAFRICA might be able to consider the science policy problems - organizational forms, operational methods, and channels of information and liaison (both domestic and international) - which an African State might typically encounter if it should choose to give added attention to international and intra-African institutional co-operation in the sphere of research and experimental development (R&D) or in that of the scientific and technological services (STS).

144. Mention will be made of three possible forms of action, which will here be illustrated with examples of what has happened in Europe so as to render the consideration of these options more concrete and meaningful:

145. (a) A first possible type of scheme is the creation or strengthening of international scientific organizations set up under international (often intergovernmental) agreements

146. Typical examples of such research organizations, in Europe, are the Organization for European Nuclear Research (CERN) in Geneva, and the Joint Institute of Nuclear Research in Dubna (USSR). Both are devoted to research in high energy physics; they operate very large laboratories employing hundreds of research scientists and engineers.

147. In Africa, action along the same organizational lines has been taken at the intergovernmental level in a number of instances, such as the institutions of the East African Community to which reference has been made (cf. paras. 88-89, above). An example of non-governmental inter-country African research ventures with international connexions in several continents is the International Centre of Insect Physiology and Ecology (ICIPE) at Nairobi.

148. The main justification for the establishment of this type of organization generally lies in the need to share expensive equipment and to pool specialized scientific staff from Africa and elsewhere. It was the existence of well-trained teams of African scientists prior to the creation of these regional research organizations that made it possible to envisage pooling arragements of this kind and also explains their success.

149. Nevertheless, it is evident that the benefits derived from such co-operative ventures have not been equal for all participants, and the reasons for this are well worth discussing at CASTAFRICA. Because of their limited scientific research potential, the smaller nations have the greatest need to embark on inter-African co-operative research but these same countries understandably encounter the greatest difficulty in exploiting to the maximum the scientific results obtained by regional research organizations.

150. CASTAFRICA might therefore wish to draw the attention of the smaller African nations to the need for very careful study of specific proposals for institutional scientific co-operation before embarking on them. In particular, they

may wish to stress the need for contributions to the budgets of the institutions chosen as vehicles for such co-operation to be conceived so that the participating States can anticipate a reasonable and predictable level of expenditure and also that operational methods should yield satisfactory scientific returns to all participants. Certainly, this twofold problem of reasonable cost and adequate benefits must be solved if the "scientific gap" between the African nations themselves is to be closed.

151. (b) A second type of scheme for regional co-operation is the establishment of national scientific institutions with an international impact. In essence, the aim of this modality is to enhance the international status of, and support for, selected existing scientific institutions in the African Member States.

152. As a basis for discussion of this possibility, reference might be made to three successful examples of national institutions in Europe which have a specifically international significance. The first two are international laboratories established in Naples for experimental collaboration in the life sciences: the Stazione Zoologica, which has existed for over a century, and the International Laboratory of Genetics and Biophysics, established in 1961. The third example is the well-established Jungfraujoch Hochalpiner Forschungsstation (Alpine high-altitude research station).

153. Prospects in this connexion appear sufficiently good for CASTAFRICA to give priority attention to the study of ways and means of enhancing the international status of, and support for, selected national institutions of advanced study and research which already exist in the African Member States of Unesco. In this connexion, and in response to the severe shortage of African R&D scientists and engineers, CASTAFRICA might study the possibility of setting up a network of African Schools for Science, restricted to post-graduate students. Already existing African research institutions, laboratories or units of international repute could perhaps become the nuclei for such a network.

154. (c) Finally, a third type of scheme for regional co-operation is the development of a purposeful programme of international research projects, each of them conducted under the guidance of its Joint Management Committee.

155. Experience in the sixties has shown that research projects of quite broad scope may be carried out successfully by a small group of countries (say, two to five) provided - and this is essential - that the undertaking be placed under the guidance of a Joint Management Committee. Such projects essentially provide for collaboration amongst university and other scientific institutions, but they should in all cases include active co-operation from at least one international organization. A good example of this kind of arrangement is the project for Nuclear Medicine and Clinical Investigations created in 1963 by the Universities of Pisa and Brussels and by EURATOM, to which the Radio-chemistry Group of Sorin (Turin) adhered later.

156. To give maximum flexibility to such projects and to minimize the danger of recurrent financial crises, it would seem that the sponsoring international organizations as well as the national universities or scientific institutions

involved, should participate in their financing. It is most important that the Joint Management Committee concerned have the sole responsibility of managing the project, and that the Committee have amongst its members both research scientists and representatives of the sponsoring organizations.

157. The essential advantage offered by this type of project is a great deal of flexibility (a) in starting new (and concluding old) phases of the research programme, and (b) in associating scientists to the project as full participants rather than as "contributing outsiders". Such co-operative ventures further require that representatives of the international organizations which act as sponsors take an active part right from the inception of the projects.

158. Joint Management Projects of this kind could provide Africa with an effective, rapid, flexible and efficient way of stimulating scientific co-operation as well as mutual information and communication, by associating creative research units from different countries in co-operative research ventures. CASTAFRICA may therefore wish to consider the possible launching of a far-reaching African Plan for co-operative research in science and technology based on such Joint Management Research Projects, supported, in each participating country, by the competent governmental science-policy-making body and benefiting from the overall co-ordinating assistance of an appropriate intergovernmental organization.

159. (d) Informal and ad hoc arrangements are another form of co-operation, the importance of which should not be underestimated. Although such arrangements cannot suffice on their own - because their impact is likely to be limited in intensity and duration - the collective effect of numerous individual and occasional links can be great. The effectiveness, of these contacts is likely to be enhanced when they take place at technical meetings, symposia, seminars, etc. CASTAFRICA may hence wish to consider the extent to which such events are playing the rôle which is potentially theirs in Africa, and suggest means for optimizing their return(1).

160. One form of co-operation which tends to be informal is the exchange of articles for publication in African scientific journals. CASTAFRICA might examine this particular aspect of inter-African co-operation in the light of the existing regional network of scientific journals(2).

3. Financing of international projects

161. In conclusion on the question of modalities of co-operation, attention is drawn to the fact that the financing of projects is an aspect which should be clearly differentiated from the conceptual and substantive management aspects. Because of the dearth of funds for research within Africa, encouragement and support should be given to negotiations which, in the first instance, aim at drawing up a realistic proposal for a project both in substantive and operational terms together with: (a) an indication of the project's order of priority at the regional level; and (b) the required capital investment and recurrent costs over the first five or ten years of operation of the project.

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(1) References to Unesco's own action in this connexion are given in document SC/CASTAFRICA/REF.6: "Unesco's activities in the field of science and technology in Africa".

(2) Cf., in this connexion, the "List of scientific and technical periodicals published in 32 countries of Africa from 1960 to 1970", which forms a part of CASTAFRICA documentation, Unesco, 26 September 1972, document SC/WS/508.

162. Such negotiations should not be hampered by the difficulty of identifying all of the sources of financing right from the start. The financing aspect could be discussed in a further round of negotiations with the various national, sub-regional, regional and international entities, both public and private, which might possibly contribute in cash or in kind.

163. In other words, while project formulation should be realistic, the uncertainty as to the obtention of the required funds should not act as a drawback for the formulation of the projects, because there is no shortage of sources to which applications could be made for the financing of high-priority, well conceived co-operative research projects in Africa.

164. Concerted action along the above lines should make possible the gradual introduction of "management by objectives" for the organization of international co-operative research in Africa. The CASTAFRICA conference may wish to invite appropriate international and bilateral agencies and foundations to work towards this end on the understanding that the determination of objectives for the research would primarily be the joint responsibility of the national science policy-making bodies of the African countries concerned.

VI. CASTAFRICA FOLLOW-UP

1. At the national level

165. The CASTAFRICA conference may wish to consider whether the Unesco/UNACAST Survey methodology for the identification of the institutional needs of individual countries in the field of science and technology(1) might not be an adequate basis, once pursued to its ultimate possibilities, for the identification of a coherent set of well-defined projects for scientific and technological development within each African country. Such coherent sets of practical projects developed by each country in consonance with their overall national development goals would be of immense value to the multilateral and bilateral assistance agencies operating in Africa.

166. Furthermore, this approach might be directed not only to projects concerning R&D and STS, but could be extended to cover, for instance, the development of post-graduate education and of training for research in science and technology. It could also easily be made to cover programmes which do not require the setting up of institutions in brick and mortar.

167. One measure which the conference might wish to recommend is the organization by Unesco, after CASTAFRICA, and at the request of individual African countries, of technical working sessions in which the Unesco/UNACAST methodology for the identification of institutional needs in science and technology would be applied in depth, preferably in the purview of UNDP country-programming activities. Some of these sessions could even be extended to the stage of project specification and design for those areas where Unesco has a well-established operational responsibility within the United Nations system of organizations.

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(1) See Section I.2 of the present chapter.

2. At the regional level

(a) Workshops on identification and design of co-operative projects in science and technology

168. As stated in Section I.3 of this chapter, the Unesco Matrix Survey on existing and prospective co-operation between African countries in research (R&D) and scientific/technological services (STS), has already clearly identified a number of areas where immediate co-operative action could be initiated. The Matrix Survey has also pointed to the appropriateness of launching the first co-operative programmes at the sub-regional(1) rather than the all-African level.

169. In principle, the matching of country replies to the Matrix Survey should thus make it possible to identify priority subjects for inter-African co-operation between groups of specified countries.

170. For each subject, workshops would have to be organized for the purpose of preparing concrete projects for co-operative action in R&D or in one or other of the areas covered by scientific/technological services. Specifically, the workshops would have to determine, for every individual co-operation project:

(i) objectives and management modalities of the project;

(ii) plan and schedule of operations, based on the PERT technique when appropriate;

(iii) manpower implications for each participating country;

(iv) financial implications for each participating country;

(v) other implications for each participating country;

(vi) desired participation and/or assistance from international inter-governmental organizations such as those belonging to the United Nations system;

(vii) desired assistance from governments of aid-giving countries;

(viii) desired assistance from regional organizations active in Africa such as the Chad Basin Commission, Common Afro-Mauritian Organization, East African Community, Organisation de Mise en Valeur du Fleuve Sénégal, River Niger Commission, Conseil de l'Entente, etc.

(ix) desired assistance from other organizations (private foundations, non-governmental organizations, etc.).

171. CASTAFRICA might therefore recommend that "Sub-regional workshops on identification and design of co-operative projects" be organized, each of which would deal with specific fields of R&D (either "discipline-oriented" or "mission-oriented") or with particular scientific and technological services, such as those already foreshadowed by the first results of the Unesco Matrix Survey.

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(1) The sub-regions here envisaged are those mentioned in Section II of this chapter, i.e. Northern Africa, Western Africa, Middle Africa and Eastern Africa.

172. It is to be hoped that the CASTAFRICA deliberations will permit the establishment of a list of specific subjects for inter-African co-operation to be considered at such workshops, together with an indication of the countries interested in each of the subjects thus selected.

173. In this respect it might prove helpful, for African countries that have not yet been able to do so, to complete their replies to the Unesco Matrix Survey on regional co-operation before CASTAFRICA convenes, in order to allow their delegations to participate fully in the debate on this question at the conference.

(b) Meetings of directors of African national science-policy-making bodies

174. CASTAFRICA might also wish to consider whether it would not be desirable to advocate a means whereby the African nations might establish their expert dialogue on science and technology policies and institutions on a recurrent and structured basis.

175. In this connexion, the conference might wish to consider the possibility of recommending that - either for Africa as a whole or at the level of African sub-regions - Unesco be requested, with possible financial support from appropriate United Nations sources, to convene, at reasonable intervals, meetings of directors of African national science-policy-making bodies, designated by governments in an expert capacity and not as government representatives(1). Such technical gatherings would consider science policy problems of major interest for African countries. In particular, these meetings would allow for questions of inter-African co-operation in science and technology (R&D and STS) to be debated at the strategic level among responsible leaders of national science policy bodies of African Member States.

176. One of the main tasks of the expert meetings would of course be to prepare concrete proposals for regional scientific co-operation requiring decisions at the level of ministers, in each of the co-operating nations concerned. Indeed, the United Nations Advisory Committee for the application of Science and Technology to Development (UNACAST), recently commenting on Unesco's science policy programme for the next decade(2), was of the opinion that science policy meetings at the governmental expert level are instrumental for the understanding of topical science policy issues and, hence, for the preparation of concrete proposals for action.

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(1) It might be noted that a series of such meetings has already been held in Latin America under the auspices of the Unesco-sponsored "Standing Conference of the Directors of national councils for science policy and research of the Latin American Member States", with UNDP financing, as a result of a recommendation of the Conference on the Application of Science and Technology to the Development of Latin America (CASTALA, Santiago, Chile, 13-22 September 1965). The proceedings of these successful meetings were published by Unesco.

(2) Unesco Executive Board documents 93 EX/14 and Corr., and 93 EX/Decisions: item 4.4.2.

177. Should CASTAFRICA decide to pursue this question, it might wish to discuss the aims, functions, composition and optimal periodicity of such expert meetings. Although the meetings would be primarily attended by directors of existing African national science-policy-making bodies, the conference might wish to ponder whether it would not be advisable that they remain open to observers from the African nations which have not as yet completed their arrangements for the establishment of similar bodies, in line with the trend described in Chapter I of the present document. For financial reasons, but also because sufficient time must be allowed for thorough technical preparations for such technical meetings, it would not seem possible to envisage their organization at the all-African level at intervals of less than four years. At the sub-regional level these intervals could conceivably be shorter.

178. From the above it should be evident that the national agencies most directly concerned with CASTAFRICA follow-up will be the national science-policy-making bodies, which will be called upon to participate in the evisaged activities in line with the mandate which is theirs within the respective national legislations. Although this mandate varies from country to country, it is usually sufficiently flexible to permit these bodies to take part in meetings of the category of "experts designated by governments"(1). It is well known that expert meetings are convened to study technical matters, and the participants attend in a personal capacity (thus making such meetings "non-representative") as opposed to the meetings of government representatives referred to in what follows, which may take decisions binding on governments (meetings of a "representative" nature).

(c) Meetings of government representatives

179. It would seem advisable that CASTAFRICA also consider the need for further meetings of a representative (e.g. intergovernmental) nature, which would consider the issues of scientific and technological development in Africa. Concretely, CASTAFRICA might state whether it considers that other African science policy conferences at the ministerial level should be convened by Unesco, and, if so, suggest a date for CASTAFRICA II, on the basis of an exchange of views with the Director-General of Unesco as to the organizational and financial implications.

180. Should it wish to take a position on the above, CASTAFRICA might take into account that the Economic Commission for Africa adopted resolution 248(XI) on 22 February 1973 at its Eleventh Session (Second Meeting of the Conference of Ministers, held in Accra from 19-23 February 1973) by which it was decided to establish a "Special Intergovernmental Committee of Experts from amongst Member States to ensure regular follow-up and review of the work of the Secretariat of the Commission in connexion with the implementation of the African Regional Plan". This Committee was constituted by Resolution No. 4 of the ECA Executive Committee at its Ninth Session (18-22 June 1973). It comprises 20 government representative from each of 20 Member States of the Commission selected on the basis of:

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(1) Cf. Unesco "Regulations for the classification of the various categories of meetings convened by Unesco", adopted by the General Conference at its fourteenth session (14 C/Resolution 23), meetings under Category VI .

4 members from the Central African sub-region,

6 members from the Eastern African sub-region,

3 members from the Northern African sub-region, and

7 members from the Western African sub-region,

the said government representatives to be "senior government officials of the Member States, who are concerned with scientific and technological affairs, technological planning and development".

181. Resolution No. 4 mentioned just above provides for the attendance, at committee meetings, of representatives of the United Nations Specialized Agencies in the capacity of observers. The committee's first meeting was scheduled to be held in Addis Ababa on 6-9 November 1973.

182. In conclusion on the subject of scientific and technological co-operation in the African continent, it can be stated that the ultimate success of the CASTAFRICA conference will depend to a great extent on the existence of appropriate machinery for national and regional science-policy-making and project implementation, both at the expert (non-representative) and at the governmental (representative) level. The specific recommendations which CASTAFRICA is expected to adopt cannot be translated into quick and efficient action unless such machinery exists, and is brought into play.

APPENDIX TO PART TWO

As described in paragraphs 47 et seq. of the main working document, the preparations for the Conference included a survey which was carried out by Unesco to identify possible areas for African inter-country co-operation in science and technology. This survey made use of a Matrix Methodology, involving three sets of matrices concerned respectively with:

A. Discipline-oriented R&D;

B. Mission-oriented R&D;

C. Scientific and technological public services.

A complete list of the fields and disciplines covered by these matrices is given in the first section of this Appendix.

Replies were received from 19 Member States(1), and these are presented in summary form in sections 2 and 3.

Contents

(1) Algeria, Burundi, Cameroon, Congo, Dahomey, Egypt, Ethiopia, Ghana, Ivory Coast, Kenya, Liberia, Mali, Mauritania, Senegal, Somalia, Sudan, Togo, Tunisia, Zaire.

Section 1. LIST OF FIELDS INCLUDED IN THE MATRIXES

Table 1. List-of fields of discipline-oriented R & D

A. 1. MATHEMATICAL SCIENCES

1 Algebra
2 Analysis and functionnal analysis
3 Applied mathematics
4 Computer science
5 Geometry
6 Logic
7 Number theory
8 Numerical analysis
9 Operations research
10 Probability
11 Statistics (general)
12 Topology

A. 2. PHYSICAL SCIENCES

1 Acoustics
2 Crystallography
3 Electricity and Magnetism
4 Electronics
5 Fluid mechanics
6 Mechanics
7 Metallography
8 Nuclear physics
9 Optics
10 Solid mechanics
11 States of mather
12 Theoretical physics
13 Thermal physics

A. 3. CHEMICAL SCIENCES

1 Analytical chemistry
2 Inorganic chemistry
3 Macromolecular chemistry
4 Nuclear chemistry
5 Organic chemistry
6 Physical chemistry

A. 4. BIOLOGICAL SCIENCES

1 Botany
2 Biology (general)
3 Biochemistry, Molecular biology
4 Biophysics
5 Cell biology
6 Entomology
7 Genetics
8 Microbiology
9 Physiology (general)
10 Radiobiology
11 Zoology

A. 5. EARTH AND SPACE SCIENCES

1 Astronomy, Astrophysics
2 Atmospheric sciences
3 Climatology
4 Ecology
5 Geochemistry
6 Geodesy
7 Geology
8 Geophysics
9 Gravity, Magnetism
10 Hydrology and Hydrobiology
11 Oceanography
12 Paleontology
13 Pedology
14 Seismology
15 Vulcanology

A. 6. ENGINEERING SCIENCES

1 Chemical engineering
2 Civil engineering
3 Construction engineering
4 Corrosion and preservation engineering
5 Electrical engineering
6 Electronics engineering
7 Hydraulics engineering
8 Industrial engineering
9 Materials engineering
10 Mechanical engineering
11 Metallurgical engineering
12 Nuclear engineering
13 Petroleum engineering
14 Processing engineering
15 Sanitary and pollution engineering
16 Telecommunications engineering
17 Transportation engineering
18 Welding engineering

A. 7. AGRICULTURAL SCIENCES

1 Agronomy (general)
2 Agro-climatology
3 Agro-ecology
4 Animal breeding
5 Animal pathology
6 Animal physiology
7 Agricultural entomology

Section 1. LISTE DES DOMAINES MENTIONNES DANS LES MATRICES

Tableau 1. Liste des domaines de la R & D orientée-discipline

A. 1. SCIENCES MATHEMATIQUES

1 Algèbre
2 Analyse et analyse fonctionnelle
3 Mathématiques appliquées
4 Informatique
5 Géométrie
6 Logique
7 Théorie des nombres
8 Analyse numérique
9 Recherche opérationnelle
10 Calcul des probabilités
11 Statistique (générale)
12 Topologie

A. 2. SCIENCES PHYSIQUES

1 Acoustique
2 Cristallographie
3 Electricité et Magnétisme
4 Electronique
5 Mécanique des fluides
6 Mécanique
7 Métallographie
8 Physique nucléaire
9 Optique
10 Mécanique des solides
11 Etats de la matière
12 Physique théorique
13 Physique thermique

A. 3. SCIENCES CHIMIQUES

1 Chimie analytique
2 Chimie inorganique
3 Chimie macro-moléculaire
4 Chimie nucléaire
5 Chimie organique
6 Chimie physique

A. 4. SCIENCES BIOLOGIQUES

1 Botanique
2 Biologie générale
3 Biochimie, biologie moléculaire
4 Biophysique
5 Biologie cellulaire
6 Entomologie
7 Génétique
8 Microbiologie
9 Physiologie (générale)
10 Radio-biologie
11 Zoologie

A. 5. SCIENCES DE LA TERRE ET DE L'ESPACE

1 Astronomie, astrophysique
2 Sciences de l'atmosphère
3 Climatologie
4 Ecologie
5 Géochimie
6 Géodésie
7 Géologie
8 Géophysique
9 Gravité, magnétisme
10 Hydrologie et hydrobiologie
11 Océanographie
12 Paléontologie
13 Pédologie
14 Sismologie
15 Vulcanologie

A. 6. INGENIERIE

1 Génie chimique
2 Génie civil
3 Génie des constructions
4 Génie de la corrosion et des techniques de préservation
5 Electrotechnique
6 Génie électronique
7 Génie hydraulique
8 Génie industriel
9 Génie des matériaux
10 Génie mécanique
11 Génie métallurgique
12 Génie atomique
13 Génie pétrolier
14 Génie des procédés de transformation
15 Génie sanitaire et anti-pollution
16 Génie des télécommunications
17 Génie des transports
18 Génie de la soudure

A. 7. SCIENCES AGRICOLES

1 Agronomie (générale)
2 Climatologie agricole
3 Ecologie agricole
4 Elevage
5 Pathologie animale
6 Physiologie animale
7 Entomologie agricole
8 Hydrologie agricole
9 Science alimentaire
10 Horticulture

Table 1 (continued)

8 Agricultural hydrology
9 Food science
10 Horticulture
11 Phytopathology
12 Plant breeding
13 Plant physiology
14 Pisciculture
15 Sylviculture

A. 8. MEDICAL SCIENCES

1 Anatomy
2 Bacteriology
3 Clinical genetics
4 Epidemiology
5 Human biology and anthropology
6 Immunology
7 Internal medicine
8 Nutrition
9 Pathology
10 Pharmacology. Chemotherapy
11 Physiology (human)
12 Psychiatry Psychotherapy
13 Surgery
14 Toxicology
15 Virology

A. 9. ECONOMIC SCIENCES

1 Business economics and management
2 Consumption, savings and investment
3 Econometry
4 Economic history
5 Economic statistics
6 Economic systems development and planning
7 Economic theory
8 Home economics
9 Income distribution
10 International economics
11 Labour economics
12 Monetary and fiscal theory, credit and banking
13 National economic accounting
14 Organization of Production
15 Price and Markets
16 Public economy
17 Rural and urban economics
18 Sectorial economics (Agricultural, Industrial Education, R & D, etc.)

A. 10. HUMAN AND SOCIAL SCIENCES

1 Archaeology
2 Architecture
3 Behavioural sciences, ethology
4 Cultural/Social anthropology
5 Demography and Population
6 Ethnology
7 History
8 Law
9 Linguistics
10 Pedagogy
11 Philology
12 Political science
13 Psychology
14 Rural sociology, Land reform
15 Sociology

Tableau 1 (suite)

11 Phytopathologie
12 Sélection végétale
13 Phytophysiologie
14 Pisciculture
15 Sylviculture

A. 8. SCIENCES MEDICALES

1 Anatomie
2 Bactériologie
3 Génétique clinique
4 Epidémiologie
5 Biologie et anthropologie humaines
6 Immunologie
7 Médecine interne
8 Nutrition
9 Pathologie
10 Pharmacologie, chimiothérapie
11 Physiologie (humaine)
12 Psychiatrie, psychothérapie
13 Chirurgie
14 Toxicologie
15 Virologie

A. 9. SCIENCES ECONOMIQUES

1 Economie et gestion de l'entreprise
2 Consommation, épargne et investissement
3 Econométrie
4 Histoire économique
5 Statistique économique
6 Systèmes économiques, développement et planification
7 Théorie économique
8 Economie ménagère
9 Répartition des revenus
10 Economie internationale
11 Economie du travail
12 Théorie monétaire et fiscale, crédit et banque
13 Comptabilité nationale
14 Organisation de la production
15 Prix et marchés
16 Economie publique
17 Economie rurale et urbaine
18 Economie sectorielle (agriculture, industrie, éducation, recherche et développement, etc.)

A. 10. SCIENCES HUMAINES ET SOCIALES

1 Archéologie
2 Architecture
3 Sciences du comportement éthologie
4 Anthropologie culturelle et sociale
5 Démographie et population
6 Ethnologie
7 Histoire
8 Droit
9 Linguistique
10 Pédagogie
11 Philologie
12 Science politique
13 Psychologie
14 Sociologie rurale, réforme agraire
15 Sociologie

Table 2. List of fields of mission-oriented R & D

B. 1. AGRICULTURE

1 Agricultural mechanics and engineering
2 Crop production
3 Crop protection
4 Crop processing
5 Crop storage and preservation
6 Farm construction, equipment and management
7 Fertilizer utilization
8 Irrigation and drainage
9 Natural pesticides
10 Pasture management
11 Pest control
12 Savannah management
13 Soil management
14 Weed control

B 2. FORESTRY

1 Forest conservation
2 Forest exploitation
3 Forest products
4 Forest protection

Tableau 2. Liste des domaines de la R & D orientée-mission

B 1. AGRICULTURE

1 Mécanique et génie agricoles
2 Production agricole
3 Protection des cultures
4 Transformation des produits agricoles
5 Stockage et préservation des produits agricoles
6 Construction, équipement et entretien des locaux à usage agricole
7 Utilisation des engrais
8 Irrigation et drainage
9 Pesticides naturels
10 Exploitation rationnelle des pâturages
11 Lutte contre les animaux nuisibles
12 Mise en valeur de la savane
13 Utilisation rationnelle du sol
14 Lutte contre les mauvaises herbes

Table 2 (continued)

B. 3. ANIMAL HUSBANDRY

1 Animal health and disease control
2 Animal production
3 Animal products
4 Animal reproduction
5 Animal selection

B 4. FISHERIES AND WILDLIFE

1 Fish finding
2 Fish farming
3 Fish preservation
4 Fish processing
5 Fishing boats and gear
6 Wild-life conservation and management

B. 5. FOOD, DRINKS AND TOBACCO INDUSTRIES

1 Alcoholic beverages
2 Animal feed
3 Dairy products
4 Edible oils and fats
5 Flour, starch and sugar
6 Food additives
7 Food processing, canning and conservation
8 Non-alcoholic beverages
9 Protein-food (meat, fish, eggs)
10 Tobacco

B. 6. CLOTHING AND FOOTWEAR INDUSTRIES

1 Footwear industry
2 Furs
3 Precious stones : jewelry
4 Textile industry
5 Wearing apparel

B. 7. MINERAL RESOURCES INDUSTRIES

1 Coal mining
2 Natural gas production
3 Crude petroleum production
4 Metal ore mining
5 Mining of crude chemicals
6 Oil shale
7 Quarry products
8 Uranium and radio-active ores

B. 8. MATERIALS INDUSTRIES

1 Aggregates
2 Artificial stones
3 Asbestos
4 Bituminous binders
5 Carbon, graphite
6 Ceramics
7 Cement and hydraulic lime
8 Cork
9 Glass and glass products
10 Iron and steel
11 Leather
12 Natural fibres
13 Natural stone
14 Non-ferrous metals
15 Paper and paper products
16 Paints and varnishes
17 Plasters
18 Plastic materials
19 Rubber and rubber products
20 Semi-conductors
21 Synthetic polymer fibres and elastomers
22 Textiles
23 Wood and wood products
24 Water-repellent coatings

B. 9. CHEMICAL INDUSTRIES-INORGANIC

1 Alkaline elements and alkaline earths
2 Boron and silicon compounds
3 Carbon and carbon products
4 Fertilizer production
5 Hydrogen, and hydrids
6 Metallic salts
7 Non-metals (halogen, oxygen and nitrogen families)
8 Organo-metallic compounds
9 Phosphorus products
10 Pigments
11 Sulphur products

B. 10. CHEMICAL INDUSTRIES-ORGANIC

1 Adhesives
2 Detergents, soaps
3 Dyestuffs
4 High polymers
5 Intermediates and solvents

Tableau 2 (suite)

B. 2. SYLVICULTURE

1 Conservation des forêts
2 Exploitation forestière
3 Produits forestiers
4 Protection des forêts

B. 3. ZOOTECHNIE

1 Hygiène animale et lutte contre les maladies
2 Production animale
3 Produits animaux
4 Reproduction animale
5 Sélection animale

B. 4. PECHERIES, FAUNE ET FLORE SAUVAGES

1 Pêche
2 Pisciculture
3 Préservation des poissons
4 Transformation du poisson
5 Embarcations et matériel de pêche
6 Préservation de la faune et de la flore sauvage

B. 5. INDUSTRIE ALIMENTAIRE, BOISSONS ET TABAC

1 Boissons alcoolisées
2 Alimentation animale
3 Produits laitiers
4 Huiles et graisses comestibles
5 Farine, amidon et sucre
6 Additifs alimentaires
7 Transformation, mise en boîtes et conservation des produits alimentaires
8 Boissons non alcoolisées
9 Produits alimentaires protéinés (viande, poisson, oeufs)
10 Tabac

B. 6. INDUSTRIES DE L'HABILLEMENT ET DE LA CHAUSSURE

1 Industrie de la chaussure
2 Fourrures
3 Pierres précieuses, joaillerie
4 Industrie textile
5 Vêtements

B. 7. INDUSTRIES MINIERES

1 Extraction du charbon
2 Production du gaz naturel
3 Production du pétrole brut
4 Extraction de minerais métalliques
5 Extraction de produits chimiques bruts
6 Extraction de schistes bitumineux
7 Exploitation de carrières
8 Uranium et minerais radio-actifs

B. 8. INDUSTRIES DE MATERIAUX

1 Agrégats
2 Pierre artificielle
3 Amiante
4 Liants bitumineux
5 Carbone, graphite
6 Céramique
7 Ciment et chaux hydraulique
8 Liège
9 Verre et produits en verre
10 Fer et acier
11 Cuir
12 Fibres naturelles
13 Pierre naturelle
14 Métaux non ferreux
15 Papier et produits en papier
16 Peintures et vernis
17 Plâtre
18 Matières plastiques
19 Caoutchouc et produits caoutchoutés
20 Semi-conducteurs
21 Fibres synthétiques polymères et élastomères
22 Textiles
23 Bois et produits en bois
24 Revêtements hydrofuges

B. 9. INDUSTRIES CHIMIQUES (PRODUITS MINERAUX)

1 Eléments alcalins et terres alcalines
2 Composés de bore et composés siliceux
3 Carbone et produits dérivés
4 Production d'engrais
5 Hydrogène et hydrures
6 Sels métalliques

Table 2 (continued)

6 Monomers
7 Petrochemicals
8 Pharmaceuticals
9 Photographic products
10 Synthetic pesticides
11 Terpenes and essential oils

B. 11. ELECTRO-MECHANICAL INDUSTRIES

1 Air compressors and gas handling equipment
2 Air conditioning equipment
3 Bearings
4 Business and office equipment
5 Distilling equipment
6 Electric power transmission and distribution equipment
7 Furnaces, heating equipment
8 Gears
9 Grinding and size reduction equipment
10 Household appliances
11 Hydraulic machinery
12 Illumination equipment
13 Internal combustion engines
14 Industrial machinery and equipment
15 Machine tools
16 Materials handling machinery
17 Mining machinery
18 Nuclear power reactors
19 Pneumatic equipment
20 Power generators
21 Printing and duplicating machinery
22 Refrigerating equipment
23 Rotating machinery
24 Textile machinery
25 Turbines

B 12. METAL FABRICATED PRODUCTS

1 Boilers
2 Cans and containers
3 Electro-plated and coated products
4 Machined and turned products
5 Pipes, fittings and valves
6 Pressure vessels
7 Sheet-metal products
8 Stampings
9 Wire products

B. 13. OPTICAL AND INSTRUMENTATION INDUSTRIES

1 Laboratory and scientific apparatus
2 Measuring and control instruments
3 Optical instruments and lenses
4 Photographic equipment
5 Watches and clocks

B. 14. ELECTRONICS AND TELECOMMUNICATIONS INDUSTRIES

1 Computer industry
2 Electron tubes
3 Integrated circuits
4 Lasers
5 Microwave links
6 Radar
7 Radio and TV receivers
8 Radio and TV transmitters recorders
9 Satellite communication
10 Semiconductor devices
11 Sonar
12 Sonic and ultrasonic devices
13 Telephone
14 X - Ray devices

B 15. FUEL AND POWER INDUSTRIES

1 Coal processing industry
2 Coking and gas industry
3 Fuel cells
4 Geothermal energy
5 Hydro-electric energy
6 Nuclear energy
7 Nuclear fuel and fuel elements ; moderators
8 Petroleum refineries

Tableau 2 (suite)

7 Métalloïdes (familles du chlore, de l'oxygène et de l'azote)
8 Composés organo-métalliques
9 Produits phosphorés
10 Pigments
11 Produits sulfurés

B. 10. INDUSTRIES CHIMIQUES (PRODUITS ORGANIQUES)

1 Adhésifs
2 Détergents, savons
3 Teintures
4 Hauts polymères
5 Intermédiaires et solvants
6 Monomères
7 Produits pétro chimiques
8 Produits pharmaceutiques
9 Produits pour la photographie
10 Pesticides synthétiques
11 Terpènes et huiles essentielles

B. 11. INDUSTRIES MECANIQUES ET ELECTRIQUES

1 Compresseurs d'air et matériel pour la manipulation des gaz
2 Matériel de climatisation
3 Paliers de roulements
4 Equipement pour les entreprises et matériel de bureau
5 Matériel de distillation
6 Matériel pour le transport et la distribution de l'énergie électrique
7 Fours, matériel de chauffage
8 Engrenages
9 Moulins et broyeurs
10 Appareils ménagers
11 Machines hydrauliques
12 Matériel d'éclairage
13 Moteurs à combustion interne
14 Matériel et équipement industriel
15 Machines-outils
16 Appareils de manutention
17 Equipements miniers
18 Réacteurs nucléaires
19 Equipement pneumatique
20 Générateurs électriques
21 Matériel d'imprimerie et de reproduction
22 Matériel frigorifique
23 Machines tournantes
24 Machines textiles
25 Turbines

B. 12. FABRICATION DE PRODUITS EN METAL

1 Chaudières
2 Réservoirs et conteneurs
3 Produits plaqués et galvanisés
4 Produits usinés et tournés
5 Tuyaux, raccords, et soupapes
6 Réservoirs et vaisseaux pressurisés
7 Produits métalliques en feuilles
8 Pièces embouties
9 Produits tréfilés

B. 13. OPTIQUE ET INSTRUMENTS

1 Matériel de laboratoire et appareils scientifiques
2 Instruments de mesure et de contrôle
3 Instruments optiques et lentilles
4 Matériel photographique
5 Horlogerie

B. 14. ELECTRONIQUE ET TELECOMMUNICATIONS

1 Ordinateurs
2 Tubes électroniques
3 Circuits intégrés
4 Lasers
5 Liaisons par micro-ondes
6 Radar
7 Récepteurs de radio et de télévision
8 Emetteurs de radio et de télévision
9 Communication par satellites
10 Matériel à semi-conducteurs
11 Sonar
12 Dispositifs soniques et ultrasoniques

Table 2 (continued)

9 Solar energy
10 Thermochemical energy (fuels and combustion)
11 Tidal energy
12 Wind energy

B. 16. TRANSPORTATION INDUSTRIES

1 Aeronautical industry
2 Automotive industry
3 Fuel distribution
4 Hover craft
5 Pipelines
6 Railway rolling stock
7 Shipbuilding and repair
8 Transport equipment

B. 17. BUILDING AND CONSTRUCTION INDUSTRIES

1 Airport construction
2 Housing
3 Inland waterways
4 Port facilities
5 Railways
6 Roads, bridges, etc.
7 Schools, hospitals and other public buildings
8 Tunnels and underground works

Tableau 2 (suite)

13 Téléphone
14 Appareils à rayon-X

B. 15. COMBUSTIBLES ET ENERGIE

1 Industrie de transformation du charbon
2 Production de coke et de gaz
3 Piles á combustible
4 Energie géothermique
5 Energie hydroélectrique
6 Energie nucléaire
7 Combustible et éléments de combustible nucléaires modérateurs
8 Raffineries de pétrole
9 Energie solaire
10 Energie thermo-chimique (combustibles et combustion)
11 Energie marémotrice
12 Energie éolienne

B. 16. TRANSPORTS

1 Industrie aéronautique
2 Industrie automobile
3 Distribution du carburant
4 Aéroglisseurs
5 Pipelines
6 Matériel ferroviaire roulant
7 Construction et réparation des navires
8 Matériel de transport

B. 17. BATIMENT ET CONSTRUCTION

1 Construction d'aéroports
2 Construction de logements
3 Voies d'eau intérieures
4 Installations portuaires
5 Chemins de fer
6 Routes, ponts, etc.
7 Ecoles, hôpitaux et autres bâtiments publics
8 Tunnels et ouvrages souterrains

Table 3. List of fields for scientific and technological public service

C. 1. NATURAL RESOURCES AND ENVIRONMENT SERVICES

1 Astronomical services
2 Energy services
3 Cartography and photogrametry services
4 Biometrical services
5 Geological survey services
6 Hydrological services
7 Integrated land-systems surveys
8 Marine and fisheries services
9 Meteorology services
10 Mining services
11 Scientific mapping services
12 Soil science services
13 Time services
14 Vulcanological services
15 Water supply services
16 Wildlife conservation services

C. 2. SCIENTIFIC AND TECHNOLOGICAL INFORMATION AND DOCUMENTATION SERVICES

1 Abstract journals
2 Centres for Scientific and Technological Documentation
3 Conference centres
4 Industrial information centres
5 Information processing services
6 Libraries of sciences and technology
7 Patent offices
8 Scientific journals
9 Statistical analysis services and data banks
10 Technology transfer centres

C. 3. SCIENTIFIC MUSEUMS AND COLLECTIONS

1 Anthropological collections

Tableau 3. Liste des domaines intéressant la création de services publics scientifiques et technologiques

C. 1. SERVICES CONCERNANT LES RESSOURCES NATURELLES ET L'ENVIRONNEMENT

1 Services astronomiques
2 Services intéressant l'énergie
3 Services de cartographie et de photogrammétrie
4 Services biométriques
5 Services d'études géologiques
6 Services hydrologiques
7 Services d'études intégrées de systèmes d'exploitation des terres
8 Services maritimes et ichtyologiques
9 Services météorologiques
10 Services miniers
11 Services de cartographie scientifique
12 Services de pédologie
13 Services de l'heure
14 Services de vulcanologie
15 Services d'approvisionnement en eau
16 Services intéressant la préservation de la faune et de la flore sauvages

C. 2. SERVICES D'INFORMATION ET DE DOCUMENTATION SCIENTIFIQUES ET TECHNIQUES

1 Bulletins de résumés
2 Centres de documentation scientifique et technique
3 Centres de conférences
4 Centres d'information industrielle
5 Services de traitement de l'information
6 Bibliothèques scientifiques et techniques
7 Bureaux de dépôt des brevets
8 Revues scientifiques
9 Services d'analyse statistique et banques de données
10 Centres de transfert de technologie

Table 3 (continued)

2 Archaeological collections
3 Botanical collections
4 Entomological collections
5 Geological collections
6 Science museums
7 Technology museums
8 Travelling exhibitions for science and technology
9 Zoological collections

C. 4. STANDARDS, NORMS INSTRUMENTATION QUALITY CONTROL

1 Biochemical control laboratories
2 Biological control laboratories
3 Bureaux of standards
4 Centres for scientific instruments manufacture maintenance and repair
5 Chemical control laboratories
6 Chemical analysis services
7 Drug control laboratories
8 Food control laboratories
9 Metrology services
10 Specification and norms services
11 Testing of materials (resistance and properties)
12 Water control laboratories

C. 5. EXTENSION AND INNOVATION SERVICES

1 Agricultural extension services
2 Computation centres
3 Educational techniques services
4 Forestry services
5 Land-use development services
6 Livestock services
7 Nutrition services
8 Pest control services
9 Public health services
10 Rural engineering services
11 Sanitation services
12 Technological innovation services
13 University polyclinics
14 Veterinary services
15 Weather control services

Tableau 3 (suite)

C. 3. MUSEES ET COLLECTIONS SCIENTIFIQUES

1 Collections anthropologiques
2 Collections archéologiques
3 Collections botaniques
4 Collections entomologiques
5 Collection géologique
6 Musées scientifiques
7 Musées techniques
8 Expositions scientifiques et techniques itinérantes
9 Collections zoologiques

C. 4. ETALONS, NORMES, INSTRUMENTS, CONTROLE DE QUALITE

1 Laboratoires de contrôle biochimique
2 Laboratoires de contrôle biologique
3 Bureau des normes et étalons
4 Centres pour la fabrication, l'entretien et la réparation des instruments scientifiques
5 Laboratoires de contrôle chimique
6 Services d'analyse chimique
7 Laboratoires de contrôle des médicaments
8 Laboratoires de contrôle des aliments
9 Services de métrologie
10 Services de spécification et de normalisation
11 Laboratoires d'essais des matériaux (résistance et propriétés)
12 Laboratoires de contrôle de l'eau

C. 5. SERVICES DE VULGARISATION ET D'INNOVATION

1 Services de vulgarisation agricole
2 Centres de calcul
3 Services relatifs aux techniques d'éducation
4 Services des forêts
5 Services concernant le développement de l'utilisation du sol
6 Services concernant l'élevage
7 Services concernant l'alimentation
8 Services de lutte contre les les animaux nuisibles
9 Services d'hygiène publique
10 Services du génie rural
11 Services sanitaires
12 Services d'innovation technologique
13 Polyclinique universitaire
14 Services vétérinaires
15 Services de lutte contre les intempéries

Section 2. LIST OF ITEMS OF COINCIDENCE

● Interaction in Northern Africa

(Diagrams A1 and B1)

ø Sudan - Egypt

MATRIX A : Both Sudan and Egypt wish to co-operate with one another in 42 fields

A1 : 11 Statistics

A2 : 1 Acoustics

A5 : 2 Atmospheric Sciences
3 Climatology
4 Ecology
7 Geology
8 Geophysics
10 Hydrology and Hydrobiology
11 Oceanography
12 Paleontology
14 Seismology

A6 : 3 Construction engineering
5 Electrical engineering
6 Electronics engineering
12 Nuclear engineering
13 Petroleum engineering
15 Sanitary and pollution engineering
17 Transportation engineering

A7 : 1 Agronomy
4 Animal breeding
10 Horticulture
11 Phytopathology
12 Plant breeding
13 Plant physiology

A8 : 2 Bacteriology
4 Epidemiology
5 Human biology and anthropology
6 Immunology
7 Internal medicine
8 Nutrition
10 Pharmacology
13 Surgery
15 Virology

A9 : 1 Business economics and management
5 Economic statistics
6 Economic systems
8 Home economics
15 Price and markets

A10 : 1 Archaeology
5 Demography & population
9 Linguistics
14 Rural sociology, Land reform

Section 2. LISTE DES POINTS DE CONVERGENCE

● Interaction en Afrique septentrionale

(Diagrammes A1 et B1)

ø Soudan - Egypte

MATRICE A : Le Soudan et l'Egypte désirent tous deux coopérer l'un avec l'autre dans 42 domaines

A1 : 11 Statistique

A2 : 1 Acoustique

A5 : 2 Sciences de l'atmosphère
3 Climatologie
4 Ecologie
7 Géologie
8 Géophysique
10 Hydrologie et hydrobiologie
11 Océanographie
12 Paléontologie
14 Sismologie

A6 : 3 Génie des constructions
5 Génie électrotechnique
6 Génie électronique
12 Génie atomique
13 Génie pétrolier
15 Génie sanitaire et anti-pollution
17 Génie des transports

A7 : 1 Agronomie
4 Elevage
10 Horticulture
11 Phytopatologie
12 Sélection végétale
13 Phytophysiologie

A8 : 2 Bactériologie
4 Epidémiologie
5 Biologie et anthropologie humaine
6 Immunologie
7 Médecine interne
8 Nutrition
10 Pharmacologie
13 Chirurgie
15 Virologie

A9 : 1 Economie et gestion de l'entreprise
5 Statistique économique
6 Systèmes économiques
8 Economie ménagère
15 Prix et marchés

A10 : 1 Archéologie
5 Démographie et population
9 Linguistique
14 Sociologie rurale, réforme agraire

MATRIX B : Both Sudan and Egypt wish to co-operate with one another in 28 fields

B1 : 2 Crop production
3 Crop protection
4 Crop processing
6 Farm construction, equipment and management
8 Irrigation & drainage
10 Pasture management
11 Pest control
13 Soil management
14 Weed control

B3 : 1 Animal health and disease control
2 Animal production
4 Animal reproduction
5 Animal selection

B4 : 1 Fish finding
2 Fish farming
3 Fish preservation
4 Fish processing
5 Fishing boats and gear

B5 : 7 Food processing, canning and conservation

B6 : 1 Footwear industry
4 Textile industry

B7 : 4 Metal ore mining

B8 : 9 Glass and glass products
10 Iron and steel
22 Textiles

B11 : 22 Refrigerating equipment

B15 : 5 Hydro-electric energy
9 Solar energy

MATRICE B : Le Soudan et l'Egypte désirent tous deux coopérer l'un avec l'autre dans 28 domaines

B1 : 2 Production agricole
3 Protection des cultures
4 Transformation des produits agricoles
6 Construction,équipement et entretien des locaux à usage agricole
8 Irrigation et drainage
10 Exploitation rationnelle des pâturages
11 Lutte contre les animaux nuisibles
13 Utilisation rationnelle du sol
14 Lutte contre les mauvaises herbes

B3 : 1 Hygiène animale et lutte contre les maladies
2 Production animale
4 Reproduction animale
5 Sélection animale

B4 : 1 Pêche
2 Pisciculture
3 Préservation des poissons
4 Transformation du poisson
5 Embarcations et matériel de pêche

B5 : 7 Transformation, mise en boîte et conservation des produits alimentaires

B6 : 1 Industrie de la chaussure
4 Industrie textile

B7 : 4 Extraction de minerais métalliques

B8 : 9 Verre et produits en verre
10 Fer et acier
22 Textiles

B11 : 22 Matériel frigorifique

B15 : 5 Energie hydroélectrique
9 Energie solaire

ø Egypt-Algeria

MATRIX A : Both Egypt and Algeria wish to co-operate with one another in 17 fields

A1 : 4 Computer sciences
11 Statistics

A5 : 11 Oceanography
14 Seismology

A8 : 2 Bacteriology

A9 : 1 Business economics and management
5 Economic statistics
6 Economic systems ; development and planning

ø Egypte - Algérie

MATRICE A : L'Egypte et l'Algérie désirent toutes deux coopérer l'une avec l'autre dans 17 domaines

A1 : 4 Informatique
11 Statistiques

A5 : 11 Océanographie
14 Sismologie

A8 : 2 Bactériologie

A9 : 1 Economie et gestion de l'entreprise
5 Statistique économique
5 Systèmes économiques ; développement et planification

A10 : 1 Archaeology
2 Architecture
4 Cultural/Social anthropology
6 Ethnology
7 History
8 Law
13 Psychology
14 Rural sociology, Land reform
15 Sociology

MATRIX B : Both Egypt and Algeria wish to co-operate with one another in 9 fields

B1 : 2 Crop production

B3 : 1 Animal health and disease control
2 Animal production
4 Animal reproduction

B7 : 3 Crude petroleum production

B8 : 10 Iron and steel
14 Non-ferrous metals

B11 : 4 Business and office equipment

B15 : 9 Solar energy

ø Egypt - Tunisia

MATRIX A : Both Egypt and Tunisia wish to co-operate with one another in 6 fields

A9 : 3 Econometry
5 Economic statistics

A10 : 3 Behavioural sciences, ethnology
4 Cultural/Social anthropology
7 History
15 Sociology

ø Algeria - Tunisia

MATRIX A : Both Algeria and Tunisia wish to co-operate with one another in 7 fields

A3 : 5 Organic chemistry
6 Physical chemistry

A7 : 1 Agronomy (general)

A8 : 9 Pathology

A9 : 1 Business economics and management
4 Economic history
7 Economic theory

A10 : 1 Archéologie
2 Architecture
4 Anthropologie culturelle et sociale
6 Ethnologie
7 Histoire
8 Droit
13 Psychologie
14 Sociologie rurale, réforme agraire
15 Sociologie

MATRICE B : L'Egypte et l'Algérie désirent toutes deux coopérer l'une avec l'autre dans 9 domaines

B1 : 2 Production agricole

B3 : 1 Hygiène animale et lutte contre les maladies
2 Production animale
4 Reproduction animale

B7 : 3 Production de pétrole brut

B8 : 10 Fer et acier
14 Métaux non ferreux

B11 : 4 Equipement pour les entreprises et matériel de bureau

B15 : 9 Energie solaire

ø Egypte - Tunisie

MATRICE A : L'Egypte et la Tunisie désirent toutes deux coopérer l'une avec l'autre dans 6 domaines

A9 : 3 Econométrie
5 Statistique économique

A10 : 3 Sciences du comportement, éthnologie
4 Anthropologie culturelle et sociale
7 Histoire
15 Sociologie

ø Algérie - Tunisie

MATRICE A : L'Algérie et la Tunisie désirent toutes deux coopérer l'une avec l'autre dans 7 domaines

A3 : 5 Chimie organique
6 Chimie physique

A7 : 1 Agronomie (générale)

A8 : 9 Pathologie

A9 : 1 Economie et gestion de l'entreprise
4 Histoire économique
7 Théorie économique

MATRIX B : Both Algeria and Tunisia wish to co-operate with one another in 2 fields

B1 : 2 Crop production

B3 : 2 Animal production

● Co-operation in Northern Africa as a whole

On the basis of the replies, it can be taken that :

ø Egypt, Sudan, Algeria and Tunisia wish to co-operate with each other in at least 3 fields

A9 : 5 Economic statistics

B1 : 2 Crop production

B3 : 2 Animal production

ø Sudan, Egypt and Algeria wish to co operate with each other in at least 8 fields

A1 : 11 Statistics (general)

A8 : 2 Bacteriology

A9 : 1 Business economics and management
5 Economic statistics
6 Economic system ; development and planning

A10 : 1 Archaeology

B8 : 10 Iron and steel

B15 : 9 Solar energy

ø Egypt, Algeria and Tunisia wish to co-operate with each other in at least 2 fields

A10 : 4 Cultural/Social anthropology
7 History

● Interaction in Western Africa

(Diagrams A2 and B2)

ø Mauritania - Senegal

MATRIX A : Both Mauritania and Senegal wish to co-operate with one another in 4 fields

A5 : 10 Hydrology and Hydrobiology

A7 : 1 Agronomy (general)
4 Animal breeding
5 Animal pathology

MATRICE B : L'Algérie et la Tunisie désirent toutes deux coopérer l'une avec l'autre dans 2 domaines

B1 : 2 Production agricole

B3 : 2 Production animale

● Coopération étendue à toute l'Afrique septentrionale

Sur la base des réponses on peut déduire que :

ø L'Egypte, le Soudan, l'Algérie et la Tunisie désirent coopérer tous ensemble dans au moins 3 domaines

A9 : 5 Statistique économique

B1 : 2 Production agricole

B3 : 2 Production animale

ø Le Soudan, l'Egypte et l'Algérie désirent coopérer tous ensemble dans au moins 8 domaines

A1 : 11 Statistique (générale)

A8 : 2 Bactériologie

A9 : 1 Economie et gestion de l'entreprise
5 Statistique économique
6 Systèmes économiques ; développement et planification

A10 : 1 Archéologie

B8 : 10 Fer et acier

B15 : 9 Energie solaire

ø L'Egypte, l'Algérie et la Tunisie désirent coopérer toutes ensembles dans au moins 2 domaines

A10 : 4 Anthropologie culturelle et sociale
7 Histoire

● Interaction en Afrique occidentale

(Diagrammes A2 et B2)

ø Mauritanie - Sénégal

MATRICE A : La Mauritanie et le Sénégal désirent tous deux coopérer l'un avec l'autre dans 4 domaines

A5 : 10 Hydrologie et hydrobiologie

A7 : 1 Agronomie générale
4 Elevage
5 Pathologie animale

MATRIX B : Both Mauritania and Senegal wish to co-operate with one another in 7 fields

B1 : 2 Crop production
4 Crop processing
8 Irrigation and drainage
10 Pasture management

B3 : 1 Animal health and disease control

B5 : 2 Animal feed

B10 : 8 Pharmaceuticals

MATRICE B : La Mauritanie et le Sénégal désirent tous les deux coopérer l'un avec l'autre dans 7 domaines

B1 : 2 Production agricole
4 Transformation des produits agricoles
8 Irrigation et drainage
10 Exploitation rationnelle des pâturages

B3 : 1 Hygiène animale et lutte contre les maladies

B5 : 2 Alimentation animale

B10 : 8 produits pharmaceutiques

ø Mauritania - Mali

MATRIX A : Both Mauritania and Mali wish to co-operate with one another in 5 fields

A8 : 2 Bacteriology
4 Epidemiology
8 Nutrition

A10 : 1 Archaeology
7 History

MATRIX B : Both Mauritania and Mali wish to co-operate with one another in 18 fields

B1 : 3 Crop protection
9 Natural pesticides
10 Pasture management
11 Pest control
12 Savannah management
13 Soil management
14 Weed control

B2 : 1 Forest conservation
2 Forest exploitation
3 Forest products
4 Forest protection

B3 : 1 Animal health
2 Animal production
3 Animal products
4 Animal reproduction
5 Animal selection

B5 : 2 Animal feed
9 Protein-food (meat, fish, eggs)

ø Mauritanie - Mali

MATRICE A : La Mauritanie et le Mali désirent tous deux coopérer l'un avec l'autre dans 5 domaines

A8 : 2 Bactériologie
4 Epidémiologie
8 Nutrition

A10 : 1 Archéologie
7 Histoire

MATRICE B : La Mauritanie et le Mali désirent tous deux coopérer l'un avec l'autre dans 18 domaines

B1 : 3 Protection des cultures
9 Pesticides naturels
10 Exploitation rationnelle des pâturages
11 Lutte contre les animaux nuisibles
12 Mise en valeur de la savane
13 Utilisation rationnelle du sol
14 Lutte contre les mauvaises herbes

B2 : 1 Conservation des forêts
2 Exploitation forestière
3 Produits forestiers
4 Protection des forêts

B3 : 1 Hygiène animale et lutte contre les maladies
2 Production animale
3 Produits animaux
4 Reproduction animale
5 Selection animale

B5 : 2 Alimentation animale
9 Produits alimentaires protéinés (viande, poisson, oeufs)

ø Mali - Senegal

MATRIX A : Both Mali and Senegal wish to co-operate with one another in 2 fields

A7 1 Agronomy (general)
4 Animal breeding

MATRIX B : Both Mali and Senegal wish to co-operate with one another in 5 fields

B1 : 2 Crop production
8 Irrigation and drainage
10 Pasture management

B3 : 1 Animal health and disease control

B5 : 2 Animal feed

ø Senegal - Ivory Coast

MATRIX A : Both Senegal and Ivory Coast wish to co-operate with one another in 10 fields

A5 : 3 Climatology
8 Geophysics
11 Oceanography

A7 : 1 Agronomy (general)
4 Animal breeding
6 Animal physiology
9 Food science
12 Plant breeding

A10 : 2 Architecture
14 Rural sociology, Land reform

MATRIX B : Both Senegal and Ivory Coast wish to co-operate with one another in 5 fields

B1 : 2 Crop production
4 Crop processing
10 Pasture management

B3 : 1 Animal health and disease control

B4 : 1 Fish finding

ø Ivory Coast - Mauritania

MATRIX A : Both Ivory Coast and Mauritania wish to co-operate with one another in 1 field

A7 : 6 Animals physiology

ø Mali - Sénégal

MATRICE A : Le Mali et le Sénégal désirent tous deux coopérer l'un avec l'autre dans 2 domaines

A7 : 1 Agronomie (générale)
4 Elevage

MATRICE B : Le Mali et le Sénégal désirent tous deux coopérer l'un avec l'autre dans 5 domaines

B1 : 2 Production agricole
8 Irrigation et drainage
10 Exploitation rationnelle des pâturages

B3 : 1 Hygiène animale et lutte contre les maladies

B5 : 2 Alimentation animale

ø Sénégal - Côte d'Ivoire

MATRICE A : Le Sénégal et la Côte d'Ivoire désirent tous deux coopérer l'un avec l'autre dans 10 domaines

A5 : 3 Climatologie
8 Géophysique
11 Océanographie

A7 : 1 Agronomie (générale)
4 Elevage
6 Physiologie animale
9 Science alimentaire
12 Sélection végétale

A10 : 2 Architecture
14 Sociologie rurale, réforme agraire

MATRICE B : Le Sénégal et la Côte d'Ivoire désirent tous deux coopérer l'un avec l'autre dans 5 domaines

B1 : 2 Production agricole
4 Transformation des produits agricoles
10 Exploitation rationnelle des pâturages

B3 : 1 Hygiène animale et lutte contre les maladies

B4 : 1 Pêche

ø Côte d'Ivoire - Mauritanie

MATRICE A : La Côte d'Ivoire et la Mauritanie désirent toutes deux coopérer l'une avec l'autre dans 1 domaine

A7 : 6 Physiologie animale

ø Ivory Coast - Togo

MATRIX A : Both Ivory Coast and Togo wish to co-operate with one another in 2 fields

A1 : 4 Computer science

A6 : 3 Construction engineering

MATRIX B : Both Ivory Coast and Togo wish to co-operate with one another in 2 fields

B1 : 8 Irrigation and drainage

B3 : 2 Animal production

ø Ivory Coast - Liberia

MATRIX B : Both Ivory Coast and Liberia wish to co-operate with one another in 1 field

B7 : 4 Metal ore mining

ø Ghana - Mali

MATRIX B : Both Ghana and Mali wish to co-operate with one another in 1 field

B1 : 2 Crop production

ø Ghana - Ivory Coast

MATRIX B : Both Ghana and Ivory Coast wish to co-operate with one another in 8 fields

B1 : 14 Weed control

B2 : 1 Forest conservation
2 Forest exploitation
3 Forest products
4 Forest protection

B5 : 7 Food processing, canning and conservation

B8 : 22 Textiles
23 Wood and wood products

ø Ghana - Liberia

MATRIX B : Both Ghana and Liberia wish to co-operate with one another in 2 fields

B1 : 2 Crop production

B7 : 4 Metal ore mining

ø Côte d'Ivoire - Togo

MATRICE A : La Côte d'Ivoire et le Togo désirent tous deux coopérer l'un avec l'autre dans 2 domaines

A1 : 4 Informatique

A6 : 3 Génie des constructions

MATRICE B : La Côte d'Ivoire et le Togo désirent tous deux coopérer l'un avec l'autre dans 2 domaines

B1 : 8 Irrigation et drainage

B3 : 2 Production animale

ø Côte d'Ivoire - Liberia

MATRICE B : la Côte d'Ivoire et le Libéria désirent tous deux coopérer l'un avec l'autre dans 1 domaine

B7 : 4 Extraction de minerais métalliques

ø Ghana - Mali

MATRICE B : Le Ghana et le Mali désirent tous deux coopérer l'un avec l'autre dans 1 domaine

B1 : 2 Production agricole

ø Ghana - Côte d'Ivoire

MATRICE B : Le Ghana et la Côte d'Ivoire désirent tous deux coopérer l'un avec l'autre dans 8 domaines

B1 : 14 Lutte contre les mauvaises herbes

B2 : 1 Conservation des forêts
2 Exploitation forestière
3 Produits forestiers
4 Protection des forêts

B5 : 7 Transformation, mise en boîte et conservation des produits alimentaires

B8 : 22 Textiles
23 Bois et produits en bois

ø Ghana - Liberia

MATRICE B : Le Ghana et le Liberia désirent tous deux coopérer l'un avec l'autre dans 2 domaines

B1 : 2 Production agricole

B7 : 4 Extraction des minerais métalliques

● Co-operation in Western Africa as a whole

One the basis of the replies it can be taken that :

ø Mali, Mauritania, Senegal and Ivory Coast wish to co-operate with each other in 7 fields

A7 : 1 Agronomy (general)
4 Animal breeding

B1 : 2 Crop production
4 Crop processing
8 Irrigation and drainage
10 Pasture management

B3 : 1 Animal health and disease control

ø Moreover, Mali, Senegal, Ivory Coast, Liberia and Ghana wish to co-operate with each other in 1 field

B1 : 2 Crop production

● Interaction in Middle Africa

(Diagrammes A3 and B3)

ø Congo - Cameroon

MATRIX A : Both Congo and Cameroon wish to co-operate with one another in 2 fields

A4 : 1 Botany
6 Entomology

ø Congo - Zaire

MATRIX A : Both Congo and Zaire wish to co-operate with one another in 1 field

A5 : 7 Geology

● Interaction in Eastern Africa

ø Ethiopia - Somalia

MATRIX B : Both Ethiopia and Somalia wish to co-operate with one another in 1 field

B3 : 1 Animal health and disease control

● Coopération étendue à toute l'Afrique Occidentale

Sur la base des réponses on peut déduire que :

ø Le Mali, la Mauritanie, le Sénégal et la Côte d'Ivoire désirent coopérer tous ensemble dans 7 domaines

A7 : 1 Agronomie (générale)
4 Elevage

B1 : 2 Production agricole
4 Transformation des produits agricoles
8 Irrigation et drainage
10 Exploitation rationnelle des pâturages

B3 : 1 Hygiène animale et lutte contre les maladies

ø Par ailleurs, le Mali, le Sénégal, la Côte d'Ivoire, le Liberia et le Ghana désirent coopérer tous ensemble dans 1 domaine

B1 : 2 Production agricole

● Interaction en Afrique centrale

(Diagrammes A3 et B3)

ø Congo - Cameroun

MATRICE A : Le Congo et le Cameroun désirent tous deux coopérer l'un avec l'autre dans 2 domaines

A4 : 1 Botanique
6 Entomologie

ø Congo - Zaire

MATRICE A : Le Congo et le Zaire désirent tous deux coopérer l'un avec l'autre dans 1 domaine

A5 : 7 Géologie

● Interaction en Afrique orientale

ø Ethiopie - Somalie

MATRICE B : L'Ethiopie et la Somalie désirent coopérer toutes deux l'une avec l'autre dans 1 domaine

B3 : 1 Hygiène animale et lutte contre les maladies

● Interaction between African sub-regions

(Diagrams A1, B1, A2, B2, A3 & B3)

ø Northern Africa - Western Africa

Both Egypt and Mauritania wish to co-operate with one another in 7 fields

A4 : 2 Biology (general)
3 Biochemistry, molecular biology
7 Genetics
8 Microbiology
11 Zoology

A8 : 15 Virology

B3 : 1 Animal health and disease control

ø Middle Africa - Eastern Africa

Both Cameroon and Burundi wish to co-operate with one another in 1 field

B1 : 3 Crop protection

Both Zaire and Burundi wish to co-operate with one another in 2 fields

B2 : 1 Forest conservation
4 Forest protection

ø Eastern Africa - Northern Africa

Both Ethiopia and Sudan wish to co-operate with one another in 2 fields

A7 : 1 Agronomy (general)

B3 : 1 Animal health and disease control

Both Ethiopia and Egypt wish to co-operate with one another in 5 fields

A5 : 8 Geophysics

B3 : 1 Animal health and disease control
2 Animal production
3 Animal products
5 Animal selection

● Interaction entre les sous-régions africaines

(Diagrammes A1, B1, A2, B2, A3, & B3)

ø Afrique septentrionale - Afrique occidentale

L'Egypte et la Mauritanie désirent coopérer toutes deux l'une avec l'autre dans 7 domaines

A4 : 2 Biologie (générale)
3 Biochimie, biologie moléculaire
7 Génétique
8 Microbiologie
11 Zoologie

A8 : 15 Virologie

B3 : 1 Hygiène animale et lutte contre les maladies

ø Afrique centrale - Afrique orientale

Le Cameroun et le Burundi désirent coopérer tous deux l'un avec l'autre dans 1 domaine

B1 : 3 Protection des cultures

Le Zaire et le Burundi désirent coopérer tous deux l'un avec l'autre dans 2 domaines

B2 : 1 Conservation des forêts
4 Protection des forêts

ø Afrique orientale - Afrique septentrionale

L'Ethiopie et le Soudan désirent coopérer tous deux l'un avec l'autre dans 2 domaines

A7 : 1 Agronomie (générale)

B3 : 1 Hygiène animale et lutte contre les maladies

L'Ethiopie et l'Egypte désirent coopérer toutes deux l'une avec l'autre dans 5 domaines

A5 : 8 Géophysique

B3 : 1 Hygiène animale et lutte contre les maladies
2 Production animale
3 Prcduits animaux
5 Sélection animale

Both Somalia and Sudan wish to co-operate with one another in 4 fields

A7 : 10 Horticulture

A10 : 5 Demography and population

B1 : 11 Pest control
13 Soil management

ø Eastern Africa - Western Africa

Both Ethiopia and Ghana wish to co-operate with one another in 4 fields

B3 : 1 Animal health and disease control
2 Animal production
3 Animal products
5 Animal selection

Both Sudan and Mauritania wish to co-operate with one another in 1 field

B1 : 3 Crop protection

Both Egypt and Ghana wish to co-operate with one another in 1 field

B3 : 1 Animal health and disease control

ø Northern Africa - Middle Africa

Both Egypte and Zaire wish to co-operate with one another in 1 field

A8 : 10 Pharmacology , chemotherapy

Both Sudan and Zaire wish to co-operate with one another in 4 fields

A5 : 10 Hydrology and hydrobioloy

A10 : 5 Demography and population

B1 : 8 Irrigation and drainage
13 Soil management

ø Western Africa - Middle Africa

Both Ivory Coast and Cameroon wish to co-operate with one another in 1 field

A4 : 1 Botany

La Somalie et le Soudan désirent coopérer tous deux l'un avec l'autre dans 4 domaines

A7 : 10 Horticulture

A10 : 5 Démographie et population

B1 : 11 Lutte contre les animaux nuisibles
13 Utilisation rationnelle du sol

ø Afrique orientale - Afrique occidentale

L'Ethiopie et le Ghana désirent tous deux coopérer l'un avec l'autre dans 4 domaines

B3 : 1 Hygiène animale et lutte contre les maladies
2 Production animale
3 Produits animaux
5 Sélection animale

Le Soudan et la Mauritanie désirent tous deux coopérer l'un avec l'autre dans 1 domaine

B1 : 3 Protection des cultures

L'Egypte et le Ghana désirent tous deux coopérer l'un avec l'autre dans 1 domaine

B3 : 1 Hygiène animale et lutte contre les maladies

ø Afrique septentrionale - Afrique centrale

L'Egypte et le Zaire désirent tous deux coopérer l'un avec l'autre dans 1 domaine

A8 : 10 Pharmacologie, chimiothérapie

Le Soudan et le Zaire désirent tous deux coopérer l'un avec l'autre dans 4 domaines

A5 : 10 Hydrologie et hydrobiologie

A10 : 5 Démographie et population

B1 : 8 Irrigation et drainage
13 Utilisation rationnelle du sol

ø Afrique occidentale - Afrique centrale

La Côte d'Ivoire et le Cameroun désirent tous deux coopérer l'un avec l'autre dans 1 domaine

A4 : 1 Botanique

Both Ivory Coast and Zaire wish to so-operate with one another in 2 fields

A5 : 4 Ecology

A7 : 4 Animal breeding

Both Togo and Zaire wish to co-operate with one another in 2 fields

A1 : 4 Computer science
11 Statistics

La Côte d'Ivoire et le Zaire désirent tous deux coopérer l'un avec l'autre dans 2 domaines

A5 : 4 Ecologie

A7 : 4 Elevage

Le Togo et le Zaire désirent tous les deux coopérer l'un avec l'autre dans 2 domaines

A1 : 4 Informatique
11 Statistique

Section 3. NOTES EXPLICATIVES/
EXPLANATORY NOTES.

ALGERIE / ALGERIA

MATRICE A

A.1 - Sciences mathématiques : Oran : Statistiques.

A.2 - Sciences physiques : Institut d'Etudes nucléaires, Alger (C.P.R.S) 55 chercheurs - 35 techniciens.

A.2.8 Physique nucléaire : recherche électronique rapide, informatique, spectroscopie atomique, étude des plasmas.

A.2.4 Electronique :Etude des résonnances magnétiques et de la relaxation dans les solides.

A.3 - Sciences chimiques : Faculté des Sciences : Alger : 170 chercheurs. Faculté des Sciences : Oran : 70 chercheurs.

A.4 - Sciences biologiques :
Alger : Université : Faculté des Sciences - 170 Chercheurs. Le département participe à la publication de la Revue d'histoire naturelle.

Oran : 75 chercheurs.

Constantine : 16 chercheurs.

A.5 - Sciences de la terre et de l'espace : Alger - Oran - Constantine : Universités : Facultés des Sciences.

Alger : Les recherches sont orientées sur la détermination des substances utiles. Une carte géophysique de l'Algérie est en cours d'élaboration avec le service de la carte géologique du Ministère de l'Industrie.
La SONAREM et le Secrétariat à l'Hydraulique sont également associés aux travaux du département.

Oran : géologie de terrain et exploitation en laboratoire.

A.5.11 Institut océanographique : (C.P.R.S.) 13 chercheurs. Les activités de l'Institut sont axées sur l'étude des algues et des petits animaux. Ces travaux sont essentiels au regard du développement de l'industrie de la pêche en Algérie.

L'Institut publie la revue "Pelagos" et dispose d'une importante bibliothèque rassemblant plus de 2000 ouvrages.

A.8 - Sciences médicales :
- accord avec le Maroc signé le 15 mars 1963.

Mise en application pour 1972/1973 et 1973/1974

Aide entre le croissant rouge marocain et le croissant rouge algérien.

- accord avec la Guinée dans le cadre du programme de coopération culturelle, scientifique et technique pour les années 1972/1973.
Les deux parties procèderont à des échanges de programmes d'études et de formation para-médicale.

La recherche en sciences médicales s'effectue dans les facultés de médecine et C.H.U.A. d'Alger, Oran et Constantine et dans les instituts d'hygiène et du trachome d'Alger.

Facultés de médecine :
Alger : 88 chercheurs.
Constantine : 13 chercheurs.

Institut du trachome : 6 chercheurs.
Etude des affections oculaires transmissibles.

Institut d'hygiène : 6 chercheurs.
Recherche sur la socio-pathologie de l'environnement et des maladies transmissibles.
Ce type de recherche est entrepris sous forme de campagnes de masse.

Sciences économiques :
Faculté d'Alger : 75 chercheurs.
Faculté de Constantine : 20 chercheurs.

Alger : Préparation de thèses, constitution de fichiers bibliographiques, législatifs, réglementaires.
Publication de la revue algérienne des sciences juridiques, politiques et économiques.

Constantine : préparation de thèses.

A.10 - Sciences humaines et sociales :
Université : Alger : Histoire ancienne, médiévale, moderne et contemporaine.
Géographie : études de géographie économique et humaine de certaines régions de l'Algérie.

Université : Oran : Sociologie : étude des mutations sociales et du développement.

Institut de linguistique et de phonétique : Alger : 18 chercheurs. Publication de la revue de linguistique ; Psycho-pédagogie ; psycho-linguistique, neuro-linguistique ; dialectologie et socio-linguistique.

Institut de géographie : 40 chercheurs.
Publication de la revue "Les Annales".

L'Institut de Géographie mène ses recherches en collaboration avec l'I.N.R.A.A. (Ministère de l'Agriculture).

MATRICE B

B.1 - Agriculture :
accords signés avec :

le Maroc : 15 mars 1963 ; mise en application pour 1972/1973, et 1973/1974.

le Cameroun : 10 octobre 1971.

la Tunisie : 26 février 1972.

Coopération agricole :

1. Projet céréales :
   - coordination des programmes d'expériences,
   - échanges d'information,
   - organisation de colloques,
   - organisation de visites de techniciens et d'experts dans les 2 pays.
2. recherches agronomiques : Pourparlers concernant l'établissement d'une convention de coopération en matière de recherches agronomiques.
3. vulgarisation agricole.
4. semences et plants :
   - échanges d'échantillons pour essais de variétés,
   - organisation de stages de perfectionnement en matière de multiplication et production des semences et plants.
   - intervention pour faciliter les approvisionnements en semences et plants.
5. formation agricole :
   machinisme agricole ; irrigation; forêts ; conservation des eaux et des sols.

B.2 et B.5 - Sylviculture et
- Industrie alimentaire, boissons et tabac
Accords signés avec le Congo : 16 septembre 1972.

- échanges de produits : sucre, bois et vin,
- mise en place de structures commerciales mixtes.

B.2.3 Produits forestiers : Bois : les besoins de l'Algérie se situent entre 35.000 et 40.000 m^3. Le Congo s'engage à satisfaire ces besoins. Les premiers contrats d'achat se sont faits à Brazzaville durant la 1ère quinzaine de novembre 1972.

B.5.1 Boissons alcoolisées : Vin : Importation au Congo de 50.000 hl pour 1972/73.

B.5.5 Farine, amidon et sucre : Le Congo s'engage à fournir à l'Algérie un quota minimum de 5.000 tonnes de sucre pendant la campagne sucrière de 1972/73 et plus à compter de 1973/74.

B.7 - Industries minières :
Accord signé avec la Tunisie : 26 février 1972.
- mise en exploitation du gisement algérien de plomb de Bou-Jabeur et traitement de minerai à l'unité de flottation située du côté tunisien du gisement,
- traitement du minerai de zinc tunisien à l'unité de flottation de Ghozaouet (Algérie).

Ces interventions communes peuvent revêtir selon la nature du projet, l'une des formes de participation suivantes :
a) création de projets communs
b) approvisionnement à long terme,
c) traitement à façon.

- Coordination des études et recherches : Un protocole d'accord de coopération algéro-tunisienne en matière minière a été signé le 18 avril 1971 entre la SONAREM, l'Office National des Mines, la SOTEMI, la Société Penaroya de Tunisie, la compagnie des phosphates de Gafsa et les industries chimiques maghrébines en vue de :

. échanger des expériences sur la politique générale de gestion et de développement du secteur minier ;

. coopérer pour la levée des cartes

géologiques des régions frontalières ;

. coopérer pour la recherche des minerais ferreux et non ferreux sur les sites d'intérêts communs ;

. coopérer en matière d'études de valorisation des phosphates de la sédirose et du spath fluor.

B.8 - Industries de matériaux :
Accord signé avec la Tunisie :
26 février 1972.
Coopération industrielle envisagée dans les secteurs a) matériaux de construction, et b) céramique.

BURUNDI

NOTES EXPLICATIVES INDIQUEES SUR LES MATRICES

(1) a) FOREAMI :
Recherche sur divers microbes (chancres syphilitiques, gonocoque, staphylocoques) et des antibiogrammes.

b) LABORATOIRE MEDICAL :
Analyse du sang.

(2) MUSEE DE GITEGA :
Rôle social et historique des objets du Musée.

(3) PLANTATION DE THE DE TEZA :
a) Bouturo-greffage (ingénieur : E. Baradandikanya).

b) Essai-international sur le riz et régional sur le maïs.

c) Variétés testées au Burundi : riz, maïs

d) Recherche sur le thé et le café, coton, pomme de terre.

e) Huile de coton, palmier, ricin.

(4) SERVICES :
a) Géologie et Mines.
b) Service des cadastres.
c) Bureau central technique.

(5) REGIDESO :
Service d'approvisionnement en énergie électrique et en eau.

(6) SERVICE DE LA GEOLOGIE ET MINES :
Carte géologique du Burundi recherche minière.

(7) SERVICE D'HYDROLOGIE AGRICOLE :
Recherche hydrologique du lac Tanganyika.

(8) SERVICE DE L'AGRONOMIE :
Thé, coton, café, canne à sucre, riz, pomme de terre, blé.

(9) SERVICE DES EAUX ET FORETS :
Service de pêche : recherche halieutique.

(10) SERVICE DE LA METEOROLOGIE :
Hydrométéorologie sur le bassin du Haut-Nil.

(11) MINES DE KARONGE :
- Basnésite (terres rares),
- Murehe : Wolfram.

(12) Croisement de races de bovins, porcs, volailles.

(13) Mouche tsé-tsé, rats, taupes.

(14) Etat sanitaire : maladie des animaux, production de vaccins, surveillance de la situation épizootique.

AUTRES NOTES EXPLICATIVES

Notes générales sur les recherches et services techniques et scientifiques :

MATRICE A

Très peu de recherches par disciplines. Certains professeurs d'universités commencent seulement à s'intéresser séparément aux recherches dans l'une ou l'autre discipline.

Domaine : Mathématique,
Botanique,
Anthropologie culturelle.

La coopération est très faible.

N.B. : Il existe depuis le début de l'année 1973 un service d'informatique.

MATRICE B

Des recherches s'effectuent au sein même des services techniques :

Ex. : 1) ISABU.
2) Géologie et Mines (Département).

Voir pour compléments MATRICE C. ci-dessous.

MATRICE C

Services scientifiques et techniques existant :

- Service vétérinaire,
- Laboratoire vétérinaire ;

recherches principales maladies des animaux, production de vaccins, surveillance de la situation épizootique.

Coopération effective Rwanda à envisager :
- Service de l'agronomie,
- Service de recherche : Institut Agronomique du Burundi.
Recherches : essai international sur le riz, projet régional sur le maïs et sur le coton.

Coopération : Zaïre - Uganda - Tchad-Haute-Volta - Kenya.

Recherches : sur le thé.

Coopération : Uganda - Kenya - Rwanda - Zaïre.

Recherches : sur le café.

Coopération : Zaïre.

Recherches : sur la canne à sucre.

- Service d'Hydrologie Agricole : Recherches hydrologiques du Lac Tanganyika.

Coopération : Zambie - Zaïre - Tanzanie.

Lac Victoria : Coopération Zaïre - Tanzanie, Rwanda - Uganda - Kenya - Soudan - Egypte - Ethiopie.

Bassin de la Kagera : Coopération : Tanzanie - Rwanda.

- Service du Génie rural :

Recherches : néant.

- Service de pêche : Recherches halieutiques. Coopération effective : Tanzanie.
- Service des Eaux et Forêts : Recherches : Sylviculture Coopération effective : néant.
- Service de l'élevage : Recherches : croisement des races exotiques. Coopération effective : Kenya - Uganda.
- Service de la Santé Animale : Recherches : éradication de la mouche tsé-tsé. Coopération effective : Tanzanie.

EXPLANATORY NOTE

(1) The Department of Botany of Yaounde University co-operates with institutions in these countries on exchange of botanical specimens, information and documentation.

(2) The National Geology Department wishes to co-operate with similar institutions in these countries on mineral and petroleum research.

(3) The National Agriculture Research Centre at Ekona co-operates with Nigeria and hopes to do so with Congo in exchange and laboratory analyses of soil and other biological specimens.

(4) The Piscicultural Research Centre of Ladja in Bangui is jointly run by these countries. Exchanges of information and fingerlings are carried out.

(5) Co-operation with these countries in the areas of tapping subterranean water, irrigation of arid land and training of water engineers.

(6) Exchange of seeds and improved vegetative materials is going on with researchers in these countries.

(7) Dr. Lantum of the Faculty of Medicine in Yaounde University hopes to co-operate with Lagos University in this field.

(8) Professor Victor N. Ngu is co-operating with Ibadan University in the chemotherapy of cancer research.

(9) The National Statistics and accounting services co-operate in running a common computer centre in Gabon doing research in budgeting, and national income accounting.

(10) All the countries of O.A.U. co-operate with each other in protecting crops through Inter-African Phytosanitary Commission based in Yaounde Cameroon.

(11) Dans le cadre de l'Organisation mondiale de la Météorologie, il existe des liens de coopération avec tous les pays africains :
- échange d'informations de routine
- informations à la demande.

(12) Ecole pour la formation des spécialistes de la faune sauvage de Gatona - Ecole nationale à vocation régionale.

(projet PNUD/FAO : 1 000 000 $ PNUD
750 000 $ Gouvernement)
Durée 5 ans - 1969-1975.

6 experts + 2 homologues.

Formation
Côte d'Ivoire, Gabon, Mali, Niger, RCA, Sénégal, Tchad, Togo, Zaïre
+ commencement recherche ?

Additional Explanatory Note

MATRIX A

A.4.1 - Botany : The Professors of the Department of Botany in Congo wish to co-operate with their counterparts in the University of Yaoundé.

A.4.6 - Entomology : O.R.S.T.O.M. and the Ecole Nationale Supérieure Agronomique (E.N.S.A.) hope to co-operate with Universities in other countries on insect research.

A.7.1 - Agronomy (général) : E.N.S.A., Yaoundé ; I.R.A.T., Bambui ; the Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux (I.E.M.V.T.) Wakwa and Bambui cooperate with these countries in forage plants, seed production and tuber crop research.
E.N.S.A., Yaoundé cooperates with these countries in pig nutrition using rejected bananas from industrial plantations.

A.7.4 - Animal breeding : I.E.M.V.T. cooperates with the researchers in the Laboratory of Farcha in Fort Lamy, Chad, in disease diagnosis, laboratory analysis of specimens and vaccine development.

A.7.7 - Agricultural entomology : I.F.C.C. and E.N.S.A. exchange information and specimens for insect identification, anatomy and morphology with researchers of these countries.

A.8.4 - Epidemiology : O.R.S.T.O.M. wishes to cooperate with sister institutions in these countries on Tse-Tse fly and Mosquito research by exchanging researchers and information.

MATRIX B

B.1.1 - Agricultural mechanics and engineering : The department of Rural Engineering and Agricultural Mechanisation of the Ministry of Agriculture cooperates with this country in obtaining the objectives indicated.

B.1.5 - Crop storage and preservation : The Chad Basin Commission grouping Cameroon, Nigeria, Chad and Niger is carrying out work in this area.

B.1.10 - Pasture management : I.E.M.V.T. in Cameroon cooperates with the same institute in these countries in exchange of materials, information and technique of pasture usage.

B.1.11 - Pest control : The International Organization for the Struggle Against the African Locust links the Cameroon with these countries in research for means and methods of controlling locust.

MATRIX C

C.1.3 - Services de cartographie et de photogrammétrie : Les services de cartographie et de photogrammétrie ne sont pas distincts des services de cartographie scientifique.
Les échanges de cartes et de renseignements se font avec les pays voisins.

C.1.6 - Services hydrologiques : Le Service du Génie Rural coopère avec les autres Etats africains dans le cadre du Comité Inter-Africain des Etudes Hydrauliques (CIEH).

C.4.7 - Laboratoires de contrôle des médicaments : Coopération dans le cadre de la Commission du Bassin du Lac Tchad, notamment par la fourniture des vaccins du Laboratoire de FARCHA.

C.5.4 - Services des forêts : Le Service Forestier souhaite coopérer avec la RCA, le Gabon, le Congo, dans les domaines législatif, économique et fiscal.

CONGO

MATRICE A

A.2 SCIENCES PHYSIQUES

A.2.2 . Cristallographie
et
A.2.9 . Optique
a) Institution concernée : Département des sciences physiques à

l'Ecole Supérieure des Sciences de l'Université de Brazzaville.

b) Cadres : 1 maître de Conférences,
1 maître assistant agrégé,
2 techniciens.

c) Equipement : suffisant.

d) Remarques : le laboratoire désire coopérer avec n'importe quelle institution qui travaille dans les mêmes domaines.

A.4 SCIENCES BIOLOGIQUES

A.4.1 . Botanique

a) Institution concernée : Laboratoire de Botanique de l'Ecole Supérieure des Sciences de l'Université de Brazzaville.

b) Cadres : 3 (2 Congolais, 1 expatrié).

c) Equipement : suffisant pour histologie, palynologie et écologie.

d) Remarques : Le programme porte sur :
- L'étude botanique et écologique des savanes et des forêts,
- L'étude pollinique des Connaracées,
- La confection des lames de référence de pollen frais,
- La confection d'un herbier.

A.4.6 . Entomologie

A.4.9 et A.4.11 . Zoologie

a) Institution concernée : Département de Zoologie et de Physiologie animale de l'Université de Brazzaville.

b) Personnel :
Biologie et systématique des Phlébotomes (Diptères)
Mme G. Vattier-Bernard, Maître de Conférences,
Mme M.F. Laurentin, Technicienne,
M. F. M'Poutou, Technicien.

Etude histologique et physiologique de la neurosécrétion
M. J.P. Grillot, Maître-assistant,
Mme P. Samba, Technicienne (histologie),
M. C. Morin, Technicien à temps partiel.

c) Travaux :
Biologie et systématique des Phlébotomes (Diptères)
Thèse d'Etat "Etude systématique et biologique des Phlébotomes cavernicoles en Afrique intertropicale" et une douzaine de publications sur le même sujet.

Etude histologique et physiologique de la neurosécrétion
Travaux entrepris dans le cadre d'une thèse d'Etat (une douzaine de publications) portant plus particulièrement sur les organes neurohémaux associés à la chaîne nerveuse ventrale des insectes.

d) Collaboration : souhaitable avec des laboratoires ayant des spécialistés homologues.

e) En projet : Monographie d'une crevette d'eau douce d'intérêt économique (notamment bio-écologie et étude de la neuro sécrétion).
M. E. N'Kouka, Assistant.

A.5 SCIENCES DE LA TERRE ET DE L'ESPACE

A.5.2 et A.5.3 . Sciences de l'atmosphère . Climatologie

a) Institution concernée : Département des Sciences physiques de l'Université de Brazzaville.

b) Cadres : 1 Maître assistant (expatrié) prépare une thèse d'Etat.

c) Equipement : suffisant.

A.5.7 . Géologie

a) Institution concernée : Laboratoire de Géologie de l'Ecole Supérieure des Sciences à l'Université de Brazzaville.

b) Personnel : 3 cadres, 1 technicien

c) Equipement : Une bibliothèque unique en Afrique centrale, une collection de roches de tout premier ordre.

d) Remarques : Les recherches concernent le domaine de la sédimentologie maritime et fluviale.

A.8 SCIENCES MEDICALES

Travaux de R et D : au Laboratoire national de Santé Publique (L.N.S.P.) et : à l'Hôpital Général de Brazzaville (H.G.)

A.8.2 . Bactériologie

a) Institution concernée : L.N.S.P.

b) Cadres : 1 Médecin bactériologiste

c) Equipement : Satisfaisant.

d) Remarques : Le travail dans les domaines de la bactériologie et de la virologie doit être renforcé.

A.8.4 . Epidémiologie

a) Département responsable : Service des grandes endémies.

b) Cadres : 2 Médecins à Brazzaville (il existe d'autres centres à l'intérieur du pays : Pointe-Noire, Dolisie, etc.).

c) Equipement : Satisfaisant.

A.8.7 . Médecine interne (et autres disciplines)

a) Institutions concernées : H.G. de Brazzaville et Maternité Blanche Gomez à Brazzaville.

b) Cadres : en nombre suffisant.

c) Equipement : Satisfaisant.

A.8.9 . Pathologie
et
A.8.13 . Chirurgie

a) Institutions concernées : L.N.S.P et H.G.

b) Cadres : 2 chirurgiens,
1 Anatomo-pathologiste.

c) Equipement : Satisfaisant.

A.8.10 . Pharmacologie, Chimiothérapie
et
A.8.14 . Toxicologie

a) Institution concernée : L.N.S.P.

b) Cadres : 1 Agrégé de Médecine,
1 Docteur en Pharmacie,
des Techniciens.

c) Equipement : Excellent.

A.10 SCIENCES HUMAINES ET SOCIALES

A.10.5 . Démographie et population

a) Institution concernée : Ecole supérieure des Lettres de l'Université de Brazzaville.

b) Cadres : 7 chercheurs.

c) Equipement : Une cartothèque comprenant de nombreuses cartes topographiques du Congo et des pays voisins ; une collection de photographies aériennes (pays tropicaux) ; des moyens d'utilisation de véhicules pour les études pratiques sur le terrain. Il est possible également d'accéder au laboratoire de géologie de l'Ecole des sciences et aux laboratoires de l'ORSTOM à Brazzaville.

d) Remarques : Les domaines spécifiques de travaux de la R et D sont la géographie urbaine et rurale, la géographie économique et la géographie physique.

A.10.9 . Linguistique
et
A.10.11 . Philologie

a) Institution concernée : Département des Sciences humaines de l'Ecole Normale Supérieure de Brazzaville (ENS).

b) Cadres : 1 Maître assistant,
Plusieurs techniciens.
(Ce personnel comprend 2 Congolais et 3 Français, dont 2 linguistes et 1 spécialiste d'ancien français).

c) Equipement : Très modeste.

d) Remarques : Un centre de linguistique et de littérature orale (C.L.A.L.O.) a été créé en décembre 1972. Il est en pleine installation. Un programme a été élaboré.

A.10.10 . Pédagogie

a) Institution concernée : Institut national de recherche et d'action pédagogique.

b) Cadres : 20 Congolais et 18 expatriés.

c) Equipement : diapositives, radiodiffusion scolaire, cinéma (1 projecteur), nagra, magnétophone, bibliothèque, équipement pour reproduction et photocopie des documents, cartes éducatives.

d) Remarques : Travaux de recherche centrés sur les problèmes de langage et d'apprentissage de la lecture.

MATRICE C

C.3 MUSEES ET COLLECTIONS SCIENTIFIQUES

A.C.3 . Collections entomologiques
et
A.C.9 . Collections zoologiques

a) Institution concernée : Université de Brazzaville.

b) Cadres : M. J.P. Grillot, Maître-assistant responsable,
MM. C. Morin et G. Bilafou,

Techniciens en entomologie (temps partiel),
M. H. Miambanzila, Taxidermiste.

c) Etendue des collections :
Entomologie : 20 000 spécimens de Lépidoptères (collecte systématique) (Rhopalocères, Atacidae, Sphingidae).

Vertébrés : 300 mammifères, 1 000 oiseaux,
300 reptiles, 100 batraciens,
200 poissons.

d) Remarques :
Entomologie : Travaux sur les Cerambycidae en préparation.

e) Coopération souhaitée : Sous forme d'échanges de matériel avec les spécialistes de diverses institutions, en particulier des pays limitrophes.

DAHOMEY

MATRICE A

Des recherches dans divers domaines couverts par la Matrice "A" sont effectuées par plusieurs départements (ou facultés) de l'Université du Dahomey à Cotonou. Contacter le Rectorat de l'Université du Dahomey, B.P. 526 à Cotonou pour se mettre en rapport direct avec les instituts, les professeurs et les assistants se consacrant à ces travaux.

Ces secteurs intéressent le Dahomey dans un proche avenir. Leur création à l'Université du Dahomey fait actuellement l'objet d'une étude profonde au Ministère de l'Education et de la Culture.

MATRICE B

Les organismes privés ou semi-privés envisagent une coopération.

MATRICE C

Divers services dépendent du Ministère du Développement Rural. On peut obtenir des renseignements à leur égard en écrivant au :

Ministère du Développement Rural
PORTO-NOVO
(Dahomey).

EGYPT / EGYPTE

General explanatory notes

(a) All African countries are members of the World Meteorological Organization, under whose auspices there is co-operation in the atmospheric sciences, and continuous and daily co-operation in the meteorological services.

(b) The so-called Nubian Sand-Stone Basin is of joint interest to Egypt, Libya, Sudan and Chad.

(c) There exist agreements between Egypt and the countries indicated in the Tables for Matrix C, concerning water supply services.

(d) The Arab countries of Africa take part in the activities of the Arab Organization for Standardization and Metrology (ASMO).

GHANA

Explanatory note (1)

I. AGRICULTURE

AGRICULTURAL MECHANICS AND ENGINEERING

Ghana has not been engaged in research projects involving agricultural mechanics and engineering but the University of Science and Technology and the University of Ghana have engineering faculties which should serve as centres for work in this field. Research work in this field is therefore intended and Ghana would be willing to co-operate with other countries where such projects have been well-established.

1. CROP PRODUCTION

Considerable work has been done in Ghana to augment crop production in the country. This area of co-operation is top in the national endeavour.

Institutions

The Institutions engaged in research on increased crop production in Ghana are as follows :

i. Crops Research Institute (CSIR)
Headquarters - P.O. Box 3785
Kumasi. Established 1963.

ii. Cocoa Research Institute of Ghana
Headquarters - P.O. Box 8
Tafo. Formerly West Africa Cocoa
Research Institute.

iii. Faculty of Agriculture
University of Ghana
P.O. Box 68, Legon, Accra
Established 1948

iv. Faculty of Agriculture
University of Science and Technology
Kumasi. Established 1953.

v. Ministry of Agriculture
Headquarters - P.O. Box M.37
Accra.

vi. Soil Research Institute,
Academy Post Office, Kwadaso, Kumasi

Key Researchers, co-operating countries and priority rating

Information on key researchers in Ghana, co-operating countries and priority rating for the various crops is indicated below :

(a) Cereal Crops

Key Researchers

Mr. M.K. Akposoe, B. Sc., **M.Sc. - Maize Breeding.**
Crops Research Institute, P.O. Box 3785, Kumasi.

Mr. H. Mercer-Quarshie, B.Sc.,M.Sc.
Sorghum and Millet Research
Crops Research Institute
P.O. Box 3785, Kumasi.

Dr. J.E. Quansah, B.Sc., M.Sc., Ph.D. - Rice Research
Crops Research Institute
P.O. Box 52, Nyankpala via Tamale

Mr. E.J.A. Khan, B. Sc., M.Sc., - Rice Research
University of Ghana
Agric. Irrigation Research Station
P.O. Box 9, Kpong

Mr. A.N. Ayeetey, B.Sc., M.Sc. - Rice Research
Agric. Irrigation Research Station
P.O. Box 9, Kpong.

Existing co-operation on cereal crop research

In the field of cereal crops, Ghana co-operates in carrying out regional projects in West Africa as follows :

(i) Cereal project - JP.26 - Under OAU/STRC (See explanatory note 19)

(ii) Co-ordinated Rice Trials : Under West African Rice Development Association (WARDA)) See explanatory note 19

Desired countries for co-operation

See explanatory note (19) on OAU/STRC J.P.26 and WARDA Co-ordinated Trials.

Priority Rating

Top Priority :

The cereal crops of importance to Ghana include maize, rice, sorghum and millet. By far maize constitutes the most important staple food of Ghanaians and research on the crop is geared towards increase of yield, increase of protein quality and reduction of height to achieve lodging resistance. The protein quality of maize is of great importance so as to solve the malnutrition problems of the country.

Rice comes next to maize in importance. The crop (in particular upland rice) can grow anywhere in Ghana but the drawbacks are low yields under peasant farming, improper agronomic practices, shattering due to time of maturity and the incidence of blast. Efforts are being geared to investigate the above problems and to find solution to them.

Sorghum and millet constitute a large proportion of cereals in the diet of the inhabitants of Northern Ghana. They are also used in the brewing of local beer (Pito) and above all the increasing importance of the poultry industry in Ghana calls for high protein sorghum for preparation of animal feeds. The problem with these crops in Ghana include low yield of local varieties, excessive height which produces lodging and the difficulty of developing synthetics acceptable to local taste and which also mature within the same growing period as the local varieties so as to benefit from the single rainy season of Northern Ghana.

There are facilities for accelerated research work on cereals both in manpower and resources.

(b) Grain Legumes

Key researchers

Mr. H. Mercer-Quarshie, B.Sc., M.Sc.
Crops Research Institute, P.O. Box 3785
Kumasi.

carries out research on groundnuts, cowpeas, soya and sesame.

Mr. A.N. Ayeetey, B. Sc., M.Sc.
University of Ghana Irrigation Research Station
P.O. Box 9, Kpong.

Mr. E.V. Doku, B.Sc., M. Sc.
Faculty of Agriculture
University of Ghana, P.O. Box 68,
Legon, Accra.

Dr. R.B. Dadson, B.Sc., M.A. Econ.,Ph.D
Faculty of Agric., University of Ghana
P.O. Box 68, Legon, Accra.

Desired countries for co-operation

Senegal and Nigeria.

Priority Rating

Top Priority :

Groundnuts, soya beans and cowpeas stand out most in the production objectives of Ghana. Groundnuts constitute an important vegetable oil seed and is used widely in the confectionary trade. There are varieties suitable for each agroclimatic zone of the country. Soya bean, another oil seed has been found to produce commercial yields in Ghana but faces the urgent problem of quick loss of seed viability. The development of these two crops would go a long way to offset the import of vegetable oils into Ghana while by-products of the crops are urgently required for the Animal feed industry.

Cowpeas are widely eaten in Ghana and they help to supplement the protein needs of the people. Here again, facilities exist for intercountry co-operation in research on the crops and other leguminous crops.

(c) Tobacco

Key Researcher

Mr. E.O. Quao, B. Sc., M.Sc.
Crops Research Institute
P.O. Box 3785, Kumasi

Desired countries for co-operation

It is intended to establish co-operation in research on tobacco with Uganda and Malawi when these countries are in a position to do so.

Priority Rating

Medium :

Tobacco growing is achieving great importance in Ghana. The country now produces over 60 % of her requirements. The co-operation desired is basically in the production of the blending type tobacco for various purposes.

(d) Root and Tuber Crops - Yam and Cassava

Key Researchers

Miss A.A. Oppong, B.Sc., M.Sc.
Crops Research Institute, P.O. Box 3785
Kumasi.

Mr. J.A. Otoo, B.Sc., M.Sc.
Crops Research Institute, P.O.Box 3785
Kumasi.

Desired country for co-operation

Nigeria.

Priority Rating

Medium :

Yam and cassava constitute the most important root and tuber crops in Ghana and research work has been going on to produce high yields and to investigate the response of the crops to fertilizer application. Also of importance is the adequate classification of yams through studies on their characteristics and cytology.

(e) Fruits and Vegetables

Key Researchers

Mr. W.S.Y. Abutiate, B.Sc., M.Sc.,
(Research on fruits - pineapples)
Crops Research Institute
P.O. Box 3785
Kumasi

Mr. Francis Agble, B.Sc., M.Sc.
(Breeding work on vegetables- tomatoes)
Crops Research Institute
P.O. Box 3785
Kumasi

Mr. J.C. Norman, M.Sc., DTA -Vegetables
University of Science and Technology,
Kumasi.

Dr. S. Sinnaidurai, B.Sc.,M.Sc.,Ph.D.
- Vegetables -
University of Ghana,
Legon

Mr. S.K. Karikari, M.Sc., - Fruits
University of Ghana,
Legon.

Desired countries for co-operation

Ivory Coast, Cameroon, Kenya, Egypt.

Priority Rating

Top Priority :

Pineapples and tomatoes are two crops in which concentrated research work is being carried out to produce raw materials to feed the local factories established to process them. Ghanaian pineapples are said to rank top most in the world market and can be a good foreign exchange earner.

Local tomato varieties are not suitable for processing due to their low content of solids and efforts are geared towards producing processing type tomatoes for the canneries.

In addition to these two crops, research work is undertaken on various vegetables including citrus, mangoes, onions, etc. There are facilities for expanded research work on the fruits and vegetables.

(f) Fibre Crops

Key Researchers

Mr. S.Y. Amanquatia, B.Sc., M.Sc.,
Plant Selection and Agronomy
Crops Research Institute, P.O.Box 3785
Kumasi.

Mr. O. Nasse
Technical Adviser, Fibre Bag Factory
Kumasi.

Dr. G.F. Nsowah, B.Sc., Dep.Agric. Sci. Ph. D.
Department of Crop Production, UST.
Kumasi.

Desired countries for co-operation

Sierra Leone, Ivory Coast, Dahomey, Nigeria Kenya, Tanzania, Sudan and Congo.

Priority Rating

Top Priority :

A fibre bag manufacturing factory has been established at Kumasi to produce bags particularly for the cocoa industry. Research work on best fibres is producing very promising results and the crops - kenaf, jute and Urena lobata - have been found to grow anywhere in Ghana. Co-ordination in research in this field will go a long way to solving some of the principal problems of quality, yield, ribboning and retting of fibres.

(g) Oil Palm

Key Researchers

Mr. M.A. Adansi, B.Sc., M.Sc.,
Crops Research Institute, P.O. Box 74,
Kade
(Oil Palm Agronomy)

Dr. J. Wonkyi-Appiah, B.Sc., M.Sc.,Ph.D
Crops Research Institute, P.O.Box 74,
Kade
(Oil Palm Breeding)

Desired countries for co-operation

Ivory Coast, Zaïre, Nigeria.

Priority Rating

Top Priority :

Ghana needs over 200 000 tons of oil per year to satisfy industrial as well as domestic needs of the country of which production is now at 20 000 tons. An oil palm research centre has been established at Crops Research Institute station, Kusi, near Kade. Since 1967 the station has expanded her plots to over 450 acres and is now producing all extension type seed requirements of the country. Government programmes of accelerating oil palm cultivation has been fully established and considerable expansion of research activities is called for to meet the demand for improved seeds and to increase the yield, oil content and oil extraction methods.

(h) Rubber

Key Researchers

Dr. A.A. Opoku, B.Sc., M.Sc., Ph.D.
University of Ghana Research Station
Kade.

Mr. S.K. Karikari, M.Sc.
University of Ghana Research Station,
Kade.

Desired countries for co-operation

Liberia, Nigeria, Ivory Coast.

Priority Rating

Medium :

Large areas in the Western Region of Ghana are being cultivated for rubber. A rubber factory has been established which produces some rubber products. Research work has been going on to produce trees with high latex yield and on stock/scion relationship for disease attack. There are facilities at the Aiyinasi experimental station and the University of Ghana station at Kade devoted specifically for research work on the crop.

Premises for research work on Crop Production

The Crops Research Institute is a government organization with its head-quarters at Kwadaso near Kumasi. It has stations distributed all over the various agro-climatic zones in the country as follows :

Moist Semideciduous Forest Zone : Kwadaso - suitable for various crops

Moist Semideciduous Forest Zone : Kusi, Oil Palm Research Centre

Rain Forest Zone : Aiyinasi - Concentrates on Rubber and Coconut.

Rain Forest Zone : on Rubber and Coconut

Guinea Savannah Zone: Nyankpala - cereal crops and legumes - notably rice, sorghum, millet and groundnuts

Sudan Savannah : Manga (Bawku) - Northern cereal crops, vegetables

Coastal Savannah : Ohawu - various crops including cereals and vegetables.

The Nyankpala and Ohawu stations have dam facilities for irrigation purposes and could readily be improved to cover wider areas.

In addition to the above major research stations, there is a good number of field trial stations covering the cross section of the country.

The University of Ghana has stations at Kpong which is provided with irrigation facilities and concentrates mainly on research work on swamp rice and sugarcane ; at Akumening near Kade in the Forest Zone ; and at Nungua on the Accra plains. The UST also has experimental fields near the University campus.

All the major research stations have fairly well equipped laboratories suitable for various purposes and are manned by officers of at least M. Sc. standard. The Cocoa Research Institute is located in the centre of the Cocoa Industry at Tafo but has a number of trial stations all over the forest zone.

2. CROP PROTECTION

Key Researchers : Entomologists

Dr. G.K.A. Buahin, B.Sc., Ph D.,
Crops Research Institute
P.O. Box 3785,
Kumasi.

Dr. M. Agyen-Sampong, B.Sc.,
Dip. Rural Science, Ph.D.
Crops Research Institute,
P.O. Box 3785
Kumasi.

Dr. Y.A. Duodo, B.Sc., M.Sc.
Crops Research Institute
P.O. Box 3785
Kumasi

Mr. B.D. Boakye, B. Sc., M.Sc.
University of Science & Technology
Kumasi

Mr. E. Owusu-Manu, DTA, B.Sc.,M.Sc.
Cocoa Research Institute of Ghana
P.O. Box 8,
Tafo.

Plant Pathologists

Mr. E.A. Addison, B.Sc., M.Sc.
Crops Research Institute
P.O. Box 3785,
Kumasi

Mrs B. Hemang, B.Sc., M.Sc.
Crops Research Institute,
P.O. Box 3785,
Kumasi

Dr. J.S. Kankam, B.Sc., M.Sc., Ph.D.
Department of Crop Production, UST,
Kumasi

Dr. Paul Lamptey, B. Sc., M.Sc.,Ph.D.
University of Ghana, Legon,
Accra

Dr. A. Asare-Nyarko, B.Sc., M.Sc., Ph.D
Cocoa Research Institute of Ghana
P.O. Box 8,
Tafo.

Nematologists

Dr. O.B. Hemeng, B.Sc.,M.Sc.,Ph.D.,
Crops Research Institute,
P.O. Box 3785
Kumasi

Dr. J.C. Gupta, B.Sc.,M.Sc., Ph.D.,
University of Science & Technology,
Kumasi

Desired countries for co-operation

Nigeria, Ivory Coast, Egypt, Kenya.

Priority Rating

Top Priority.

Premises

There are well-equipped laboratories at the Cocoa Research Institute of Ghana, University of Ghana, Crops Research Institute, and the University of Science and Technology.

CROP PROCESSING

No proposals.

3. CROP STORAGE AND PRESERVATION

Key Researcher

Mr. Anthony Ofosu, B.Sc., M.Sc.
Crops Research Institute,
Private Post Bag, Pokoase,
Accra.

Desired countries for co-operation

Nigeria, Ivory Coast.

Priority Rating

Top Priority :

One of the biggest problems facing Ghana is the problem of storage due to rapid infestation of storage pests and fungal diseases. A food storage section has been established at Pokoase as a wing of the Crops Research Institute to cater for the preservation of harvested crops. Achievements to date have been encouraging and inter-country co-operation should help to accelerate results.

Premises

The Food Storage Section of the Crop Research Institute is located at the Institute's Pokoase Station near Accra. There are facilities in the biochemistry departments of the University of Ghana, University of Science and Technology and the Food Research Institute has well equipped laboratories to augment resources for accelerated research in this field.

FARM CONSTRUCTION, EQUIPMENT AND MANAGEMENT - NIL

No research in this field.

4. FERTILIZER UTILIZATION

Key Researchers

Dr. C.S. Ofori, Dipl.- Landwirt,
Dr.Sc. Agr.
Soil Research Institute, Academy Post Office,
Kwadaso, Kumasi.

Mr. A.T. Halm, B.Sc., M.Sc.
Soil Research Institute, Academy Post Office,
Kwadaso, Kumasi

Dr. P.K. Kwakye, Ph. D.,
Soil Research Institute, Academy Post Office,
Kwadaso, Kumasi

Dr. D.K. Acquaye, B.Sc., Ph.D.,
University of Ghana,
Legon

Dr. E.J. Thompson, M.Sc., Ph.D.,
University of Ghana,
Legon

Mr. E.Y. Safo, B.Sc., M.Sc.
Department of Crop Production, UST,
Kumasi.

Desired countries for co-operation

Senegal, Nigeria, Kenya, Sierra Leone, Egypt and Sudan.

Priority Rating

Top Priority :

One of the greatest problems facing soil fertility in Ghana is the rapid loss of soil nutrients in the Savanna areas due to the heavy torrential rains which produce leaching. The productive capacity of the soil has to be restored by use of chemical and organic fertilizers but the peasant farming methods do not appear to be ideal for fertilizer use. Another problem is the determination of fertilizer formulations suitable for different crops under different soil conditions. The farmer is incapable of mixing his own fertilizers and package deals have been devised but which do not conform with the requirements of different soil types and for different crops. Research is therefore going on to establish a broad basis of fertilizer requirements for different crops and there are facilities to determine the type of fertilizers suitable for Ghana soils for the purpose of manufacturing them locally. A co-ordinated research in this field will provide useful information for areas of similar conditions of cropping.

5. IRRIGATION AND DRAINAGE

Key Researchers

Mr. E.J.A. Khan, B.Sc., M.Sc.
University of Ghana AIRS,
P.O. Box 9,
Kpong.

Mr. E.E. Ayeetey, B.Sc., M.Sc.
University of Ghana AIRS,
P.O. Box 9,
Kpong.

Desired countries for co-operation

Egypt, Sudan, Senegal.

Priority Rating

Top Priority :

Practically all areas in Ghana are

suitable for farming at all times but the limiting factor is availability of water specially in Northern Ghana and the poor drainage conditions of the heavy soils of the Accra Plains. Fortunately, the creation of the Volta Lake has provided ideal conditions for developing irrigation systems over large areas of Ghana. There are government plans to develop irrigation system for the Accra plains especially for rice, sugarcane and the vegetable crops of the country. Facilities for research are available at the Agricultural Irrigation Research Station, Kpong, to cater for this. There is also need for research work to determine the irrigation needs for the crops and the drainage pattern of heavy and saline soils of the Accra plains and the Keta areas respectively to render them suitable for crop cultivation.

Premises

Agricultural Irrigation Research Station, Kpong.

NATURAL PESTICIDES

No proposals.

6. PASTURE MANAGEMENT

Key Researchers

Dr. E.O. Asare, B.Sc., M.Sc., Ph.D.,
UST,
Kumasi.

Mr. Adjei Tetteh, B.Sc.,M.Sc.
Animal Research Institute
P.O. Box 20,
Achimota

Dr. J.A. Agyare, B.Sc., Ph.D.
Ministry of Agriculture,
P.O. Box M.37,
Accra.

Mr. M.K. Antwi, B.Sc., M.Sc.
Ministry of Agriculture,
P.O. Box M.37,
Accra.

Mr. F.K. Fianu, B.Sc. M.Sc.
University of Ghana,
Legon.

Dr. R.E. Larsen, B.Sc., M.Sc., Ph.D.
University of Ghana,
Legon.

Desired countries for co-operation

Kenya, Nigeria, Tanzania, Uganda, Zambia.

Priority Rating

Top Priority :

By far the bulk of the meat (cattle, goats, etc.) requirements of the country is imported. Pasture research with a view to producing domestic animals capable of providing the dairy products as well as the animal protein requirements of the country has been undertaken by the Animal Research Institute and the University of Ghana but needs to be supplemented by results obtained in other countries for good animal husbandry.

Premises

Animal Research Institute - Facilities exist at the Pokoase Station, Nyankpala Agricultural Experimental Station, at the University of Ghana Farm, at Manga and at Kpong Irrigation Research Station, Kpong.

7. PEST CONTROL

As 2. above.

SAVANNAH MANAGEMENT

No proposals.

8. SOIL MANAGEMENT

Key Researchers

Dr. H.B. Obeng, B.Sc., M.Sc., Ph.D.,
Soil Research Institute,
Academy Post Office,
Kwadaso, Kumasi

Dr. S.V. Adu, B.Sc., Ph.D.
Soil Research Institute,
Academy Post Office,
Kwadaso, Kumasi

Dr. G.K. Asamoah, B.Sc., M.Sc., Ph.D.
Soil Research Institute,
Academy Post Office,
Kwadaso, Kumasi

Mr. J.A. Mensah-Ansah, B.Sc.
Soil Research Institute,
Academy Post Office,
Kwadaso, Kumasi

Mr. E. Bruce-Okine, B.Sc., M.Sc.
Soil Research Institute,
Academy Post Office,
Kwadaso, Kumasi

Mr. F.S. Ablorh, B.A., M.Sc.
University of Science and Technology,
Kumasi

Dr. E. Baffoe-Bonnie, B.Sc., M.Sc.,Ph.D
University of Science and Technology,
Kumasi

Dr. D.K. Acquaye, B.Sc., Ph.D.
University of Ghana,
Legon.

Desired countries for co-operation

Nigeria, Dahomey, Togo, Ivory Coast, Egypt.

Priority Rating

Top Priority.

Premises

There are well equipped laboratories at the Soil Research Institute and at the Faculties of Agriculture, UST and University of Ghana, Legon and facilities exist at the Agricultural Experimental Stations in the country.

9. WEED CONTROL

Key Researchers

Dr. K.A. Haizel, B.Sc., Ph.D.
University of Ghana,
Legon

Mr. A.G. Carson, B.Sc., M.Sc.
Crops Research Institute,
P.O. Box 3785,
Kumasi

Mr. M.A. Adansi, B.Sc., M.Sc.
Crops Research Institute,
P.O. Box 74,
Kade

Mr. M.K. Akposoe, B.Sc., M.Sc.
Crops Research Institute,
P.O. Box 3785
Kumasi

Desired countries for co-operation

Nigeria, Ivory Coast.

Priority Rating

Top Priority :

Perhaps one reason why Ghanaian farmer is poor is due to lack of adequate weed control to augment his crop yield under traditonal methods of farming. Several weedicides are under investigation with various crops and concerted effort by several countries will go a long way of solving the food problem in Africa.

Premises

All agricultural experimental stations in the country.

Explanatory note (2)

II. FORESTRY

Institutions

The Institutions in Ghana concerned with Forestry activities are as follows :

i. The Forest Products Research Institute of the Council for Scientific and Industrial Research - Headquarters - P.O. Box 63, University Post Office, Kumasi,Ghana.

ii. Department of Forestry, Post Office Box 527, Accra.

The Department of Forestry is divided into 4 main disciplines comprising : Forest Conservation and Management, Planning Branch, Silvicultural Branch and the Forest Utilization and Timber Service Branch.

10. FOREST CONSERVATION

There has not been any research work on conservation but facilities exist at forest districts in the Forest zone of Ghana.

Staff available

Mr. J. François, B.Sc., - Chief Conservator of Forests -
P.O. Box 527,
Accra

Mr. K. Kesse, B.Sc., Deputy Chief Conservator of Forests
P.O. Box 527,
Accra

Mr. J.F. Baidoo, M.A., Conservator of Forests,
P.O. Box 1917,
Kumasi.

Desired countries for co-operation

Gabon, Ivory Coast.

Priority Rating

Medium.

Indiscriminate destruction of natural forests has upset the ecological balance of many areas of the world. This apart from altering the seasonal changes has resulted in soil erosion and soil degradation with a resultant drop in food production. The Department of Forestry in Ghana has a responsibility of ensuring the perpetuation of forest cover over areas dedicated for forestry work but there is need for a co-ordinated effort to study the best way of exploitation of these forests so as to maintain the ecological balance, save the natural flora from extinction as well as ensure the continuous production of timber and forest products for the benefit of posterity.

11. FOREST EXPLOITATION

No Research on this subject but practices exist.

Staff available

Mr. J.F. Baidoo, M.A., Working Plan Officer,
Depatment of Forestry,
P.O. Box 1917,
Kumasi

Mr. Baidoo is assisted by other professional staff in controlling exploitation in Forest reserves.

Desired countries for co-operation

Gabon, Ivory Coast.

Priority Rating

Top Priority.

12. FOREST PRODUCTS

Key Researchers

Mr. E.W. Addo-Ashong, B.Sc., M.Sc.
Forest Products Research Institute,
Kumasi

Mr. W.K. Ashiabor, B.Sc., M.Sc., D.T.C.
Forest Products Research Institute,
Kumasi

Mr. N.A. Darkwa, B.Sc., M.Sc.
Forest Products Research Institute,
Kumasi

Desired countries for co-operation

Gabon, Nigeria, Dahomey, Ivory Coast, Somalia.

Priority Rating

Top Priority.

13. FOREST PROTECTION

Key Researchers

Dr. A.O. Asiedu, B.Sc., M.Sc., Ph.D.,
Forest Products Research Institute,
P.O. Box 63,
UST, Post Office
Kumasi

Mr. S.K.N. Atuahene, B.Sc., M.Sc.
Forest Products Research Institute,
P.O. Box 63,
UST. Post Office,
Kumasi

Mr. A. Teyegaga, B.Sc., M.Sc.
Forest Products Research Institute,
P.O. Box 63,
UST. Post Office,
Kumasi

Mr. Mensah Bonsu, B.Sc., M.Sc.
Forest Products Research Institute,
P.O. Box 63,
UST. Post Office,
Kumasi

Desired countries for co-operation

Gabon, Guinea, Ivory Coast, Lesotho, Nigeria.

Priority Rating

Top Priority.

Premises

Forest Products Research Institute.

14. SYLVICULTURE

Key Researchers

Dr. A.K. Tuffour, B.Sc., M. Sc., Ph.D.
Forest Products Research Institute
University P.O. Box 63,
Kumasi

Mr. S.P.K. Britwum, B.Sc., M.Sc.
Forest Products Research Institute,
Kumasi

Mr. J.Y. Atakora, B.Sc., M.Sc.
Forest Products Research Institute
Kumasi

Mr. Okyere-Boateng, B.Sc., M.Sc.,
Forest Products Research Institute,
Kumasi

Mr. J. Brookman-Amissah
Department of Forestry,
P.O. Box 1917
Kumasi

Desired countries for co-operation

Gabon, Guinea, Ivory Coast, Lesotho, Nigeria.

Priority Rating

Top Priority.

Premises

Forest Products Research Institute.

Explanatory note (3)

III. ANIMAL HUSBANDRY

Institutions and Premises

i. Animal Research Institute of the Council for Scientific and Industrial Research (CSIR)
P.O. Box 20,
Achimota

ii. Department of Animal Science
University of Ghana,
P.O. Box 68,
Legon, Accra.

iii. Division of Veterinary Services
Ministry of Agriculture,
P.O. Box M.161,
Accra.

iv. Faculty of Agriculture
Animal Husbandry Division, UST,
Kumasi

(a) ANIMAL HEALTH AND DISEASE CONTROL - POULTRY DISEASES

Key Researchers

Mr. L. Nutor - DVM, MV. Sc.,M.R.C.V.S.
Animal Research Institute,
P.O. Box 20,
Achimota

Dr. R.K.O. Assoku - BVMS, MRCVS, Ph.D.
University of Ghana,
Legon

Mr. J.D. Corkish, B.V.Sc., MRCVS
Veterinary Laboratory, Division of
Veterinary Services,
P.O. Box M.161,
Accra - Poultry Diseases

Dr. E.N.W. Oppong, BVSM, MRCVS, Ph.D.
University of Ghana,
Legon

Mr. E.W. Agudu, B.Sc., M.Sc.
Animal Research Institute,
P.O. Box 20,
Achimota - Poultry Diseases.

Desired countries for co-operation

Nigeria, Togo, Ivory Coast, Kenya, Uganda, Egypt, Sudan, Ethiopia.

Priority Rating

Top Priority.

Premises

Animal Research Institute, P.O. Box 20, Achimota, Ghana.

(b) ANIMAL HEALTH AND DISEASE CONTROL

Key Researchers

Mr. D. Sarpong, B.Sc., M.Sc.,
Animal Research Institute
(Identification, Mapping out of helminth parasites of domestic animals)

Dr. A.J. Bucknor
Animal Research Institute
(Identification, Mapping out of helminth parasites of domestic animals)

Desired countries for co-operation

Ivory Coast, and Togo.

Priority Rating

Medium.

Premises

Animal Research Institute, P.O. Box 20, Achimota, Ghana

(a) ANIMAL PRODUCTION - HUSBANDRY AND NUTRITION OF POULTRY

Key Researchers

Dr. E.W. Agudu, B.Sc., M.Sc.
Animal Research Institute,
P.O. Box 20,
Achimota

Mr. A.G. Kesse, B.Sc., M.Sc.
University of Science and Technology,
Kumasi

Mr. B. Williams, B.Sc., M.Sc.
University of Ghana,
Legon

Mr. B.L. Nutor, DVN, M.V.Sc., MRCVS,
Animals Research Institute,
P.O. Box 20,
Achimota

Dr. R.E. Larsen, B.Sc., M.Sc., Ph.D.,
University of Ghana,
Legon.

Desired countries for co-operation

Nigeria, Ivory Coast, Kenya, Uganda, Egypt, Ethiopia, Sudan.

Priority Rating

Top Priority.

Premises

Animal Research Institute, Achimota ; University of Ghana, Legon ; University of Science and Technology, Kumasi.

(b) ANIMAL PRODUCTION - NUTRITION RUMINANTS

Key Researchers

Dr. R.E. Larsen, B.Sc., M.Sc., Ph.D.,
University of Ghana,
Legon.

Dr. John Burton, Ph.D.
University of Ghana,
Legon

Mr. E.K. Assey
Animal Research Institute,
P.O. Box 20,
Achimota

Desired countries for co-operation

Nigeria.

Priority Rating

Top Priority.

Premises

Animal Science Department, University of Ghana, Legon ; Animal Research Institute, P.O. Box 20, Achimota.

(c) ECONOMICS OF ANIMAL PRODUCTION

Key Researchers

Mr. S.Y. Atsu, B.Sc., M.Sc., ISSE
University of Ghana,
Legon

Mr. S.K. Awuah, B.Sc., M.Sc.
University of Science and Technology,
Kumasi

Mr. K. Amonoo, B.Sc., M.Sc.
Animal Research Institute,
P.O. Box 20,
Achimota

Desired countries for co-operation

Kenya, Malawi, Nigeria, Tanzania, Uganda, Sudan, Ethiopia.

Priority Rating

Medium.

Premises

Facilities exist at the Animal Research Institute and the Agriculture Faculties of the University of Ghana, Legon and UST, Kumasi.

17. ANIMAL PRODUCTS - POULTRY PRODUCTS

Key Researchers

Mr. E.W. Agudu, B.Sc., M.Sc.,
Animal Research Institute,
P.O. Box 20, Achimota

Mr. A.G. Kesse, B.Sc., M.Sc.
Animal Production Department
University of Science and Technology
Kumasi

Dr. R.E. Larsen, B.Sc., M.Sc., Ph.D.
University of Ghana,
Legon

Mr. B. Williams, B.Sc., M.Sc.
Food Research Institute,
P.O. Box M.20,
Accra

Miss A. Anna-Abban, B.Sc., M.Sc.
University of Ghana,
Legon

Desired countries for co-operation

Nigeria, Ivory Coast, Kenya, Uganda, Egypt, Ethiopia, Sudan.

Priority Rating

Top priority due to shortage of animal protein. The amount of animal protein in the diet of Ghanaians is relatively small. The tsetsefly has limited the varieties of cattle to be managed in many parts of the country. The poultry industry has of late achieved considerable success but needs to be supplemented with research results.

ANIMAL REPRODUCTION

No proposals.

(a) ANIMAL SELECTION

Key Researchers

Dr. R.E. Larsen, B.Sc., M.Sc., Ph.D.
University of Ghana,
Legon

Dr. E.N.W. Oppong, BVSM, MRCVS, Ph.D.
University of Ghana,
Legon

Desired countries for co-operation

Nigeria, Togo, Ivory Coast, Kenya, Uganda, Sudan, Egypt, Ethiopia.

Priority Rating

Top Priority.

Explanatory note (4)

IV. FISHERIES AND WILDLIFE

Institutions and Premises

The available Institutions in Ghana include :

i. The Food Research Institute of the Council for Scientific and Industrial Research (CSIR)
P.O. Box M.20
Accra

ii. Food Science Department,
University of Ghana,
Legon

iii. Volta River Basin Research (UNDP) Project,
Akosombo

iv. Fisheries Department of the Ministry of Agriculture

v. Department of Game and Wildlife

vi. Institute of Acquatic Biology.

18. FISH FINDING - FISHERIES BIOLOGY AND TECHNOLOGY

Key Researchers

Mr. Martin A. Mensah, B.Sc.
Fisheries Research Unit
Ministry of Agriculture
Accra

Mr. L. Amoo, B.Sc.
Fisheries Research Unit
Ministry of Agriculture
Accra

Miss Emilia Annan, B.Sc.
Fisheries Research Unit
Ministry of Agriculture
Accra

Desired countries for co-operation

Republic of Togo, Dahomey, Nigeria, Ivory Coast, Uganda, Tanzania, Malawi, Guinea, Senegal, Gambia.

Premises

Fisheries Research Unit, Ministry of Agriculture, Accra.

Priority Rating

Top Priority .

19. FISH FARMING

Key Researchers

Mr. Eric A. Kwei, B.Sc., M.Sc.
Mr. Miloe Ansah-Emmin, B.Sc.
Mr. Don Quaynor, B.Sc.
Mr. R.O.A. Osae, B.Sc.
Chief John Vanderpuje, B.Sc., M.Sc.
Mr. Charles Asafo, B.Sc., M.Sc.

Fisheries Research Unit, Ministry of Agriculture, Accra.

Desired countries for co-operation

Republic of Togo, Dahomey, Ivory Coast, Nigeria.

Premises

Fisheries Research Unit, Ministry of Agriculture, Accra.

Priority Rating

Top Priority.

20. FISH PRESERVATION AND PROCESSING

Miss G. Okraku-Offei, B.Sc. (Hons),
Food Research Institute,
Accra

Miss L. Amu, B.Sc., M.Sc.
Food Research Institute,
Accra

Mr. J.N.N. Adjetey, B.Sc., M.Sc.
Ministry of Agriculture,
Accra

Mr. V.N. Dowuona, B.Sc., M.Sc.
Ministry of Agriculture,
Accra

Mr. K.O. Watanabe
UNDP Expert, Volta Basin Research Unit,
Akosombo

Mr. E.M. Mensah,
Volta Basin Research Unit,
Akosombo

Desired countries for co-operation

Republic of Togo, Dahomey, Nigeria, Uganda, Tanzania, Malawi.

Priority Rating

Top Priority.

Premises

Food Research Institute, Accra ; Volta Basin Research Unit, Akosombo ; and Food Science Department, University of Ghana, Legon.

FISH PROCESSING

As in 20 above.

21. FISHING BOATS AND GEAR

Key Researchers

Mr. F. Abayo - Boatyard Div. of GIHOC
Tema Boatyard
Corp., Tema

Mr. P. Dinglasson, FAO
Fisheries Expert
Tema Boatyard
Corp., Tema.

Mr. Dan. Qyuaynor, B.Sc.,
Fisheries Research Unit,
Ministry of Agriculture

Desired countries for co-operation

Togo, East African countries.

Priority Rating
Top Priority.

22. WILDLIFE CONSERVATION AND MANAGEMENT

Key Researcher

Mr. E.O. Asibey, B.Sc.
Dept. of Game and Wildlife,
P.O. Box M.239,
Accra

Desired countries for co-operation

Ivory Coast, Kenya.

Priority Rating
Medium.

Premises

Games and Wildlife Division, Department of Parks and Gardens,
P.O.Box M.239,
Accra.

Explanatory note (5)

V. FOOD, DRINKS AND TOBACCO INDUSTRIES

Institutions and Premises

The Institutions in Ghana concerned with this field of research comprise the following :

i. Food Research Institute of the Council for Scientific and Industrial Research (CSIR), Headquarters - P.O. Box M. 20, Accra.

ii. Cannery Division of the Ghana Industrial Holdings Corporation, Headquarters, Accra.

iii. Vegetable Oil Mills Division of GIHOC, Headquarters, Accra.

iv. Department of Food Science, University of Ghana, Legon.

v. Animal Research Institute of the Council for Scientific and Industrial Research, Headquarters : P.O. Box 20, Accra.

vi. Animal Science Department, University of Ghana, P.O. Box 68, Legon.

vii. Animal Husbandry Division, Ministry of Agriculture, P.O. Box M.37, Accra.

viii. Livestock Division, University of Science and Technology, Kumasi.

23. ALCOHOLIC BEVERAGES - FLOOR, STARCH SUGAR AND SUGAR CONFECTIONARIES

Key Researchers

Miss A. Amdah, B.Sc., B.Sc. (Hons) M. Phil.

Dr. A.J. Youngs, B.Sc., Ph.D.
Dept. of Food Science,
University of Ghana,
Legon.

Desired countries for co-operation

Senegal - Institut de Technologie

Priority Rating

Medium.

24. ANIMAL FEED - POULTRY AND PIGS

Key Researchers

Mr. E.W. Agudu, B.Sc., M.Sc.,
Animal Institute (Research)

Mr. A.G. Kesse, B.Sc., M.Sc., UST,
Kumasi.

Mr. F.T. Buamah, B.Sc., M.Sc.,
Animal Husbandry Division
Ministry of Agriculture,
Accra.

Mr. B. Williams, B.Sc., M.Sc.
Animal Science Dept.,
University of Ghana,
Legon.

Dr. D.O. Andah, B.Sc., D.Ag.Sc.,Ph.D., M. Biol.,
Animal Research Institute
Achimota.

Dr. C.W. Cameron, B.Sc., Ph.D.
Animal Science Dept.,
University of Ghana.

Mr. A.K. Tuah, B.Sc., M.Sc.
Livestock Division, UST,
Kumasi.

Desired countries for co-operation

Nigeria, Kenya, Uganda, Sierra Leone.

Priority Rating
Top Priority.

DAIRY PRODUCTS

No research in this field, but Ghana will be anxious to co-operate with the following countries : Republic of Togo, and East African countries.

25. EDIBLE OILS AND FATS

Key Researcher

Mr. J.B.K.A. Ata, B.Sc., M.Sc.,
Food Research Institute (Fats & Oils).

Desired countries for co-operation

Ivory Coast, Dahomey, Nigeria, Zaïre.

Priority Rating
Medium.

FLOUR, STARCH AND SUGAR
No proposals.

FOOD ADDITIVES
No proposals.

26. FOOD PROCESSING - CANNING AND CONSERVATION

Key Researchers

Mr. Dei-Tudu, B.Sc., Dip. in Food Sc. M.Sc.
Food Research Institute (Fruits and Vegetables)

Mr. J.B.K.A. Ata, B.Sc., M.Sc.
Food Research Institute (Fats & Oil)

Mr. St John A. Blootey, B.Sc., M.Sc. (Meat),
Food Research Institute,
Accra.

Miss Okraku-Offei, B.Sc., (Hons.)
Food Research Institute,
P.O. Box M.20,
Accra.

Miss L. Amum, B.Sc., M.Sc.
Food Research Institute,
P.O. Box M.20,
Accra.

Desired countries for co-operation

Nigeria, Ivory Coast, Togo, East African countries.

Priority Rating
Top Priority.

VI. CLOTHING AND FOOTWEAR INDUSTRIES

No proposals.

Explanatory note (6)

VII. MINERAL RESOURCES INDUSTRIES

Institutions and Premises

The Institutions in Ghana concerned with Mineral Resources industries are as follows :

i. Geological Survey Department, Headquarters : P.O. Box M.80, Accra

ii. State Gold Mines Corporation, Headquarters : P.O. Box 26, Tarkwa

iii. Department of Geology, University of Ghana, Legon.

COAL MINING

No proposals.

27. NATURAL GAS PRODUCTION

Key Researchers

Dr. M.K. Kahn, B.Sc., Ph.D.,
Geological Survey Department

Mr. J.E. Cudjoe, B.Sc., M.Sc.
ARCS, FGAS, Geological Survey Dept.

Mr. G.O. Kesse, B.A., M.Sc.,
Geological Survey Department

Mr. J.K.A. Banson, B.Sc., M.Sc.,
Geological Survey Department

Mr. M. Mensah, B.A., M.Sc.
Department of Geology,
University of Ghana

Mr. Anan York, B.Sc., M.Sc.,
Geological Survey Department.

Desired countries for co-operation

Nigeria, Libya, Gabon, Algeria.

Priority Rating

Top Priority.

28. CRUDE PETROLEUM PRODUCTS

Key Researchers

Dr. M.K. Kahn, B.Sc., M.Sc., Ph.D.
Mr.G.O.Kesse, B.A., M.Sc.,
Mr. J.E. Cudjoe, B.Sc., M.Sc., ARCS, FGAS
Mr. J.K.A. Banson, B.Sc., M.Sc.
Mr. Anan York, B.Sc., M.Sc.

} Geological Survey Department

Mr. M. Mensah, B.Ac., M.Sc.
Department of Geology,
University of Ghana.

Desired countries for co-operation

Nigeria, Libya, Gabon and Algeria.

Priority Rating

Top Priority.

29. METAL ORE MINING

(a) Gold and Manganese

Key Researchers

Mr. Atiase, State Gold Mines Corporation

Dr. E.K.E. Williams, ACSM, M.Sc., D.Sc., MIME, AIMM, MASEPS, MGHIE, State Gold Mines Corporation

Mr. B.K. Paintsil, B.Sc., M.Sc.
State Gold Mines Corporation

Desired countries for co-operation

Zambia, Egypt, Morocco and Congo.

(b) Bauxite

Key Researchers

Mr. L.K.A. Quarshie, B.A., M.Sc., Ashanti Gold Fields Corporation

Mr. G.O. Kesse, B.A., M.Sc., Geological Survey Department

Mr. S.H. Manteaw, B.Sc., Geological Survey Department

Mr. K. Barming, B.Sc., M.Sc. Geological Survey Department

Mr. J.G.A. Renner, B.Sc., M.Sc. Aluminium Industries Commission, Accra.

Desired countries for co-operation

Guinea and Nigeria.

Priority Rating

Top Priority.

(c) Iron and Copper

Key Researchers

Mr. G.O. Kesse, B.A., M.Sc. Geological Survey Department

Mr. K. Barming, B.Sc., M.Sc. Geological Survey Department

Mr. S.H. Manteaw, B.Sc. Geological Survey Department.

Desired countries for co-operation

Liberia, Zambia and Congo.

Priority Rating

Top Priority.

MINING OF CRUDE CHEMICALS

No proposals.

OIL SHALE

No proposals.

30. QUARRY PRODUCTS (LIMESTONE AND ROCK AGGREGATES)

Mr. P.K. Blay, B.Sc., M.Sc., Geological Survey Department

Mr. J.K. Ayetey, B.Sc., M.Sc., Building and Road Research Institute, P.O. Box 40 University Post Office, Kumasi

Mr. B.K. Paintsil, B.Sc., M.Sc., State Gold Mines Corporation

Dr. K.A.B. Asihene, B.Sc., M.Sc., University of Science and Technology, Kumasi

Mr. E.A. Adade, B.Sc., M.Sc., State Gold Mines Corporation

Mr. G.O. Kesse, B.A., M.Sc., Geological Survey Department

Mr. K. Barning, B.Sc., M.Sc., Geological Survey Department

Mr. J.K.A. Banson, B.Sc., M.Sc., Geological Survey Department.

Desired countries for co-operation

Nigeria, Togo and Upper Volta.

Priority Rating

Top Priority.

31. URANIUM AND RADIOACTIVE ORES

Key Researchers

Mr. J.K.A. Banson, B.Sc., M.Sc., Geological Survey Department

Mr. J.A. Ako, B.Sc., M.Sc., Geological Survey Department

Mr. B.K. Paintsil, B.Sc., M.Sc., State Gold Mining Corporation

Desired countries for co-operation

Niger.

Explanatory note (7)

VIII. MATERIAL INDUSTRIES

Institutions

The Institutions engaged in research in this field in Ghana are as follows :

i. Building and Road Research Institute of the Council for Scientific and Industrial Research, P.O. Box 40, University Post Office, Kumasi.

ii. Faculty of Engineering, University of Science and Technology, Kumasi.

iii. Department of Industrial Art, University of Science and Technology, Kumasi.

iv. Forest Products Research Institute, P.O. Box 63, University Post Office, Kumasi.

v. Institute of Standards and Industrial Research, P.O. Box M.32, Accra.

32. AGGREGATES, NATURAL STONES, CERAMICS CEMENT AND HYDRAULIC LIME

Key Researchers

Dr. A.H.B. Cross, M. Met., Ph.D., FIM, Institute of Standards and Industrial Research

Dr. K. Amonoo-Neizer, B.Sc., Civil Eng., M. Phil., Ph.D. Building and Road Research Institute, Kumasi

Mr. A.K. Chatterjoe, B.Sc., M.Sc., Building and Road Research Institute, Kumasi

Mr. J.K. Ayetey, B.Sc., M.Sc., Building and Road Research Institute, Kumasi

Mr. J.K. Abankwa, B.Sc., DIC National Standards Board, Accra.

Desired countries for co-operation

Dahomey, Ivory Coast, Nigeria, Somalia, Togo and Upper Volta.

Priority Rating

Top Priority.

33. PAINTS AND VARIETIES PLASTERS, RUBBER AND RUBBER PRODUCTS

There are specialists in these fields but no specific research projects have been set up to develop new products although various factories have been established to manufacture items. Co-operation in these fields is therefore intended.

Desired countries for co-operation

Dahomey, Ivory Coast, Liberia.

Priority Rating

Top Priority.

34. TEXTILES

Key Researchers

Mr. K.A. Idam, NDA, ATD, RFD,
Mr. L.A. Baah, Dip. Tech. ATJ, MANC
Mr. E.A. Clover, NDADA, ATD, FRSA,
Mr. E.K.N. Berko, BAPG Dip.(Textiles)

Dept. of Industrial Art, University of Science and Technology, Kumasi.

Desired countries for co-operation

Dahomey, Ivory Coast, Liberia, Nigeria, Togo.

Priority Rating

Top Priority.

35. PAPER AND PAPER PRODUCTS

Key Researchers

Mr. E.W. Addo-Ashong, B.Sc., M.Sc.,
Mr. W.K. Ashiabor, B.Sc., M.Sc., DTC
Mr. N.A. Darkwah, B.Sc., M.Sc.(Pulp and Paper Tech.
Mr. J.B. Smith, B.Sc., M.Sc.

Forest Products Research Institute, P.O. Box 63 University Post Office, Kumasi.

Desired countries for co-operation

Gabon, Nigeria, Dahomey, Ivory Coast, Somalia.

Priority Rating

Top Priority.

Premises

Forest Products Research Institute, Kumasi

36. GROUND WATER RESOURCES

Key Researchers

Mr. E. Lartey, B.Sc., M.Sc., MASE, NICE, GM, FGAAS
Water Resources Unit. P.O.Box M.32 Accra

Mr. Nii Boi-Ayibotele, B.Sc., DHE
Water Resources Unit, P.O. Box M.32, Accra.

Desired countries for co-operation

Ivory Coast, Nigeria, Togo and Upper Volta.

Priority Rating

Top Priority.

Explanatory note (8)

IX. CHEMICAL INDUSTRIES (INORGANIC)

Institutions and Premises

Research into industries based on inorganic chemistry is carried out at the Departments of Chemistry, University of Ghana, and the University of Science and Technology.

37. ALKALINE ELEMENTS AND ALKALINE EARTHS

Key Researchers

Prof. Bekoe, B.Sc., D.Phil.
University of Ghana,
Department of Chemistry

Dr. E.H. Amonoo-Neizer, B.Sc., Ph.D.,
University of Science and Technology,
Kumasi

Dr. W.A. Asomaning, M.Sc., D. Phil.,
University of Ghana, Legon.

Desired countries for co-operation

Nigeria.

Priority Rating.

Top Priority.

BORON AND SILICON COMPOUND, CARBON AND CARBON PRODUCTS

No proposals.

38. FERTILIZER PRODUCTION

Key Researchers

Prof. Bekoe, B.Sc. D.Phil.
University of Ghana, Legon

Dr. E.H. Amonoo-Neizer, B.SC., Ph.D.
University of Science and Technology
Kumasi

Dr. W.A. Asomaning, M.Sc., D.Phil.,
University of Ghana, Legon.

Desired countries for co-operation

Congo, Egypt, Kenya, Nigeria, Madagascar, Tunisia, Zambia and Uganda.

Priority Rating

Top Priority.

39. HYDROGEN AND HYDRIDES

Key Researchers

Prof. Bekoe, B.Sc., D.Phil.
University of Ghana, Legon

Dr. E.H. Amonoo-Neizer, B.Sc., Ph.D.
University of Science and Technology,
Kumasi

Dr. W.A. Asomaning, M.Sc., D.Phil.,
University of Ghana, Legon.

Desired countries for co-operation

Nigeria.

Priority Rating

Top Priority.

40. NON-METALS (HALOGEN, OXYGEN AND NITROGEN FAMILIES)

Key Researchers

Prof. Bekoe, B.Sc., D.Phil.
University of Ghana, Legon

Dr. E.H. Amonoo-Neizer, B.Sc.,D.Phil.
University of Science and Technology
Kumasi

Dr. W.A. Asomaning, M.Sc., D.Phil.
University of Ghana, Legon.

Desired countries for co-operation

Nigeria.

Priority Rating

Top Priority.

41. ORGANO-METALLIC COMPOUNDS

Key Researchers

Prof. Bekoe, B.Sc., D.Phil.
University of Ghana, Legon

Dr. E. H. Amonoo-Neizer, B.Sc.,Ph.D.
University of Science and Technology
Kumasi

Dr. W.A.A Asomaning, M.Sc., D.Phil.
University of Ghana, Legon.

Desired countries for co-operation

Nigeria.

Priority Rating

Top Priority.

42. PIGMENTS

Key Researchers

Prof. Bekoe, B.Sc., D.Phil.
University of Ghana, Legon

Dr. E.H. Amonoo-Neizer, B.Sc., Ph.D.
University of Science and Technology,
Kumasi

Dr. W.A. Asomaning, M.Sc., D. Phil.
University of Ghana, Legon

Desired countries for co-operation

Congo, Egypt, Kenya, Madagascar, Nigeria, Tunisia, Uganda, Zambia.

Priority Rating

Top Priority.

Explanatory note (9)

X. CHEMICAL INDUSTRIES (ORGANIC)

Institutions and Premises

Institutions available in Ghana which are capable of collaborating in this field are listed below :

i. Forest Products Research Institute of the Council for Scientific and Industrial Research (CSIR)
P.O. Box 63, University Post Office
Kumasi.

ii. Department of Chemistry, University of Ghana, Legon.

iii. Department of Chemistry and Chemical Technology, University of Science and Technology, Kumasi.

43. ADHESIVES

Key Researchers

Dr. M. Dakubu, M.Sc., Ph.D.
University of Ghana,
Department of Chemistry,
Legon

Prof. F.A. Kufour, B.Sc., Ph.D.,ARIC
Department of Chemistry and Chemical Technology, University of Science and Technology, Kumasi.

Dr. A.N. Patel, B.Sc., Ph.D.,ARIC.
Dip. Chemical Engineering, Department of Chemistry & Chemical Technology, University of Science and Technology, Kumasi.

Desired countries for co-operation

Nigeria.

Priority Rating
Medium.

DETERGENTS, SOAPS, DYESTUFFS, HIGH POLYMERS INTERMEDIATE AND SOLVENTS, MONOMERS, PETROCHEMICALS PHARMACEUTICALS, PHOTOGRAPHIC PRODUCTS AND SYNTHETIC PLASTICS

The technical know-how for the above industries exists and can be introduced without further research work and development. A lot of manufacturing work is already going on in these fields and only needs diversification.

44. TERPENES AND ESSENTIAL OILS

Key Researchers

Prof. A.N. Tackie, B. Pharm.,Ph.D.,
M.P.S., Faculty of Pharmacy,
University of Science & Technology,
Kumasi

Dr. W.M.K. Tesekpo, M.Pharm., Ph.D.,
ARSEC, FCS
Faculty of Pharmacy, University of Science & Technology, Kumasi

Prof. Quartey,
Department of Chemistry, University of Ghana, Legon

Dr. M.C.Chaco, M.Sc., Ph.D.,
University of Ghana, Legon

Dr. Asomaning, M.Sc., D. Phil.
University of Ghana, Legon.

Desired countries for co-operation

Nigeria.

Priority Rating

Medium Priority.

Explanatory note (10)

XI. ELECTRO-MECHANICAL INDUSTRIES

Institutions and Industries

Faculty of Engineering,
University of Science and Technology,
Kumasi

The Public Works Department,
Headquarters, P.O. Box 136, Accra.

45. AIR-CONDITIONING EQUIPMENT FURNACES, HEATING EQUIPMENT INTERNAL COMBUSTION ENGINE. REFRIGERATING EQUIPMENT

Key Researchers

Prof. K.O. Kessey, B.Sc., M.Sc.,Dr.Sc. (ENG) University of Science and Technology, Kumasi

Dr. F.K. Wiafe, M.Sc., Ph.D.
University of Science and Technology
Kumasi

Mr. E.A. Baryeh, M.Sc.
University of Science and Technology
Kumasi

Mr. J.O. Cruicho Shank, M.Sc.
University of Science and Technology
Kumasi

Desired countries for co-operation

Algeria, Cameroon, Dahomey, Egypt, Ivory Coast, Liberia, Nigeria, Sierra Leone, and Togo.

46. BEARINGS, GEARS, HYDRAULIC MACHINERY, INDUSTRIAL MACHINERY AND EQUIPMENT

Key Researchers

Prof. F.O. Kwami, Dip. Ing. Dr.Ing. Tu
University of Science and Technology,
Kumasi

Dr. A. Abroba, Cudjoe, B.Sc.,(ENG) M.Sc.
University of Science and Technology,
Kumasi

Dr. J.W. Powell, B.Sc., (ENG) Ph.D. MIMEECHE, University of Science and Technology, Kumasi

Dr. L.K. Agbeguge, B.Sc., M.Sc., D.Sc. University of Science and Technology, Kumasi

Dr. B.A. Ntin, B.Sc., Ph. D. University of Science and Technology, Kumasi

Mr. V.K. Kpodo, B.Sc., M.Sc., UST, Kumasi

Dr. D.A. Ardeyfio, B.Sc., M.Sc., Ph.D. UST, Kumasi.

Desired countries for co-operation

Algeria, Cameroon, Dahomey, Egypt, Ivory Coast, Liberia, Nigeria, Sierra Leone,Togo.

Priority Rating

Top Priority.

47. MACHINE TOOLS

Key Researchers

Prof. F.O. Kwami, Dip. Ing., Dr.Ing. Tu. University of Science and Technology Kumasi

Mr. T.D. West, B.Sc., M.Sc. University of Science and Technology Kumasi

Mr. H. Washington, Technical Instructor University of Science and Technology, Kumasi

Desired countries for co-operation

Algeria, Cameroon, Dahomey, Egypt, Ivory Coast, Liberia, Nigeria, Sierra Leone,Togo.

Priority Rating

Top Priority.

Explanatory note (11)

XII. OPTICAL AND INSTRUMENTATION INDUSTRIES

Institutions

Department of Electrical Engineering, University of Science and Technology, Kumasi.

48. MEASURING AND CONTROL INSTRUMENTS

Key Researchers

Prof. E.B. Kwakye, Dr. ENG University of Science and Technology, Kumasi

Dr. K.K. Kyiama, B.Sc., DIC, Ph.D. DIEE University of Science and Technology, Kumasi

Mr. F. Asamoah, B.Sc., M.Sc., University of Science and Technology, Kumasi

Desired countries for co-operation

Egypt, Kenya, Nigeria.

Priority Rating

Top Priority.

Explanatory note (12)

XIII. ELECTRONIC AND TELECOMMUNICATION INDUSTRIE

Institutions

Post and Telecommunication Department Ghana Broadcasting Corporation

Department of Electrical Engineering University of Science and Technology, Kumasi

49. MICROWAVE, LINKS, RADIO AND TV RECEIVERS, RADIO AND TV TRANSMITTER RECORDERS, TELEPHONE

Key Researchers

Dr. N.O. Sodzi, B.Sc., M.Sc., Ph.D. MIEE, NGHIE, University of Science and Technology, Kumasi

Dr. K.A. Asuman, B.Sc., M.Sc., Ph. D. MIEE, University of Science and Technology, Kumasi

Mr. G.E. Afari, M.Sc. University of Science and Technology Kumasi

Mr. S.C. Palm, Dip. in Aircraft Radio Equip., M.Sc. University of Science and Technology, Kumasi.

Desired countries for co-operation

Egypt, Kenya, Nigeria.

Priority Rating

Top Priority.

50. HEAVY CURRENT ENGINEERING

Key Researchers

Mr. M.V.O. Ceasar, B.Sc., M.Sc., DIC University of Science and Technology, Kumasi

Mr. S.K. Fokuo, B.Sc. University of Science and Technology Kumasi

Mr. S.B. Arthur, M.Sc.
University of Science and Technology
Kumasi

Mr. K. Seidu, B.Sc., M.Sc., MIEE
University of Science and Technology
Kumasi

Desired countries for co-operation

Egypt, Kenya, Nigeria.

Priority Rating

Top Priority.

51. INTEGRATED CIRCUITS, SEMI-CONDUCTOR DEVICES

Key Researchers

Prof. E.B. Kwakye, Dr. ENG.
University of Science and Technology,
Kumasi

Dr. N.D. Sodzi, B.Sc., M.Sc., Ph.D.
MIEE, MGHIE, University of Science
and Technology, Kumasi

Dr. K.K. Kyiama, B.Sc., M.Sc., Ph.D.
MIEE, University of Science and
Technology, Kumasi

Dr. K.A. Assuman, B.Sc., M.Sc., Ph.D.,
MIEE, University of Science and
Technology, Kumasi

Mr. S.C. Palm, Dip. Aircraft Radio
Equip., M.Sc., University of Science
and Technology, Kumasi

Mr. S.K. Fokuo, B.Sc.
Department of Electrical Engineering
University of Science and Technology
Kumasi

Mr.S.B. Arther, M.Sc.
University of Science and Technology
Kumasi

Mr. G.E. Fari, M.Sc.
University of Science and Technology,
Kumasi

Mr. M.V.O. Ceasar, B.Sc., M.Sc., MIEE,
Grad I, Mech. E.N.G. , University of
Science and Technology, Kumasi

Mr. K. Seidu, B.Sc., M.Sc., MIEE
University of Science and Technology,
Kumasi

Desired countries for co-operation

Egypt, Nigeria, Kenya.

Priority Rating

Top Priority.

52. SATELLITE COMMUNICATION

Intended co-operation with Egypt,
Nigeria and Kenya.

This project will become top priority when the atomic reactor project at Kwabenya becomes a reality.

Explanatory note (13)

XIV. BUILDING AND CONSTRUCTION INDUSTRIES

Institutions and Premises

i. Building and Road Research Institute of the Council for Scientific and Industrial Research, P.O. Box 40, University Post Office, Kumasi.

ii. Department of Civil Engineering, University of Science and Technology, Kumasi.

iii. Department of Housing and Planning Research, University of Science and Technology, Kumasi.

iv. Department of Architecture, University of Science and Technology, Kumasi.

v. Department of Planning, University of Science and Technology, Kumasi

53. AIRPORT CONSTRUCTION, ROADS, BRIDGES, TUNNELS AND UNDERGROUND WORK

Key Researchers

Dr. J.W.S. de Graft-Johnson, B.Sc., M.Sc., Highway Eng. Ph.D. (Soil Mech.)
Building and Road Research Institute, Kumasi.

Dr. N.D. Gudigasu, B.Sc., Ph.D. (Soil mech.)
Building and Road Research Institute, Kumasi.

Dr. N.K. Kumapley, M.Sc., DIC,
University of Science and Technology, Kumasi.

Mr. S.L. Yeboah, B.Sc., Eng., M.Sc. Eng.,(Soil Mech.)
Building and Road Research Institute, Kumasi.

Dr. C.A.B. Obi, M.Sc., Ph.D., DIC, AM Inst. Highway Eng.
University of Science and Technology, Kumasi.

Mr. A.K. Castel, B.Sc., Eng.
Building and Road Research Institute,
Kumasi.

Desired countries for co-operation

Ivory Coast, Nigeria, Sierra Leone, Togo, Sudan, Upper Volta.

Priority Rating

Top Priority.

54. HOUSING,SCHOOLS, HOSPITALS AND OTHER PUBLIC BUILDINGS

Key Researchers

Prof. L. Christian, Dip. Eng., Arch.
T.H. Darmstadt, University of Science and Technology, Kumasi.

Prof. P.A. Abloh, B.A. Dip. Soc. Sc.
University of Science and Technology, Kumasi.

Mr. A.N.K. Laryea, Dip. Arch. ARIBA,
University of Science and Technology, Kumasi.

Mr. J.K. Nutsugah, Inter RIBA, A.A. Dip. Arch, A.A. Trop. Arch.
Building and Road Research Institute, Kumasi.

Mr. Y.R. Akinbolu, M.Sc., AIOB
University of Science and Technology, Kumasi.

Desired countries for co-operation

Ivory Coast, Nigeria, Sierra Leone, Sudan, Togo, Upper Volta.

Priority Rating

Top Priority.

Explanatory note (14)

1. No avenues for co-operation exist in the provision of these services between Ghana and any of the African Member States. On grounds of language and proximity the most fruitful relationship and Surveying and Mapping Services should be fostered between Ghana and Nigeria. This desired co-operation should be given top priority since the development of the natural resources and general planning of the countries depend on proper surveying and mapping as emphasized by the UN Third Regional Cartographic Conference for Africa, Addis Ababa, October 1972. Thus exchange of ideas between the two countries is of paramount importance.

2. The Ghana Meteorological Services Department, as a member of the WMO, has already established links of co-operation with other meteorological services especially those in Africa in the field of meteorology and climatology. This co-operation is in the form of exchange of basic meteorological data for purposes of weather prediction for aviation and hydrology, and climatological summaries and publications, and is mandatory for all countries which are signatories to the WMO convention.

There is however more room for improvement in the exchange of data and publications in certain aspects of meteorology. For example, the Meteorological Department of Ghana would like more co-operation in the exchange of published data in the fields of Radiation Climatology and Hydrology with all African countries, especially these countries bordering Ghana, i.e. Ivory Coast, Togo, Dahomey, Upper Volta, Niger and Nigeria.

The Water Resources Research Unit of the C.S.I.R. which is responsible for water resources research in Ghana would like to have more co-operation in the exchange of basic data on hydrology with the neighbouring countries above. This is because the largest river basin in the country viz. the Volta River basin originates from these countries (Nigeria excluded). In our opinion we regard this as top priority.

3. In the provision of Geological Survey Services there is co-operation between Ghana and almost all the Member States of the OAU. This takes the form of exchange of Bulletins, Journals, Memoires, etc.

However in the actual survey of mineral and other resources of Ghana it is felt that tighter co-operation should be encouraged with countries such as Togo, Upper Volta and Ivory Coast with whom we share common borders. In addition, due to the similarity of technical problems encountered in the provision of Geological Survey Services, it is felt that co-operation in this field with Nigeria will be mutual benefit.

The desired co-operation should be regarded as of top priority.

4. There already exists the FAO-sponsored Soil Correlation Committee for West Africa which mainly deals with Soil Survey,

Classification and Land-use planning. The members are Ghana, Togo, Nigeria, but results are made available to all West African countries. There is also the OAU/CSTR - which deals with exchange of publications through the Inter-African Bureau for Soils and Rural Economy. There is also WARDA, co-operative in soil suitable for rice production and their fertilization to which all West African countries belong.

There is however a top-priority need to set up closer co-operation in all aspects of Soil Science Services between Ghana, Togo, Ivory Coast and Sierra Leone.

5. In the field of Energy Services, Ghana's Volta River Authority develops Hydro-electric power from the Volta Dam at Akosombo. Ghana already supplies electricity to Togo. There is therefore co-operation between Ghana and Togo. It is felt that such co-operation might be extended to Dahomey in the near future.

Explanatory note (15)

6. Translation Centre for West African countries

West African countries have identical climatic conditions and vegetation. Also, almost all of them attained independence in the past two decades. They are thus faced with the same problems in their national developments, and their scientists work towards common goals. The two major languages in use in these countries are French and English. For scientific, technical and industrial establishments in these countries to benefit from results of scientific research, it should be possible to obtain translations of important research results in the two major languages. Nations in the region will benefit tremendously if they would co-operate in establishing a Regional Translation Centre to serve the interests of the courses in the region

The Centre might have to acquire literature from the important scientific establishments and industries in co-operating nations and make translations available in English and French for use.

7. Scientific and Technical Journals

A large number of scientific and technical journals are currently issued in Africa South of the Sahara. Although many of them are listed in Ulrichs International Periodical Directory and other indexes, it is difficult to isolate those journals issued in Africa from such international publications. A group of officers may jointly pull together to compile a list of scientific and technical journals issued in Africa South of the Sahara. It should provide information on title, issuing body, date of publication, editor, and addresses from which it can be obtained. It will be useful if the journals are grouped into subjects so that interested persons can refer to relevant sections for information on which is available in the fields of interest to them.

Already existing co-operation in exchange of scientific journals with many African countries.

8. Directory of Scientific and Technical Research Centres in Africa South of the Sahara

Selected information officers from different countries in the region may be commissioned to prepare a Directory of Scientific and Technical Research Centres in the region. The Directory will list organizations which are engaged in scientific research and who are prepared to make available results of their research to other establishments wanting to see them. This must be compiled from information supplied by government and non-government institutions, private firms and universities.

Explanatory note (16)

9. Identification of material collected and exchange of new material. Following description :

This is an inter-state problem which is made more complicated by the fact that key reference collections are almost all in Museums of developed countries and in fact continue to accumulate there as both expeditions and individual collectors continue to visit Ghana and other parts of West Africa. One consequence of this situation is that people working in francophone countries often use different names for particular animals from those current in anglophone countries with resulting confusion.

The resolution to this problem lies in an inter-state effort to establish one or more adequately financed and staffed regional museums, not concerned in any way

with public display but purely scientific institutes concerned with curation, identification and extension of taxonomic information. To sugar the pill on a national level, one might arrange that one country was responsible for, say, bird taxonomy and collections, another for reptiles, a third for the marine fauna, and so on. This would require some planning but is the sort of arrangement which would produce the initial basis for building reference collections in reliable conditions and could lead ultimately to the situation where it would be possible, without danger of loss of very valuable material, to attempt to have returned to Africa key material now in European and American Museums.

Explanatory note (17)

10. There is no strong direct co-operation between Ghana and other African countries in the general areas of Standards, Norms, Instrumentation and Quality Control, apart from common membership of international organizations, such as ISO, IEC, IAEA.

In Ghana, the main organizations charged to provide these services are the Ghana Standards Board, Calibration and Measurements Laboratory of the Council for Scientific and Industrial Research Government Chemical Laboratory. There might be similar organizations in West Africa, especially in Nigeria where co-operation in finding solutions to problems encountered in the provision of these services would be most welcome.

Precision Measurements form the basis for the provision of these services and this presupposes the existence of Standard Reference Laboratories which keep Physical and Chemical Standards for Comparison or Calibration.

On a long-term basis, there is a strong need for preparing the grounds for the eventual setting up of a West African Reference Physical and Chemical Laboratory which will serve the measurement needs of all the agencies charged with the provision of these services. At present, calibration of instruments used in the provision of such services is done in developed countries. With rapid industrialization this method becomes inconvenient, time-consuming and in the long run very costly as no local expertise is developed.

Ghana has embarked on setting up Reference Laboratories such as the Calibration Laboratory of the CSIR Co-operation now with a similar organization in Nigeria in the acquisition of Physical and Chemical Standards of Measurement which will make the future desired union less costly and more meaningful.

Explanatory note (18)

11. There is a rather weak association in the provision of Forestry Services through the membership of the African Forestry Commission. However for more localised benefits there is need for the Forestry Departments in Ghana, Nigeria and the Ivory Coast to co-operate in their efforts to provide forestry services to back their economies.

Explanatory note (19)

12. Description of Cereal project JP-26 (OAU/STRC)

The project JP-26 is an OAU/STRC project covering West African countries and involves uniform trials for maize, sorghum and millet. The project is designed to evaluate the performances of the crop selected from improvement programmes of the participating countries at sites through out the regions. The number of countries is not static and more countries register their participation from year to year. The crop selections after two years are replaced in trial by new countries.

Information secured from these trials will be of value in identifying zones of adaptation for the tested varieties. In addition, the trials should increase the exchange of seed and information among participating countries to the mutual benefit of all.

The countries currently engaged in the trial comprise : Ivory Coast, Senegal, Gambia, Niger, Ghana, Dahomey, Nigeria, Upper Volta, Mali and Cameroon.

The list of key researchers, sites, fields of interest and institutions is given below :

1. Dr. David Curtis - Maize, Sorghum & Millet, 118 Forsythe Lane Dekalb, Illinois, 60115, USA.

2. Mr. J. Nabos - Sorghum & Millet
Selectrion CRA Bambey, Senegal.

3. Mr. J. Nabos - Sorghum & Millet
Terna, IRAT,
B.P. 6, Niamey, Niger.

4. J.P. Eckabil - Sorghum & Millet
Station IRAT Custale per Makolo
Cameroon.

5. M.K. Akposce - Maize
Plant Breeder (Maize)
Crops Research Institute
Kumasi, Ghana.

6. Hamidou, Tehidome, Kola } as No. 4
Cameroon - Sorghum & Millet

7. Mr. Ajau, Roy Peters, Sasfro,
Aid Sorghum & Millet Unit
Serere, P.O. Scoroti, Uganda.

8. C. Roblodo - Sorghum & Millet
IRAT, B.P. 596, Sair, Upper Volta.

9. M. N'Gustia Bosso - Maize
IRAT 635, Bouake, Ivory Coast.

10. Mercer-Quarshie - Sorghum & Millet,
P.O. Box 3785, Kwadaso, Kumasi, Ghana.

11. Ian R. Hancoak - Sorghum & Millet,
Yundum Agric. Station Dept. of Agric.,
Bathurst, Gambia.

12. Bono, Soumare, IRAT -
B.P. 438, Bamako, Mali.

13. J. Le Conta - Maize & Sorghum , IRAT,
110, rue de l'Université, Paris 7ème.

14. Mr. B.S. Taylor -Leader, Maize,Sorghum
& Millet, Corn & Sorghum Investigations
Cereal Crops Research Division
Kano, Nigeria.

15. Dr. S.A. Eberhart
Crops Research Division - Agronomy Dept.
Iowa State University,
Ames, Iowa, 50010, U.S.A.

16. Mr. M. Dumont - Millet
(Field Trial Officer, OAU/STRC JP-26)
B.P. 6073, Dakar, Senegal.

The project is fully financed by the OAU/STRC.

13. Description of Co-ordinated Rice Trials (WARDA)

The West African Rice Development Association comprises Dahomey, Gambia, Ghana, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal and Sierra Leone. The association has its headquarters in Monrovia, Liberia, and has the objective of developing rice production within the West African Region.

In 1973, the association started a co-ordinated fertilizer trial for the crop in all Member Countries, including Ghana. The aim of the trial is to study the response of the best local variety to fertilizer application and to study the economics of fertilizer use.

Several observation including growth of the plant, incidence of pests and diseases, days to 50 % flowering, days to maturity, lodging, plant height and grain yield per acre would be collected and evaluated to determine the potentialities of the variety.

In Ghana, the trial is being conducted at the Crops Research Institute station, Nyankpala, and at the University of Ghana Irrigation Research station, Kpong.

The specialists engaged on the trial in Ghana and their addresses are given below :

Dr. J.E. Quansah, B.Sc., M.Sc., Ph.D.
Nyankpala Agricultural Experimental Station,
P.O. Box 52,
Tamale

Mr. E.J.A. Khan, B.Sc., M.Sc.
Agric. Irrigation Research Station
P.O.Box 9
Kpong

Mr. A.N. Ayeetey, B.Sc., M.Sc.,
Agric. Irrigation Research Station
P.O. Box 9
Kpong.

The trial is fully financed by the West African Rice Development Association.

IVORY COAST/COTE D'IVOIRE

Notes explicatives concernant :

MATRICE A

A.1 Sciences mathématiques

A.1.4 Informatique : intérêt programmes scientifiques, notamment programme Annova (Fortran) pour l'Agronomie et programme PST du Sénégal. Enseignement centre OCAN, au Gabon.

A.1.11 Statistique : Méthodologie et résultat d'enquêtes démographiques, agricoles et économiques. Pays : Sénégal, Cameroun et Haute-Volta.

A.2 Sciences physiques

A.2.12 Physique atmosphérique : intérêt pour les pluies artificielles.

A.4 Sciences biologiques

A.4.1 Botanique : étude de la flore agrostologique. Coopération souhaitée avec les pays de savane voisins.

A.4.2 Biologie générale : biologie de la reproduction des mammifères. Pays : Kenya, Nigeria.

A.4.3 Biochimie : étude de la biogenèse du caoutchouc.

A.4.5 Biologie cellulaire, surtout biologie supcellulaire, étude des membranes, avec pays forestiers.

A.4.6 Entomologie : lutte biologique. Pays d'Afrique Orientale, Madagascar et Nigeria ?

A.4.7 Génétique : amélioration des espèces végétales : hybridation interspécifique + obtention et emploi des plantes haploïdes. Afrique de l'Est.

A.4.9 Physiologie générale : étude des membranes musculaires. Autres pays intéressés ?

A.4.10 Radio-biologie : emploi de radio isotope pour l'étude de la physiologie du latex, la nutrition minérale des végétaux et l'alimentation hydrique.

A.4.11 Zoologie : étude de différentes espèces animales. Sénégal, Nigeria et Kenya.

A.5 Sciences de la terre

A.5.3 Climatologie : bioclimatologie. Pays voisins.

A.5.4 Ecologie : écologie des lacs de barrages. Ghana, Nigéria.
Ecologie forestière - Zaïre.
Ecologie lagunaire - Dahomey, Togo, Nigéria.

A.5.7 Géologie : Hydrogéologie - Dahomey, Haute-Volta.
Géologie du socle - Libéria.
Géologie des sédiments - Ghana, Dahomey, Togo et Nigéria.

A.5.8 Géo-physique : physique du sol. Sénégal

A.5.10 Hydrologie et hydrobiologie : étude des bassins versants. Haute-Volta, Ethiopie et Madagascar.

A.5.11 Océanographie : inventaire des stocks. Sénégal et Congo.

A.5.12 Paléontologie : fossiles écocènes. Ghana ?

A.5.13 Pédologie : exploitation des sols de savane et sols sur socles granitiques. Bureau inter-africain des sols (BIS) à Bangui (RCA). Sénégal, Tchad, Cameroun.

A.5.14 Sismologie : recoupement nécessaire avec le travail d'enregistrement par le Centre de LAMTO. Pays voisins?

A.6 Sciences de l'Ingénieur

A.6.3 Génie des constructions : comparaisons à faire avec les travaux de l'Ecole Nationale Supérieure des Travaux Publics (ENSTP) et le Centre de Recherche en Architecture et Urbanisme (CRAU). Pays voisins ?

A.6.8 Génie Industriel : travaux ITIPAT. Coopération envisagée avec Sénégal et Nigéria (FIR et IITA).

A.7. Sciences agricoles

A.7.1 Agronomie : relations sol-plantes, système des fumures, matières organiques, travail du sol. Pays voisins.

A.7.2 Climatologie agricole : Agro-Climatologie et Bio-Climatologie appliquées aux plantes fourragères. Pays voisins ?

A.7.3 Ecologie agricole : aptitudes culturales riz pluvial. Nigéria.

A.7.4 Elevage : production fourragère , amélioration génétique des animaux, étude de digestibilité et ranch de gibiers. Sénégal, Nigéria, Zaïre et Tanzanie.

A.7.5 Pathologie animale ; problème de la trypano-résistance.

A.7.6 Physiologie Animale : digestibilité ? Pays voisins ?

A.7.9 Science alimentaire : étude de carences, essai de maïs riche en protéines. Sénégal et Nigéria.

A.7.11 Phytopathologie : lutte biologique contre les pourridiers - Cameroun. Etude des phytophtoras et moisissures : toxiques - Sénégal et Nigéria. Maladies de la canne à sucre - Kenya et Madagascar.

A.7.13 Phytophysiologie : étude de la résistance à la sécheresse. Pays voisins, de savane.

A.7.14 Pisciculture : étude des exploitations intensives en eau douce (tilapias). Congo et Nigéria.

A.7.15 Sylviculture : étude des plantations d'essence forestière. Nigéria Ghana, Libéria.

A.8. Sciences médicales

A.8.2 Bactériologie, étude du choléra.

A.8.3 Génétique clinique, biologie, immunologie ; problème de l'immunonématologie. Nigéria, Ghana.

A.8.8 Nutrition : étude de la nutrition infantile. Pays voisins.

A.8.10 et A.8.14 Pharmacologie - Toxologie : étude des propriétés pharmaco-dynamiques des substances naturelles végétales Ghana, Nigéria.

A.9 Sciences économiques

A.9.6 Systèmes économiques, prix, économie sectorielle : étude de la croissance économique : structure du capital, main-d'oeuvre, échanges intra et extra africains, croissance sectorielle ... Ghana, Nigéria, Zaïre et Sénégal.

A.10 Sciences humaines et sociales

A.10.1 Archéologie, histoire : fouilles et recherches historiques. Ghana, Libéria.

A.10.2 Architecture : recherche d'un type adapté d'habitat rural. Pays voisins.

A.10.3 Sciences du comportement : étude des comportements culturels traditionnels. Ghana, Libéria.

A.10.5 Démographie et Population :problème des recensements démographiques. Haute-Volta, Mali.

A.10.6 Ethnologie : problème des archives et documents historiques, Sénégal, Ghana, Nigéria.

A.10.8 et A.10.9 Droit - linguistique : étude des régimes fonciers et matrimoniaux, étude des langues africaines. Pays voisins.

A.10.10 Pédagogie (audiovisuel) : recherches pour la télévision éducative au Niger ; littérature orale : problème de la tradition orale au Niger.

A.10.15 Sociologie. Pays voisins.

MATRICE B

B.1 Agriculture

B.1.1 Mécanique et génie agricoles : essais de culture attelée, motorisation en pays de savane. Sénégal.

B.1.2 Production agricole : définition de systèmes et techniques d'exploitation pour zones de savane. Sénégal, Mali et Haute-Volta.

B.2 Sylviculture

B.2.1 Conservation des forêts : sélection et exploitation d'essences forestières. Libéria, Ghana, Nigéria.

B.4 Pêcheries

B.4.5 Embarcations et matériels de pêche sur lacs de barrages et lagunes. Ghana et Nigéria.

B.4.6 Préservation de la faune et de la flore sauvages : parcs nationaux et ranch de gibiers. Cameroun, Sénégal, Zaïre, et Afrique Orientale.

B.5 Industrie alimentaire

B.5.3 Produits laitiers : recherche, comparaisons. Pays voisins.

B.7 Industries minières

B.7.4 Minerais métalliques : le fer, Libéria,Nigéria.

B.8 Industrie de matériaux

B.8.19 Caoutchouc et produits caoutchoutés. Libéria.

B.8.22 et B.8.23 Textiles et bois. Ghana, Nigéria.

MATRICE C

C.1 Services des resources naturelles

C.1.4 Services biométriques. Sénégal, Ghana, Nigéria.

C.2 Services d'information

C.2.1 Bulletins de résumés : pays voisins.

C.2.2 Centre de documentation scientifique. Sénégal, Ghana, Nigéria.

C.5 Services de vulgarisation

C.5.1 Vulgarisation agricole. Pays voisins.

C.5.8 Lutte contre les animaux nuisibles. Pays voisins.

SUGGESTIONS POUR UNE REPARTITION DES DOMAINES DE LA R ET D AUXQUELS POURRAIENT S'INTERESSER LES DIVERSES ORGANISATIONS ET INSTITUTIONS AFRICAINES (1)

Organisation Commune Africaine et Malgache (OCAM)

A.1.4 Informatique

A.1.11 Statistiques(général)

A.10.2 Architecture

A.10.5 Démographie et Population

C.1.9 Services météorologiques

C.2.5 Services des traitements de l'information.

INSTITUT INTERNATIONAL D'AGRICULTURE TROPICALE (I.I.A.T.), IBADAN, ASSOCIATION POUR LE DEVELOPPEMENT DE LA RIZICULTURE EN AFRIQUE OCCIDENTALE (ADRAO)

A.7.1 Agronomie (général)

A.7.2 Climatologie agricole

A.7.3 Ecologie agricole

A.7.7 Enthomologie agricole

A.7.9 Science alimentaire

A.7.11 Phytopathologie

A.7.12 Sélection végétale

A.7.13 Phytophysiologie

A.7.15 Sylviculture

B.1.1 Mécanique et génie agricole

B.1.2 Production agricole

B.1.3 Protection des cultures

B.1.4 Transformation des produits agricoles

B.1.5 Stockage et préservation des produits agricoles

B.1.7 Utilisation des engrais

B.1.8 Irrigation et drainage

B.1.10 Exploitation rationelle des pâturages

B.1.12 Mise en valeur de la savane

B.1.13 Utilisation rationelle du sol

B.1.14 Lutte contre les mauvaises herbes.

B.2.1 Conservation de forêts

B.2.2 Exploitation forestières

B.2.3 Produits forestiers

B.2.4 Protection des forêts

COOPERATION DANS LE CADRE DES ACCORDS LIANT LES PAYS DE L'ENTENTE
(Côte d'Ivoire, Dahomey, Haute-Volta, Niger et Togo)

A.7.4 Elevage

A.7.5 Pathologie animale

A.7.6 Physiologie

B.3.2 Production animale

B.3.4 Reproduction animale

B.3.5 Sélection animale

C.5.6 Services concernant l élevage.

CENTRE IVOIRIEN DE RECHERCHES ECONOMIQUES ET SOCIALES (CIRES), Abidjan
INSTITUTE OF STATISTICS, SOCIAL AND ECONOMIC RESEARCH (ISSER), Ghana
NIGERIAN INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH (NISER), Lagos

A.9.6 Système économique : développement et planification

A.9.15 Prix et marchés

A.9.18 Economie sectorielle

C.2.8 Revues scientifiques

(1) Des projets de coopération sont déjà en voie d'exécution en plusieurs des domaines mentionnés.

CENTRE DE TRADITION ORALE, Niamey, Niger

A.10.9 Littérature orale (linguistique)

TRAITES D'AMITIE ET DE COOPERATION CONCLUS ENTRE LA COTE D'IVOIRE ET CERTAINS AUTRES PAYS AFRICAINS

C.1.5 Services d'études géologiques

C.1.6 Service hydrologique

C.1.7 Service d'études intégrées des systèmes d'exploitation des terres

C.1.8 Service maritime et ichtyologique

C.3.5 Collections géologiques

ORGANISATION COMMUNE DE LUTTE CONTRE LES GRANDES ENDEMIES (OCGE)
ORGANISATION COMMUNE DE LUTTE ANTIACRIDIENNE ET DE LUTTE ANTI-AVIAIRE (OCLALAV)

Domaines scientifiques idoines.

ASSOCIATION DES UNIVERSITES AFRICAINES (AUA)

C.3.3 Collections botaniques

C.3.4 Collections entomologiques

M A L I

Note explicative concernant les Matrices A.1 à A.4 :

Il existe des chercheurs, des laboratoires de recherche et de recherche appliquée à l'Ecole Nationale Supérieure, à l'I.P.R. de Katibougou et à l'Ecole Nationale des Ingénieurs. Dans le domaine de l'analyse et de l'analyse fonctionnelle il existe une coopération entre le Mali et le Brésil par l'intermédiaire de l'Unesco ; dans le domaine de la géométrie avec la Hongrie ; et dans le domaine de la physique avec la France. D'autre part, le Mali souhaite coopérer avec le Niger dans le domaine de la physique thermique.

Note explicative concernant certains projets existants :

Géologie : Coopération existante entre le Mali et la Yougoslavie par l'intermédiaire de l'Unesco. Coopération directe souhaitée avec la Yougoslavie et le Sénégal.

Hydrobiologie :

Coopération inexistante mais l'importance de ce domaine pose le problème. Coopération directe souhaitée avec la République Centrafricaine qui possède un laboratoire d'Hydrobiologie comme le Mali, et avec la France.

Botanique et Entomologie :

Au niveau des grandes écoles, la coopération existe entre le Mali et la France par le canal de l'Unesco. Coopération directe souhaitée entre le Mali, la France et le Sénégal.

Microbiologie :

Coopération entre le Mali et la Marse (Rabat) par l'intermédiaire de l'Unesco. Coopération directe souhaitée avec le Maroc, le Sénégal et la France (ORSTOM).

Note explicative (1) concernant la Matrice A.7

Agronomie :

Des structures pour la recherche agronomique existent sur place. Coopération souhaitée avec le Sénégal, la Haute-Volta et la France.

Elevage :

Jusqu'ici développement et recherche auto-centrés. Coopération souhaitée avec le Sénégal, la Haute-Volta et la France.

Note explicative concernant la Matrice A :

Economie et Gestion de l'entreprise :

Coopération existant avec le BIT : le Mali a établi l'Institut de Productivité et de Gestion Prévisionnelle. Coopération souhaitée avec la Guinée, la Mauritanie et le Sénégal.

Note explicative (2) concernant la Matrice A.10 :

La note explicative (2) concerne les activités de l'Institut des Sciences Humaines du Mali. Il existe une coopération entre le Mali, le Niger et la Haute-Volta. Il faut noter l'existence au Mali du Centre Régional de

Documentation et de Recherche Historique Ahmed Baba (CEDRAB). Le Mali, le Niger et la Haute-Volta ont en commun un projet Peul. Désir de renforcer cette coopération existante et d'initier de nouveaux projets avec le Cameroun, la Guinée, la Mauritanie, le Sénégal, la France et les Pays-Bas.

Note explicative concernant la Matrice B.8.6 :

Céramique :

Coopération existant entre le Mali et la Corée et la République démocratique allemande. Coopération souhaitée avec la Guinée et le Sénégal.

Note explicative concernant la Matrice B.10.2 :

Détergents et savons :

La Sepom (usine à Koulikoro) se sert essentiellement de machines importées de la République fédérale d'Allemagne. Une coopération plus poussée avec ce pays pourrait améliorer la qualité des produits de la Sepom.

Note explicative (3) concernant la Matrice B.12.4 :

Produits usinés et tournés :

Les Ateliers de Markala sont essentiellement dédiés à la fabrication de pièces détachées des instruments aratoires. Une coopération avec le Sénégal et la Guinée contribuerait à améliorer la nature des pièces fabriquées et à rationnaliser leur production, compte tenu des besoins réels des Etats concernés.

Note explicative concernant la Matrice B.15.9 :

Energie solaire :

Dans le domaine de l'Energie solaire, le Mali possède un laboratoire avec plusieurs chercheurs. Ce laboratoire coopére déjà avec le Niger, le Nigéria et le Sénégal. Le développement des techniques d'exploitation de l'énergie solaire requiert une coopération avec des pays industrialisés comme la France, l'URSS, les Etats-Unis d'Amérique ou le Canada. Le problème qui se pose est surtout celui de la rentabilité des appareils.

MAURITANIA / MAURITANIE

A. NOTES EXPLICATIVES SOUMISES PAR LA DIRECTION DE L'AGRICULTURE DU MINISTERE DU DEVELOPPEMENT RURAL

Les notes ci-dessous sont limitées au domaine essentiellement agricole et accessoirement para-agricole.

Il convient d'examiner et d'analyser les matrices dans une optique dynamique tenant compte des changements qui pourraient intervenir au niveau de chaque pays dans la classification des priorités.

L'absence de renseignements précis sur le potentiel scientifique et technologique (PST) des autres pays africains, ainsi que sur leurs structures et sur les domaines qu'ils jugent prioritaires en vue d'une coopération avec d'autres pays, n'a pas permis une exploitation opérationnelle des informations.

L'exercice de réponses aux matrices devra donc être complété pour qu'une coopération - à l'échelle continentale - puisse s'instaurer entre les différents pays africains. Ceci devra se faire dans un souci de complémentarité et de cohérence entre les divers programmes et projets.

Pour ce qui est du domaine de coopération à envisager entre la Mauritanie et les autres pays du continent nous commenterons, conformément aux recommandations de la commission, les sujets ayant déjà fait l'objet d'un accord et nous soulignerons ceux pour lesquels nous estimons qu'une coopération est à envisager.

Domaine :

A.7.7 Entomologie agricole : elle concerne essentiellement la lutte biologique contre la cochenille blanche du palmier-dattier.

Ce projet, opérationnel depuis deux ans, dispose d'un laboratoire à Nouakchott, d'un chercheur expatrié et de trois Assistants nationaux.

Outre la Mauritanie ce Projet intéresse le Niger avec qui nous avons passé des accords dans le domaine de la formation et de la lutte.

Le Tchad et le Mali sont en voie d'être saisis officiellement pour leur participation au projet auquel la Mauritanie souhaiterait donner un caractère sous-régional.

A.7.8 Hydrologie agricole : ce projet s'inscrit dans le cadre de la mise en valeur du fleuve Sénégal. Il intéresse les pays riverains. Il s'agit d'un domaine de coopération prioritaire.

A.9.18 Economie Sectorielle agriculture :

domaine hautement prioritaire. Projet intéressant le Mali et le Sénégal, susceptible de s'inscrire dans le cadre de l'OMVS.

A.10.14 Sociologie rurale : les problèmes posés par la réforme agraire intéressent également le Mali et le Sénégal. Coopération à rechercher avec ces deux pays.

B.1.2 Production agricole : domaine prioritaire aussi bien pour le Tchad que le Mali, le Niger, le Sénégal et la Haute-Volta, compte tenu de la complémentarité écologique de ces pays dont l'intérêt commande qu'un Projet soit mis à exécution.

Nous disposons à cet effet d'un cadre institutionnel pour une participation entière à ce projet.

B.1.3 Protection des cultures : axée essentiellement contre les Acridiens : criquet pélerin et criquet migrateur. Projet déjà opérationnel. Exécution assurée par l'OCLALAV et l'OICMA, deux organisations auxquelles nous appartenons.

B.1.4 Transformation des produits agricoles : concerne avant tout la transformation des mils et sorghos. Un projet existe qui groupe tous les pays de l'Afrique de l'Ouest.

Une coopération dans ce domaine entre la Mauritanie et le Sénégal ne peut que s'avérer fructueuse, ce dernier pays disposant d'un Institut de Technologie Alimentaire (I.T.A.).

B.1.5 Stockage et préservation des produits agricoles : domaine de coopération à envisager entre la République Islamique de Mauritanie, le Mali, le Niger et le Sénégal. Ces pays ont des productions pour le moins marginales qu'il importe de pouvoir conserver et préserver de façon efficace.

B.1.7 Utilisation des engrais : peu important pour l'instant. Un projet commun aux quatre pays précédemment cités permettrait de déterminer les formules d'engrais les mieux adaptés en assurant leur rentabilité.

B.1.8 Irrigation et drainage : un projet conjoint Mauritanie, Mali et Sénégal prévoit, dans le cadre de l'OMVS, la mise en valeur par irrigation des terres riveraines du fleuve Sénégal.

Ce projet est opérationnel pour ce qui est de l'irrigation par la régularisation du fleuve mais non opérationnel pour le drainage.

B.1.10 Exploitation rationnelle des pâturages: Suite à la sécheresse de ces dernières années ce projet revêt une importance extrême aussi bien pour la Mauritanie que pour le Mali et le Sénégal. L'utilisation des pâturages, les déplacements des troupeaux constituent une préoccupation pour tous les pays sahéliens.

La fixation de parcours, la conservation de certaines zones à végétation spécifique peuvent contribuer à atténuer les périodes de soudure.

B.1.12 Mise en valeur de la savane : il s'agit d'un projet qui trouve sa place dans la lutte contre la désertification et l'exode rural.

B.1.13 Utilisation rationnelle des sols : la diversité des sols ainsi que la nécessité de les utiliser à des fins agricoles ou sylvo-pastorales mérite une attention particulière de la part des pays sahéliens.

B.1.14 Lutte contre les mauvaises herbes : Projet qui ne présente pas un caractère prioritaire.

B.1.15 Lutte contre la désertification : il s'agit d'un projet régional pour lequel tous les Etats de la zone sahélienne et sahélo-soudanaises doivent se mobiliser et libérer des moyens importants.

B.9.4 Production d'engrais : bien que n'ayant pas un caractère prioritaire ce projet mérite d'être étudié dans le cadre de la mise en valeur du Sénégal.

C.1.6 Service hydrologique : domaine où la coopération est possible, mais faute de moyens, la Mauritanie n'envisage pas d'y participer. Il s'agit bien sûr d'un service hydrologique axé sur l'Agriculture.

C.1.4 Bioclimatologie : projet déjà opérationnel entre le Mali et le Sénégal. Exécuté actuellement par l'OMVS dans les centres de SAME, KAEDI et GUEDE.

C.5.1 Service de vulgarisation agricole : Projet dont la priorité est moyenne. La Mauritanie serait intéressée par un tel Projet notamment sur le plan de la formation, et en collaboration avec l'Algérie, le Mali et le Sénégal.

AUTRES NOTES EXPLICATIVES

A.1.4 et A.1.11 Informatique Statistiques

En 1974, la Mauritanie disposera d'un ordinateur qui se chargera de traiter les principales données économiques et financières du pays.

A.7.4 Pathologie animale

Il s'agit de rassembler les données éparses que, çà et là, on rencontre dans les différents centres vétérinaires du pays et de les rattacher au Centre National d'Elevage et de Recherches Vétérinaires qui sera opérationnel en 1974.

A.5.7 Géologie,

A.5.8 et A.5.9 Géophysique Gravité, magnétisme

En 1974, la Mauritanie disposera d'un Laboratoire National de Recherche Géologique et Minière qui prendra en charge ces trois domaines.

A.5.10 et A.5.13 Hydrologie Pédologie

Ces domaines revêtent un caractère interrégional dans le cadre de l'OMVS.

A.5.11 Océanographie

La Mauritanie dispose d'un important Laboratoire National des Pêches qui s'occupe d'études océanographiques.

A.7.1 Agronomie générale,

A.7.2 Climatologie agricole,

A.7.3 et A.7.8 Ecologie Hydrologie agricole

Une coopération interrégionale dans le cadre de l'OMVS est prévue dans ces domaines.

A.7.4 et A.7.5 Elevage Pathologie animale

Ce secteur, très important en Mauritanie, dispose d'une importante documentation et serait prêt à une coopération interrégionale immédiate.

A.7.9 et A.8.8 Science alimentaire Nutrition

Dans ce domaine très important la Mauritanie est très en retard. C'est donc l'un des nombreux domaines où tout est à faire.

A.8.4 et A.8.9 Epidémiologie Pathologie

La Mauritanie sera dotée à très court terme d'un Centre National d'Hygiène comprenant une structure s'occupant d'épidémiologie et de pathologie.

A.9 Sciences économiques

Il existe au sein du Ministère de la planification et du développement industriel une Direction de la Planification et de la Recherche. En collaboration avec la Cellule de Planification des Nations Unies (projet MAU/11), cette Direction s'intéresse à toutes les disciplines retenues dans la rubrique A.9, comme thèmes permanents d'étude et de recherche.

A.10 Sciences sociales et humaines

Il existe pour tous ces domaines, une possibilité latente de coopération, étant donné la création récente de la Maison de la Culture.

B.3 Zootechnie

Il existe au sein du Ministère du développement rural une structure, la Direction de l'Elevage et des industries animales qui serait à même d'étudier des propositions de coopération.

B.2 Sylviculture,
et
B.4 Pêcheries, faune et flore sauvages

Il existe au sein du Ministère du développement rural une structure, la Direction de l'Aménagement rural laquelle englobe le Service de la Protection de la Nature. Cette Direction serait à même d'étudier des propositions de coopération.

B.11 Industries mécaniques,
et
B.12 Fabrication de produits en métal

Il existe au sein du Ministère de la Planification et du développement industriel, une structure, la Direction de l'industrialisation, qui serait à même d'étudier des propositions de coopération.

Au sein du Ministère de l'Equipement, les services mentionnés ci-dessous couvrent les trois domaines suivants :

B.15 Combustibles et énergie : Direction de l'Energie et l'Hydraulique

B.14 Electronique et télécommunication : Direction de l'Office des Postes et Télécommunications

B.17 Bâtiment et construction : Direction de l'Habitat, de l'Urbanisme et de la Topographie.

C.1.8 Services maritimes et ichtyologiques

Le Laboratoire National des Pêches de Nouadhibou, rattaché à la Direction des Pêches du Ministère de la Planification et du Développement industriel est chargée, en collaboration avec la circonscription maritime de Nouadhibou, de la politique en matière de recherche océanographique et ichtyologique. Elle pourrait établir avec précision l'ensemble des possibilités de coopération qui existent dans son domaine.

C.1.16 Services intéressant la préservation de la faune et de la flore sauvages

Le Service de la Protection de la Nature, rattaché à la Direction de l'Aménagement Rural du Ministère du Développement Rural, assure la préservation de la faune et de la flore en Mauritanie. Ce Service est tout indiqué pour fixer les conditions de la coopération dans ce domaine.

C.2.2 Centres de documentation scientifique et technique
et
C.2.6 Bibliothèques scientifiques et techniques

Le Ministère de la Culture et de l'Information vient d'inaugurer la Maison de la Culture qui regroupe différents services culturels tels que la Bibliothèque Nationale, le Musée National, le Centre National de la Recherche Scientifique.

C.2.5 Services de traitement de l'information

Le Ministère des Finances et du Commerce va incessamment installer un Centre d'informatique (ordinateur IBM) qui traitera l'essentiel de l'information en matière financière et économique.

C.2.7 Bureaux de dépôt des brevets

La Direction de l'industrialisation du Ministère de la Planification et du Développement industriel pourrait définir les conditions dans lesquelles une coopération serait envisagée en matière d'information industrielle et de transfert de brevets.

C.3.5 Collections géologiques

Le Laboratoire National de Géologie rattaché à la Direction des Mines et de la Géologie, est l'organisme chargé des collections géologiques. Il pourrait définir les conditions de coopération en matière de Musée géologique.

C.3.6 et C.3.7 Musées scientifiques / Musées techniques

Domaines neufs ou l'apport des pays développés sera prépondérante, les expositions et musées scientifiques et techniques sont à rattacher au Ministère de la Planification et du Développement industriel qui serait tout indiqué pour dégager les conditions de leur création et de la coopération active avec les pays de longue tradition industrielle.

C.3.9 Collections zoologiques

La Direction de l'Elevage, en collaboration avec la Direction de l'Aménagement Rural (Service de la Protection de la Nature), pourrait dégager les conditions d'une création d'un parc zoologique et définir en même temps les différents aspects d'une coopération féconde dans ce domaine.

C.4.11 Laboratoires d'essais des matériaux (résistance et propriétés)

Le Laboratoire National des Travaux Publics du Ministère de l'Equipement est tout indiqué pour dégager les différents aspects de la coopération.

C.5.3 Services relatifs aux techniques d'éducation

Les Ministères de l'Education nationale ont créé un service de Planification scolaire, un service national pédagogique et entrevoient la mise en place d'un embryon d'instituts d'enseignement supérieur. Il serait possible au Ministère de l'Enseignement supérieur de préciser les conditions réelles d'une coopération en matière universitaire.

S E N E G A L

Note explicative (1)

Organisation pour la mise en valeur du fleuve Sénégal (O.M.V.S.)

Au sein de cette organisation, le Sénégal, le Mali et la Mauritanie coopèrent en plusieurs domaines. Pour le moment, les travaux de recherche et de développement conjoints sont à la phase d'étude. Il existe un Secrétariat général permanent à l'OMVS pour coordonner toutes les recherches et études menées en commun entre ces trois pays.

Les domaines de coopération visent les points suivants :

A) Recherche agricole (ou, plus exactement, détermination et mise au point des méthodes de mise en valeur agricole) : il s'agit de combiner les résultats de recherche acquis dans le cadre du bassin du Sénégal aussi bien que dans le monde entier, pour déterminer les caractéristiques d'ensembles technologiques complets adaptés aux conditions physiques et socio-économiques de la vallée du delta. Il faudra ensuite appliquer ces ensembles technologiques en les incorporant aux projets de développement nationaux, tout en veillant à les réadapter selon les conditions spécifiques existantes pendant l'avancement des projets de développement.

La mise au point des ensembles technologiques de base demandera une attaque pluridisciplinaire disposant de moyens importants. L'exécution de ce travail, séparément par chaque Etat, conduirait à des duplications inutiles et coûteuses. De surcroît, il serait difficile à chaque Etat de mobiliser les ressources humaines nécessaires à une attaque pluridisciplinaire effective permettant des résultats rapides. La mise au point des techniques spécifiques à appliquer dans chaque projet, nécessite toutefois que ce travail soit étroitement associé à l'effort de développement national accompli par chaque participant.

Il faudrait aboutir à une concertation multinationale qui permette d'éviter la duplication des programmes, de promouvoir et d'assurer l'utilisation généralisée des résultats acquis, et de veiller à une bonne répartition des stations expérimentales le long du bassin du Sénégal.

B) Transport maritime :

Problèmes posés par l'étude du fleuve Sénégal et des équipements nécessaires au transport fluvial et maritime.

C) Energie et son utilisation :

Les études de factibilité sur les possibilités de production de l'énergie sont achevées. Les études d'exécution ne pourront toutefois démarrer que lorsque le financement des ouvrages sera assuré. Dans le présent programme, il s'agit essentielle-

ment d'études multinationales sur l'utilisation de l'énergie. Les utilisations à des fins nationales seraient définies par chaque Etat concerné qui ferait des propositions pour inclusion dans un programme d'ensemble. La même approche pourrait être envisagée pour les études de ressources minières qui sont pour l'instant menées sous forme de projets nationaux.

D) Les études d'aménagement hydroagricoles :

Quoique les projets de développement de la production agricole doivent être essentiellement de caractère national, il pourrait être intéressant pour les Etats intéressés de créer un bureau d'études commun pour les aménagements hydroagricoles. Ce bureau pourrait organiser des travaux conjoints de recherche, superviser les études effectuées par les unités de recherche participantes (par exemple, sociétés contractantes) et contrôler l'état d'avancement des travaux.

E) Diverses autres études : liées au développement intégré du bassin du fleuve Sénégal: sociologique, médicinal, industriel, etc.

Note explicative (2)

Coopération avec le Zaïre : recherches sur l'énergie nucléaire :

Le département Carbone 14 de l'IFAN (Université de Dakar) désire coopérer avec le Centre Nucléaire de TRICO, Kinshasa, placé sous la tutelle du Ministère de l'Energie. Le C 14 dispose d'un important matériel de mesure d'énergie nucléaire et procède quelquefois à certains essais et mesures atmosphériques.

Note explicative (3)

Coopération avec la Côte d'Ivoire :

Une délégation ivoirienne du Ministère de la Recherche Scientifique a séjourné à Dakar du 10 au 17 février 1973 dans le but de jeter une base de coopération scientifique et technologique entre la Côte d'Ivoire et le Sénégal. Cette démarche fait suite à la visite officielle du Président Léopold Sédar en Côte d'Ivoire en 1972. Comme il est possible de le constater, dans les réponses du Sénégal aux matrices A et B, la coopération avec la Côte d'Ivoire concerne plusieurs secteurs mais priorité sera donnée à l'agriculture et à l'élevage. Une concertation permanente sera établie entre les deux organismes chargés de coordonner les travaux de recherche dans les deux pays.

Notes explicatives (4) et (6)

Le Sénégal souhaite coopérer avec le Nigéria par des échanges d'informations entre les instituts de recherche des deux pays.

Note explicative (5)

Coopération avec le Niger : Recherche sur l'utilisation de l'énergie solaire

L'Institut de Physique Météorologique (Faculté des Sciences, Université de Dakar) fait des recherches sur l'utilisation de l'énergie solaire. Cet Institut souhaite coopérer avec l'Office de l'énergie solaire (ONERSOL) de Niamey (but : des études conjointes concernant une meilleure rentabilité de la pompe solaire).

Dans le domaine de l'agriculture et de l'élevage, des échanges d'informations doivent être organisés entre les services techniques du Niger et du Sénégal.

Note explicative (7)

Coopération avec la Haute-Volta :

Le Président Sangoulé Lamizana, Président de la République de Haute-Volta, répondant à l'invitation de Monsieur Léopold Sédar Senghor Président de la République du Sénégal, a effectué une visite de travail au Sénégal du 12 au 15 février 1973. Les deux parties ont conclu un accord tendant à renforcer leur relation en vue de favoriser davantage leur coopération dans les domaines scientifiques et techniques.

Note sur la coopération avec la Gambie

Recherche Génie Hydraulique, Industriel et des Transports :

Pendant la 8ème session du Comité sénégalo-gambien les deux délégations ont procédé à l'examen du projet relatif aux études hydrologiques et topographiques du bassin du fleuve Gambie. Le Comité a demandé à la firme contractante de poursuivre des études qui permettront aux deux gouvernements de connaître les possibilités et les effets de l'aménagement du fleuve, pour la mise en valeur du bassin entier et dans l'intérêt des deux parties concernées.

Au sujet du futur pont transgambien les deux parties ont convenu de terminer la phase d'études le plus rapidement possible. Le Comité a en outre insisté sur la nécessité d'entreprendre dans les plus brefs délais des études pour la construction de la route Bignona-Brikene.

Note sur la coopération avec le Nigéria

Recherche dans les domaines des sciences de l'ingénieur et des sciences agricoles :

Le Sénégal souhaite coopérer avec le Nigéria en échangeant des informations entre les instituts de recherche et en organisant des réunions professionnelles et autres contacts intellectuels entre les chercheurs et les exécuteurs des projets de recherche.

Note générale sur la coopération avec d'autres pays

La coopération avec d'autres pays est vivement souhaitée, aussi, ne serait-ce que sous l'angle d'informations scientifiques entre pays africains voisins qui s'ignorent généralement sur le plan scientifique.

Note sur la coopération avec le Conseil africain pour l'arachide

Un projet régional de recherche sur l'aflatoxine devrait être élaboré au sein du Conseil africain de l'arachide. Avec l'élargissement de la CEE, les pays africains francophones et anglophones pourraient coopérer pour la mise en oeuvre de ce projet qui serait susceptible d'être financé par le FED. L'Institut de Technologie Alimentaire de Dakar pourrait servir comme centre de recherche régional.

Note sur la coopération avec l'Institut International d'Agriculture Tropicale, Ibadan

Les travaux de l'Institut International d'Agriculture Tropicale (IITA) pourraient intéresser le Sénégal. Un échange d'informations concernant les résultats de la recherche est souhaité.

Note générale concernant l'Université de Dakar

Au sein de l'Université de Dakar, il existe diverses unités scientifiques qui coopèrent avec d'autres universités africaines.

L'Association scientifique de l'Ouest africain (WASA) est une association qui a été créée il y a une dizaine d'années et qui a regroupé au début les associations scientifiques du Nigéria, du Ghana et du Sierra-Léone. Ces associations nationales sont constituées de chercheurs à titre personnel, leur vocation étant l'encouragement de la recherche scientifique et la compréhension et la diffusion de la science en Afrique de l'Ouest. La WASA a pour but de faciliter les contacts entre ces associations nationales en publiant un journal et en organisant des conférences scientifiques. La revue de la WASA paraît régulièrement depuis 1961 en abordant surtout les aspects de la recherche universitaire. Des conférences ont eu lieu tous les deux ans successivement au Nigéria, au Ghana et en Sierra Léone (Freetown). A cette dernière conférence assistaient certains chercheurs de l'Université de Dakar, de l'IFAN, de l'ORSTOM Sénégal et Côte d'Ivoire. Ce fut l'occasion pour de nombreux anglophones de découvrir qu'il y avait de très nombreux organismes de recherche en Afrique francophone.

A un conseil d'administration de la WASA, les représentant des pays anglophones ont émis le souhait de voir se constituter des associations de chercheurs dans les pays francophones, avec affiliation à la WASA de façon à permettre de réels et efficaces échanges d'informations scientifiques entre pays africains voisins qui s'ignorent généralement sur le plan scientifique. Afin de faciliter cet élargissement de la WASA, les responsables anglophones décidaient d'éditer leur bulletin en langue anglaise et française et de lui donner un titre double, en ajoutant en français "Journal de l'Association scientifique de l'Ouest africain". Depuis 1967, c'est un fait acquis. En 1967, une association scientifique de Côte d'Ivoire a été créée et, en avril 1968, la conférence générale de la WASA a eu lieu avec un très grand succés en Abidjan. En 1970, une section sénégalaise de la WASA a été créée. Celle-ci a participé à la conférence au Nigéria en avril 1970. Le Secrétaire général de la section sénégalaise est le Doyen de la Faculté des Sciences.

Note générale concernant la coopération dans le domaine des sciences sociales

Les membres du Conseil International de la Philosophie et des Sciences Humaines désirent développer sur le plan international la coopération de la philosophie des sciences humaines et des disciplines connexes et de servir par là la recherche au moyen d'un organisme approprié. Le Délégué régional pour l'Afrique est le Professeur A. N'Daw, chef du département de la philosophie à l'Université de Dakar.

Ces membres estiment nécessaire d'organiser, en vue de la confrontation des résultats obtenus, l'interpénétration des recherches portant sur la philosophie, les sciences humaines et des disciplines connexes. Ils considèrent qu'une étude comparative approfondie des civilisations mettra en évidence

la richesse et la dignité de chacune des cultures nationales et, par là, leur droit à un commun respect. Ils sont persuadés qu'une meilleure connaissance de l'homme, de ses instincts, de ses moeurs et de son comportement individuel et collectif, est la condition indispensable du rapprochement des peuples en ce qu'elle fait apparaître la concordance des aspirations essentielles de l'homme en même temps qu'elle inflige aux préjugés de race la condamnation la plus décisive. Ils sont conscients de l'intérêt qu'il y a à aider chaque fois que possible la réalisation de l'unité morale et spirituelle de l'humanité.

C'est sur la base de ces considérations que la Conférence des Directeurs d'Institutions de Recherche Economique et Sociale en Afrique (1) s'est tenue à Dakar du 29 janvier au 1er février 1973. Durant cette réunion, il a été beaucoup discuté de la coopération internationale africaine, de la mise en oeuvre de la coopération régionale :

- application par les instituts de leurs résultats de recherche ;
- réunions professionnelles ;
- contacts intellectuels avec chercheurs et exécuteurs de projets.

Avec l'augmentation sensible en qualité et en quantité des instituts de recherche dans les pays africains, il sera peut-être bientôt possible d'envisager sérieusement des programmes de recherches régionaux. Le Secrétariat permanent de la CODESRIA est assuré provisoirement par l'Institut Africain de Développement Economique et de Planification (IDEP), Dakar.

SUDAN / SOUDAN

I. CO-OPERATION WITH AFRICAN COUNTRIES IN THE FIELD OF ANIMAL RESOURCES

A. EXISTING PROJECTS

(a) Near East Animal Health Institute

Regional project undertaken by five Near East Countries - Iran, Iraq, Lebanon, Sudan and Egypt. The objective of the project is the establishment in each of the five countries of an Animal Health Institute for research into the control of the local animal diseases of major economic importance.

In the Sudan, a laboratory was established and equipped for research on contagious bovine pleuropneumonia and contagious canine pleuropneumonia. Considerable work was done on the development of a lyophilized egg adjuvant vaccine.

The sponsoring agency is the United Nations Development Programme. Coordination on a regional basis is carried out by an office located in Beirut, Lebanon.

Libya and Somalia are members of the Near East Region of FAO. They could also benefit from this Project which is now being extended as : Near East Animal Health and Production Coordinating Unit.

(b) Joint Project n° 15

The objective of this project is the control and eradication of Rinder Pest Disease from several African countries, including the Sudan.

The D.R. of the Sudan joined phase IV of the project which continued for three years (1969-1972). Countries involved in this phase, besides the Sudan, are Ethiopia, Somalia, Kenya, Uganda and Tanzania. The policy is to vaccinate cattle, all ages, with tissue culture vaccine, for three successive years. The sponsoring agency in the OAU/STRC. Technical Aid from the UK has been obtained to support this activity. The project is still operating and it is believed that cooperation between the Sudan and its neighbours - namely Chad, Uganda, Kenya and Ethiopia - must continue for a long time to come in connection with rinderpest control.

Another disease on which a joint effort is being arranged by OAU is contagious bovine pleuropneumonia. In this field, cooperation between Sudan, Chad, Uganda, Kenya and Ethiopia is essential.

B. FUTURE PROJECTS

(a) Animal Production

Cooperation with Egypt and Kenya in proposed, is the fields of Animal Production and Animal Selection. These fields, in our opinion, are very wide and cover breeding, development and selection of suitable breeds ; the use of information concerning artificial insemination; and experience gained in these fields.

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(1) Connue désormais sous le sigle : CODESRIA.

Priority:Medium.

(b) Fisheries and Wildlife

Cooperation is required with Egypt in the following : Utilization of fish resources - including fish finding, fish processing, and fish boats and gear. Field of activity : Red Sea and Lake Nubia.

Priority : High.

(c) Wild-life Conservation and Management

Suggest cooperation with Uganda (High priority), Ethiopia (Medium priority) and Central African Republic (Medium priority).

II. POSSIBLE COOPERATION WITH AFRICAN COUNTRIES IN THE FIELD OF FOOD INDUSTRIES

1st Priority : - Egypt

Egypt is well advanced in the field of food industry research and production. It is advanced in fruits and vegetables, starch and its by-products, brewer, baking, sugar and confectionaries, etc. It has 20 institutes for food industry.

- Niger

Niger, where SADIAMIL and SOTRAMIL are located, is well advanced in the field of cereal processing in research and application.

2nd Priority : - Kenya

Kenya is advanced in the field of export of fresh fruit and vegetables, canned pineapple ; meat processing ; and industry of canning and dehydration.

- Nigeria

Nigeria is advanced in the field of oil processing. It has 19 institutes working on food and food-related research.

- Ivory Coast

Ivory Coast is advanced in processing of cocoa and it has 11 institutes working on food and food related research.

3rd Priority : - Ethiopia

Ethiopia is advanced in export of fresh fruits and vegetables, processing of coffee. It is a good market for Sudanese cereals due to similar food habits.

- Algeria

Algeria is advanced in the field of wines industries.

- Somalia

Somalia has good experience in the field of export of fresh fruits, especially bananas.

III. MEDICAL FIELDS : EXISTING COOPERATION IN A.GAMBIAE RESEARCH AND CONTROL IN LAKE NASSER AND ITS EXTENSION LAKE NUBIA BETWEEN EGYPT AND THE SUDAN

The building of the High Dam and the formation of Lake Nasser and its extension into the Sudan, Lake Nubia, has had, as a consequence, the upsurge of new health hazards of some considerable magnitude, most important of which is the possible invasion of the lake by Anopheles Gambiae from the Sudan. A. Gambiae is a notorious mosquito and has in fact invaded Egypt as a ubiguitous mosquito twice in the last two decades. In 1942, it caused a severe epidemic of malaria in Upper Egypt causing one million cases. The death rate in that outbreak was greater than that due to cholera in 1947.

The second time was in 1950 when it was eradicated very efficiently from Upper Nubia.

Therefore, as a result of a recommendation by the World Health Organization, coordination was established in the control of A. Gambiae between the Sudan and Egypt. Consequently, there is now a project in which both countries are cooperating by surveying the entire lake every few months.

There is a bilateral agreement that all the area North of Abu Fatma should be kept free of A. Gambiae.

1. Institutions : Regional Planning of Aswan : through the Medical Entomology Research Institute Dokki, Cairo, and the Medical Entomology Branch of the Central Health Research Laboratories, Khartoum, Sudan, POB 287.

ii. The researchers on the Egyptian side are :

Dr. Amin Musa Gad Ph. D. Medical Entomology Research Institute, Dokki, Cairo.

Mr. Abdulla Said B.Sc. Agriculture, Lake Nasser Development Centre, Regional Planning of Aswan.

iii. The researchers on the Sudanese side are :

Dr. Osman Mohmed Abdel Nur, Ph. D.

Mr. Mustafa Beshir, M.Sc.

The agreement was negotiated in 1970, and resulted in a protocol which was ratified by both governments in the same year. The surveying is carried out by scientists from both countries concurrently and as one group.

It takes the form of lake-wide surveys of mosquitoes and other insects, with particular reference to A. Gambiae.

From time to time these teams are joined by the Director of Malaria Control, United Arab Republic of Egypt, and the Province Medical Officer of Health Northern Province, Sudan, as administrators.

T O G O

MATRICE A

Note explicative (1)

Informatique et statistique générale.

Pour ces deux disciplines, une forme de coopération existe déjà entre les Etats membres de l'OCAM, par la création de l'Institut d'Informatique de Libreville. Le Zaïre est associé à ce projet (ancien membre de l'OCAM, et par le fait que le premier directeur de cet Institut est un citoyen de nationalité Zaïroise). M. Théodore Kponton et M. Nazaire Freitas sont les spécialistes togolais de la statistique et participent souvent aux travaux de cet Institut.

Dans le domaine de l'Electronique, il existe au Ghana, une industrie de montage d'appareils électroniques, la Ghana Sanyo, en association avec le Japon. Le marché togolais étant fourni dans ce domaine par une autre importante firme japonaise, SONY, on peut noter qu'une perspective de coopération Ghana-Togo existe, avec l'appui stratégique du Japon, éventuellement en association avec la République fédérale d'Allemagne.

Note explicative (2)

Dans le domaine de la Physique, des contacts ont été pris entre M. Albert Kekeh (Togo, Directeur de l'Ecole des Sciences de l'Université du Bénin) et M. Abdou Moumouni (Niger) lors de la Conférence de l'OCAM tenue à Lomé (Avril 1972). Les conversations ont été axées sur une éventuelle coopération, surtout dans le domaine de l'énergie solaire.

Note explicative (3)

En ce qui concerne la Chimie, liée aux recherches sur la pharmacopée africaine, le Ghana et le Nigeria paraissent beaucoup en avance. En 1970, un docteur en chimie, M. Gerson Hodouto, chef du laboratoire de recherche de Togopharma, s'est rendu à Ibadan (Nigeria) pour assister en tant qu'observateur à la 7ème Conférence biennale de la WASA. Il a pu prendre contact avec le professeur Ekong (Université d'Ibadan) et de collègues venus du Ghana.

Une seconde liaison est assurée par M.Sam Messan Adjamgba, Université du Ghana, Legon, et l'Université du Bénin.

Au Togo même, les autorités nationales ont construit un laboratoire de recherche axé principalement sur la Pharmacopée africaine, et un texte est à l'étude pour la création d'un Centre de Recherche sur la Médecine Traditionnelle Africaine. Chimistes, botanistes, médecins, pharmaciens et autres spécialistes auront alors un cadre de travail adéquat. La coopération amorçée en 1970 et 1971 avec le Ghana et le Nigéria ne pourra qu'aller en profondeur. Les efforts mentionnés ci-dessus doivent être naturellement doublés d'une coopération dans le domaine de la Microbiologie.

Zoologie. Une unité de recherche est actuellement formée à l'Université du Bénin autour de M. Robert Bourgat, et de Mme Marie-Louise Salami, et porte sur la parasitologie. Il existe donc une base nationale de coopération qui pourrait intéresser des collègues des universitès de pays limitrophes.

Géologie et Pédologie. Les recherches géologiques ont été depuis longtemps déjà entreprises dans chaque état d'Afrique dès les débuts de la colonisation. Il existe donc dans chaque pays une équipe et un service de recherches géologiques et minières. Au Togo, les géologues du Bureau de Recherches Géologiques et

Minières (BRGM) constituent une solide ossature. Des équipes équivalentes existent déjà dans les pays limitrophes (Ghana, Haute-Volta, Niger).

Géophysique. Le Centre d'Observation de l'ORSTOM du Sénégal est chargé du Togo. Il existe, de ce fait, une base de coopération Togo-Sénégal-France (par le canal de l'ORSTOM). Il s'agira d'exploiter cette base de coopération.

Note explicative (4)

Comme dans le domaine des recherches géologiques, une tradition identique s'est installée en matière de recherches hydrologiques.

Par ailleurs, un comité hydraulique interétatique a été créé entre certains Etats d'Afrique de l'Ouest d'expression française. Le siège de cet organisme est à Ouagadougou. Ce Conseil dispose, dans chaque Etat, d'un Comité de l'Eau. Au Togo, le Comité de l'Eau est présidé par un représentant de l'Arrondissement de l'Urbanisme et de l'Hydraulique au Ministère des Travaux Publics et comprend des représentants des autres Ministères. L'existence dans chaque Etat, de tels comités, supervisés par un Conseil régent, à Ouagadougou, constitue incontestablement une infrastructure opérationnelle de coopération dans cette matière.

Il existe au Togo, un Centre Régional de Formation pour l'Entretien Routier (CERFER) commun aux pays du Conseil de l'Entente (Dahomey, Côte d'Ivoire, Niger, Togo, Haute-Volta) auquel participe le Zaïre. Ce centre forme les conducteurs d'engins lourds du Génie Civil. Il reste à exploiter cette infrastructure, financée avec le concours de l'US-AID.

Il existe également au Togo le Centre de la Construction et du logement, établi avec le concours du PNUD. Ce centre, où s'est constitué déjà une équipe de chercheurs (chimistes, physiciens, ingénieurs) en se développant, pourrait avoir une vocation internationale.

Génie des Transports. Le Service des Transports Routiers existe au Togo. Il travaille en étroite collaboration avec des homologues des pays du Conseil de l'Entente.

En ce qui concerne les Sciences Agricoles, en général, les observations déjà faites sont valables : existence d'équipes déjà fort anciennes ; existence dans les pays limitrophes, d'équipes similaires.

Par ailleurs, tous les domaines relatifs aux sciences agricoles n'ont pas atteint le même degré d'organisation. C'est ainsi que dans le domaine de la viande, le Fonds de Garantie des emprunts du Conseil de l'Entente permet d'envisager d'importants programmes de coopération.

Les efforts déployés par ce Fonds présagent une coopération fructueuse dans le domaine des sciences agricoles, en collaboration notamment avec l'US-AID.

Note explicative (5)

En dehors des considérations générales déjà faites, il faut noter que dans le domaine des Sciences médicales, les organismes internationaux tels que l'OMS, l'UNICEF en unifiant leurs interventions, aident les Etats Membres à une collaboration plus active.

En outre, le Togo et le Ghana viennent de signer un accord de coopération dans le domaine de la Santé Publique et de la Recherche Médicale (30 mars 1973).

Note explicative (6)

Le Département d'Archéologie de l'Université du Ghana fait des travaux importants et ses résultats pourraient être exploités par le Togo étant donné la similitude des sites. Cependant, l'expérience des autres pays en la matière, (Mali, Haute-Volta, Nigeria...) ne doit pas être négligée.

Dans le domaine de l'Anthropologie Culturelle et Sociale de l'Ethnologie de l'Histoire de l'Afrique, de l'étude des langues nationales, de la Sociologie, il existe le Centre Régional pour la Tradition Orale (CRDTO) créé à Niamey. Ce centre, qui a une vocation régionale, a pour but de coordonner les travaux de recherche des chercheurs des pays concernés. Etabli avec l'assistance de l'Unesco, le centre est régi par une convention ratifiée par le Togo. D'ores et déjà, deux chercheurs togolais travaillent partiellement sur un programme qui a reçu l'accord du CRDTO.

Démographie et Population. Dans le cadre de la célébration de l'année 1974 comme année de la population, un certain nombre de séminaires régionaux sont organisés avec l'assistance d'organismes de pays industrialisés. C'est ainsi qu'un séminaire a été organisé à Accra (Ghana) en janvier avec la participation de chercheurs des pays limitrophes avec l'assistance du Carolina Population Centre (University of North Carolina & Chapel Hill). Une Table Ronde a été prévue à Lomé (30 juillet - 3 août 1973) par le CODESRIA (Conseil pour le Développement de la Recherche Economique et Sociale en Afrique, Dakar).

Enfin, des programmes spécifiques sont en cours ou à l'étude qui associeront des chercheurs togolais avec la participation de chercheurs d'organismes étrangers (Carolina Population Center.CICRED - France).

Notes explicatives générales

a) Economie politique :

L'existence de la Banque Centrale des Etats de l'Afrique de l'Ouest BCEAO, est un moyen de coopération entre Etats Membres.

Dans le cadre de l'OCAM, les Etats mettront au point un plan comptable commun des pays de cette organisation inter-africaine. Au Togo c'est l'équipe du Service de la Statistique qui est chargée de cette matière.

b) Sciences humaines et sociales :

Il existe un projet de l'Unesco pour la création en Afrique du Sud du Sahara, d'un Centre de Recherche et de Coordination dans les Sciences sociales. A la Conférence au Sommet de l'OCAM, tenue à Lomé en avril 1972, le Togo a posé sa candidature pour abriter ce futur centre et a demandé aux Etats Membres de soutenir sa candidature à la Conférence générale de l'Unesco lorsque cette question viendra à l'ordre du jour de la Conférence.

Auparavant, en février 1971, le Togo, avec l'assistance de l'Unesco a organisé une Table Ronde sur le rôle des sciences sociales et humaines dans le développement. La Table Ronde a soutenu l'idée de la création d'un Centre de Coordination, de Documentation et de Recherche en Sciences Sociales en Afrique.

Par la suite le gouvernement togolais, avec la participation de l'Unesco a organisé une seconde Table Ronde sur la Planification des activités de recherche en Sciences Sociales en Afrique, du 3 au 10 Octobre 1972. La Table Ronde de Lomé a défini un programme de recherche et exprimé son point de vue selon lequel l'objectif à long terme est la création en Afrique du Sud du Sahara d'un Centre de Recherche de Documentation de Coordination en Sciences Sociales. A la 17ème Conférence générale de l'Unesco, le Ministre Togolais de l'Education Nationale a officiellement posé la candidature du Togo pour abriter ce futur centre. Le Togo s'offre par conséquent, dans ce domaine, comme pays ouvert à la coopération scientifique internationale.

c) Sciences de l'Education :

Au niveau de l'enseignement supérieur, un Conseil Africain et Malgache de l'Enseignement Supérieur, siègeant à Ouagadougou (Haute-Volta) tente de résoudre les problèmes posés par l'harmonisation des enseignements, l'équivalence des diplômes, dans les Etats membres.

MATRICE B

Note explicative générale pour la section "B.1 AGRICULTURE"

Pour les 4 domaines considérés (Production Agricole, Irrigation et Drainage, Hygiène Animale et Lutte contre les Maladies, Produc-Animale) il existe une base sérieuse de coopération : le Conseil de l'Entente et le Fonds de Garantie qu'il a créé. Des accords ont été signés par les cinq partenaires entre eux, et avec les Etats-Unis notamment pour l'encouragement de la production animale.

Production d'engrais. L'exploitation des phosphates de KPEME sur la côte togolaise est une occasion pour développer la coopération en matière de production d'engrais. Même si à l'étape actuelle, le phosphate est exporté, à l'état brut ou semi-traité, la richesse du minerai, l'importance des réserves font augurer la possibilité de création d'industries chimiques, notamment dans le domaine des engrais. Cette coopération pourra intéresser tous les pays limitrophes. A l'étape actuelle, les possibilités de coopération n'ont pas été étudiées à fond.

En matière de pêche, la coopération germano-togolaise est très active.

Le Fonds de Garantie des emprunts du Conseil de l'Entente s'intéresse particulièrement au problème de la viande.

Dans le domaine de l'industrie textile, les recherches entreprises par l'IRCT (Institut de Recherche sur le Coton et les Textiles) occupent une place importante. L'IRCT est un organisme de recherche et de coopération franco-togolaise (chercheurs français et togolais, contribution financière des deux pays). Par ailleurs, l'industrie textile togolaise de Dadja, vers le centre du pays, est une entreprise de la coopération germano-togolaise. Les tissus produits par cette entreprise ont conquis le marché togolais en tissus imprimés.

Note explicative (7)

L'exploitation des carrières a donné lieu au Togo à la naissance de grandes entreprises telles que la CIMAO (Ciment d'Afrique Occidentale) en coopération avec la Côte d'Ivoire et

la France. Cette entreprise pourrait approvisionner, plus tard, les pays voisins en ciment (Ghana, Dahomey, Nigéria, Haute-Volta).

Par ailleurs, le marbre a donné naissance à la SOTOMA, Société Togolaise de Marbrerie, entreprise également florissante qui exploite le marbre togolais.

L'exploitation de ces diverses carrières peut être le point de départ d'une coopération fructueuse entre le Togo et les pays voisins.

Note explicative (8)

Grâce à la coopération canadienne, l'énergie hydro-électrique fournie par le barrage d'Akossombo sur la Volta (Ghana) alimente actuellement le Togo et le Dahomey. La construction des lignes haute tension pour le transport de l'énergie a donné l'occasion à une fructueuse collaboration des trois pays : Ghana, Togo et Dahomey. Dans la perspective d'une impulsion à donner à la recherche une coopération peut avoir lieu sur la base des relations déjà établies.

Note explicative (9)

Un projet d'utilisation de l'énergie solaire a été soumis pour financement au PNUD par le Niger. Le principal responsable du projet est M. Abdou Moumouni. Il a pris contact au Mali, en Haute-Volta, au Togo et au Dahomey pour que ces pays soient associés au projet. Le Dr. Albert Kekeh, Directeur de l'Ecole des Sciences de l'Université du Bénin a été vivement intéressé par la suggestion de M. Abdou Moumouni.

Raffinerie de pétrole. Il existe un projet de raffinerie de pétrole au Togo. La pose de la première pierre a eu lieu en Mai 1973. C'est un projet dont la réalisation est financée par les parties intéressées (Togo, Royaume-Uni et Etats-Unis d'Amérique, République fédérale d'Allemagne).

Construction d'aéroports. Un certain nombre de pays africains sont groupés au sein de l'ASECNA (Association pour la Sécurité de la Navigation Aérienne). C'est sous l'égide de cet organisme que sont conçus les programmes de construction et de gestion des aérodromes des pays membres.

Installations portuaires. Le port autonome de Lomé est construit dans le cadre de la coopération germano-togolaise.

La route internationale Lomé-Haute-Volta se construit dans le cadre d'un prêt du Fonds Européen de Développement.

MATRICE C

Notes explicatives diverses

a) L'Institut Géographique National (France) est l'organisme qui s'occupe des services de cartographie dans la plupart des pays francophones d'Afrique de l'Ouest, dont le Togo. Il y a également l'ORSTOM. Des services analogues existent dans les états africains anglophones (Ghana, Nigéria). Les services de cartographie établis par des institutions américaines, et intéressant l'Afrique, existent également. Ce sont là des bases d'une coopération, bases qui pourraient être utilement exploitées.

b) Il existe à Niamey le Centre Régional de Documentation et de Recherche sur la Tradition Orale, regroupant les pays qui ont élaboré un programme dit "Plan Coordonné de Ouagadougou" amendé à Niamey (juillet 1970). Le CRDTO offre son cadre à la coopération des chercheurs désireux d'exécuter des programmes de recherche concernant la collecte sur la tradition orale. Le centre fonctionne avec l'assistance des gouvernements africains et l'Unesco.

Le Togo a ratifié l'accord créant le CRDTO.

c) Centres de Conférences. Le Togo, grâce à une infrastructure hôtelière moderne, grâce à des installations de traduction simultanée équipées (à Lomé, il existe une salle de 3.000 places avec les équipements d'écoute pour 800 personnes, et une seconde salle de 50 personnes équipée pour les petites conférences), à une infrastructure concrète pour la coopération internationale. Du reste, des démarches sont en cours avec le Coordinateur du CODESRIA (Conseil pour le Développement des Instituts de Recherche en Afrique : IDEP, Dakar) afin de voir si Lomé ne pourrait pas être choisi comme plaque tournante des réunions de travail du CODESRIA, étant donné qu'en plus du caractère fonctionnel des installations de Lomé, le Togo occupe une position géographique centrale pour plusieurs pays africains, et cela comporte un atout financier non négligeable. Les frais de transport vers le Togo des participants à ces conférences constituent également un stimulant : il est plus cher d'aller vers un bout de l'Afrique que de converger vers un pays ayant une position géographique centrale.

d) Service de traitement de l'information. Il existe déjà, au niveau des pays de l'OCAM, une coopération dans le domaine de l'Informatique (le Centre de Libreville au Gabon).

De plus, le dépouillement et l'analyse des résultats du recensement général de la population de Mars 1970 au Togo a posé des problèmes à ce pays. Des arrangements ont été conclus et, grâce à la coopération des services de l'Université du Ghana à Legon, le traitement des données pourra être fait. On pourrait développer et généraliser cette expérience de coopération dans le domaine du traitement de l'information.

Note explicative (10)

a) Information bibliographique. Une petite expérience d'échange d'information bibliographique existe à titre individuel entre des chercheurs togolais et dahoméens (Instituts de Recherche Appliquée du Dahomey), et togolais et ghanéens (Université du Ghana, Legon : Institute of African Studies, Department of Sociology). On pourrait généraliser l'expérience à des bibliothèques, dépassant le cadre des individus. Les ouvertures mentionnées dans les notes 13 et 14 peuvent être utilisées comme canaux possibles de cette coopération.

Il existe au niveau de l'OCAM, un Office Africain et Malgache de la Propriété Industrielle (OAMPI) qui joue le rôle de bureau de dépôt des brevets. Le Togo en est membre.

b) Revues. Un système d'échanges de publications est établi entre certains organismes togolais et des institutions similaires des pays mentionnés. Il reste à systématiser ces échanges de façon à constituer des collections complètes.

La jeune Université du Bénin et les autres institutions de recherche sont confrontées aux problèmes des collections. Des missions sont envoyées dans des pays présumés avoir une certaine expérience en la matière.

Au niveau de l'OCAM, des tentatives sont faites pour harmoniser les techniques d'éducation (plusieurs réunions ont déjà eu lieu sur l'enseignement de l'histoire et de la géographie d'Afrique).

TUNISIE / TUNISIA

Notes explicatives

(1) Le Ministère des affaires culturelles et de l'information signale ce qui suit :

Descriptions des projets élaborés dans le passé :

- Création du Comité maghrebin pour l'Archéologie, les Musées, les Monuments et Sites, les Arts et Traditions populaires.

- Activités pour favoriser la concertation entre les pays du Maghreb afin de promouvoir une action commune en matière d'archéologie et de défense du patrimoine culturel maghrébin.

- Rencontre annuelle dans l'un des pays du Maghreb.

- Réalisation de projets en commun : Centre maghrébien de Tipaza (Algérie) ; Laboratoire Central d'Analyse et de Restauration (I.N.A.A. Tunisie). Fouilles communes : projet Tunis-Carthage ; Qualaâ des Beni Hammad (Algérie) ; Sijilmassa (Maroc).

Rapports relatifs aux négociations :

- Des négociations sont en cours avec la Libye et l'Egypte.

- Des contacts sont prévus avec la Mauritanie, le Sénégal et le Zaïre.

(2) Le Ministère de l'éducation nationale s'intéresse aux projets de coopération dans le domaine de la mécanique des fluides et plus spécialement du transfert de chaleur et de masse. Il s'intéresse aussi à une coopération dans l'étude de l'écoulement de l'eau à travers les milieux poreux (problème d'intérêt pour l'agriculture). Cette coopération se ferait par l'entremise de l'Institut de Recherches Scientifiques et Techniques (I.R.S.T.) (5 chercheurs).

(3) Le Ministère de l'éducation nationale signale que la chimie organique peut constituer une base assez large de coopération dans la mesure où elle n'exige pas une infrastructure technique très avancée. Les investigations peuvent être menées par des procédés classiques. En outre, elle débouche directement sur l'industrie. Cette coopération se ferait par l'entremise de la Faculté des Sciences (9 chercheurs).

(4) Le Ministère de la Santé Publique signale ce qui suit :

La coopération dans le domaine de la Santé Publique constitue une nécessité tout au moins entre pays où la pathologie, l'écologie et les conditions climatiques sont très voisines. Cette coopération peut se concevoir parfaitement dans la lutte contre l'épizootie rabique nord-africaine, les foyers impaludés qui gagneraient à être entièrement éradiqués ou encore l'étude des moyens à mettre en oeuvre pour prévenir ou juguler le choléra.

Si l'action de l'un des pays nord-africains n'était pas faite d'une façon conjuguée avec les pays voisins, le résultat serait d'une efficacité très réduite étant donné que l'extension de la maladie se ferait à partir du ou des pays dans lesquels la lutte contre pareils fléaux n'aurait pas été entreprise. Ceci montre bien l'utilité et même la nécessité d'une coopération surtout entre pays ayant des problèmes pathologiques communs.

L'institution depuis une dizaine d'années environ de Journées Maghrébines puis d'un Congrès Maghrébin de Médecine ont visé justement de pareils objectifs.

Par ailleurs, en raison de la spécialisation très poussée qui nécessite à la fois des cadres nombreux et des moyens importants, les pays en voie de développement comme la Tunisie ont intérêt à avoir des rapports constants non seulement avec les pays d'Afrique mais également avec des pays avancés (France, Royaume-Uni, Etats-Unis d'Amérique), ce qui permettrait aux cadres tunisiens de se perfectionner et d'accéder aux techniques modernes.

Les domaines de coopération pourraient inclure les suivants :

a) la collaboration dans le domaine de la production de l'échange de sérums et vaccins entre les pays d'Afrique du nord est vivement conseillée puisque d'une part aucun de ces pays ne peut à lui seul assurer la production de toute la gamme de ces produits et que d'autre part, la fabrication des sérums antiscorpionique et antivipérin nécessite des scorpions et des vipères qu'on rencontre aisément dans ces pays. Aussi, un partage pourrait se faire entre les pays d'Afrique du nord pour la production et la commercialisation de ces sérums.

b) L'épidémiologie des maladies transmissibles existant en Afrique du nord pourrait être utilement étudiée par les pays maghrébiens. La Tunisie serait en mesure de promouvoir une telle action dès que le projet de création d'un laboratoire Central de Santé Publique, prévu pour la période 1974-1978, aura été réalisé.

c) Des études comparatives touchant un certain nombre de maladies existant dans le maghreb pourraient être envisagées par les services nationaux de médecine. Dans le domaine de la médecine interne, il s'agirait de l'étude d'affections telles que la cirrhose dite "méditerranéenne", la maladie tuberculeuse, etc. Un tel projet pourrait également intéresser d'autres pays riverains de la Méditerranée. Des chercheurs à l'Hôpital Charles Nicolle s'intéressent à ces questions, ainsi qu'à des recherches dans le domaine de la bactériologie (streptocoque et son action dans certaines affections tels que le rhumatisme articulaire aigü ou les néphrites).

d) Des études de microbiologie pourraient également faire l'objet de coopération (epizootie rabique, paludisme, affections entériques), avec la participation des chercheurs de l'Institut Pasteur de Tunis.

e) En matière de pathologie, on pourrait entreprendre un travail en commun sur certaines affections particulièrement fréquentes en Afrique du Nord (cancers du cavum, sarcomes lymphoïdes, etc.).

f) Enfin, l'Hôpital Razi de la Manouba, spécialisé en psychiatrie pourrait mener des recherches en commun avec des institutions appropriées d'autres pays.

g) Faut-il aussi signaler que plusieurs projets de coopération entre la Tunisie et avec des pays autres que ceux du Tiers-Monde existent déjà : à l'Institut d'Ophtalmologie de Tunis, avec l'aide de la F.I. Proctor Foundation, University of California, San Francisco, on étudie l'épidémiologie, l'histoire naturelle et le contrôle du Trachome ; à l'Institut de Pneumophtisiologie de l'Arina, avec l'aide du U.S. Health Department, on étudie la rentabilité de la microscopie

directe dans le dépistage de la tuberculose pulmonaire ; à l'Institut National de la Santé de l'Enfance à Tunis, avec l'aide d'organismes des Etats Unis d'Amérique, on poursuit des recherches sur la croissance et le développement des enfants, et sur la réponse immunologique chez les enfants malnutris ; à l'Institut National de la Nutrition à Tunis, avec la participation de US-A.I.D., on mène une enquête nationale sur les maladies nutritionnelles, et on étudie la Lysine, etc.

(5) Le Ministère de l'Agriculture signale que la coopération pourrait porter notamment sur :

a) Les disciplines relatives à la connaissance des facteurs du milieu naturel (climatologie, écologie agricole) et les effets de ceux-ci sur les systèmes de culture (agronomie générale) ; ces différentes disciplines peuvent être regroupées dans un thème plus large qui serait l'étude du milieu culturel. En effet, ces différentes disciplines ne peuvent pas être étudiées séparément. L'objectif dans ce domaine est d'établir à partir de la connaissance des principaux facteurs du milieu naturel les systèmes de culture les mieux adaptés de façon à assurer l'exploitation rationnelle des ressources naturelles.

b) L'entomologie agricole et la phytopathologie : les dégâts causés aux cultures par les parasites animaux et végétaux sont considérables, la mise au point de méthodes de lutte efficaces nécessite une connaissance approfondie de la biologie de ces parasites d'où la nécessité de développer les études de base dans ce domaine. En entomologie les études portent sur différentes catégories d'insectes et plus particulièrement : la cératite, les cochenilles, les noctuelles, les pucerons, les scolytes...

En phytopathologie les études portent sur différents champignons parasites tels que l'oïdium, fusarium, verticilium ... ainsi que sur les maladies à virus de certaines cultures (cultures maraîchères, arbres fruitiers).

c) La sélection végétale est un domaine privilégié de coopération, car quel que soit le potentiel scientifique sont il dispose aucun pays ne peut se passer de l'importation de matériel végétal soit utilisable directement dans la pratique soit à utiliser dans ces programmes d'amélioration génétique spécifiques. On peut retenir entre autres les groupes de plantes suivantes : les céréales, les arbres fruitiers, les plantes maraîchères et les plantes fourragères.

(6) Le Ministère du Plan signale que la proposition de coopération suggérée avec l'Algérie, l'Egypte et le Maroc pourrait se situer au niveau de :

a) l'Institut d'Economie quantitative - Ali Bach Hamba - dans le domaine des techniques quantitatives de planification : méthodes de planification, méthodes d'estimation des paramètres et des variables économiques. Il s'agit principalement de confronter les expériences dans ce domaine afin de dégager des possibilités d'élaborer des techniques communes à utiliser dans l'élaboration du Plan.

b) L'Institut national de la Statistique pour l'élaboration d'une méthodologie de sondage dans le domaine des enquêtes agricoles et principalement les enquêtes sur l'élevage. De même une coopération pourrait s'établir pour l'amélioration des méthodes d'enregistrement et d'analyse au niveau de l'Etat civil.

(7) Le Ministère de l'Agriculture signale que l'accroissement de la production du secteur agricole constitue l'un des objectifs économiques communs aux pays d'Afrique. La coopération scientifique pourrait intervenir notamment dans les domaines suivants :

a) Les cultures vivrières de base : les céréales (blé et orge) qui constituent la base de l'économie alimentaire des pays à climat méditerranéen. Les techniques traditionnelles de production céréalière ne permettent plus de faire face aux besoins compte tenu de l'accroissement démographique d'une part et de la limitation des superficies à consacrer à ces cultures d'autre part. Ainsi l'accroissement de la production ne pourrait provenir que de l'amélioration de la productivité résultant de :

- l'utilisation de variétés améliorées adaptées aux conditions climatiques particulières de ces régions,

- l'amélioration des techniques culturales,

- la diffusion rationnelle des résultats acquis.

Ces différents aspects et plus particulièrement celui relatif au problème variétal pourraient faire l'objet d'un programme coopératif.

b) L'élevage : production de viande et de lait. De la situation d'exportateurs, des pays tels que les pays d'Afrique du nord sont devenus ou sur la voie de devenir importateurs de viande. La situation en matière de production laitière est encore plus défavorable. Or les résultats des recherches effectuées dans le domaine de l'élevage et de la production fourragère et de l'utilisation des pâturages montrent qu'il existe des marges de progrès considérables dans le domaine de la production de viande et de lait. L'amélioration des résultats déjà obtenus et l'étude des moyens de leur mise en application à grande échelle pourraient constituer un secteur privilégié de coopération régionale compte tenu de l'intérêt que suscite ce secteur.

(8) La lutte contre les processus de dégradation du milieu naturel : parmi les processus de dégradation du milieu naturel il y a lieu de mentionner le phénomène de désertisation qui menace la plupart des zones présahariennes. Ce phénomène mérite une attention particulière en raison des conséquences écologiques, économiques et sociologiques considérables qu'il peut avoir. Il y a lieu non seulement d'analyser le processus mais aussi de mettre au point des techniques permettant d'en limiter les effets néfastes. Un tel objectif nécessite de la part des pays riverains, une conjugaison des efforts. Il est vraisemblable que la réalisation d'un tel projet dépasse les possibilités de financement des pays concernés et nécessite une assistance internationale accrue.

(9) **Le Ministère des affaires culturelles et de l'information signale ce qui suit :**

Description des projets élaborés dans le passé :

- Revue Maghreb
- Revue Africa
- Cahiers des arts et traditions populaires
- Notes et documents (divers).

(10) Le Ministère de l'Agriculture signale que pour être pleinement efficace la coopération au niveau des programmes de recherche dans le domaine agricole doit être prolongée par une coopération au niveau des services de vulgarisation qui sont chargés de la transmission des acquis de la recherche et de l'innovation technique d'une façon générale. Ces services constituent en quelque sorte une structure relai entre les organismes de recherche et les structures de production. Une coopération dans ce domaine viserait notamment à renforcer les échanges de documents de matériel audio-visuel et de tout autre moyen susceptible de faciliter la diffusion des acquis. La coopération pourrait également porter sur la préparation des documents ainsi que sur les problèmes de méthodologie d'une façon générale.

Note générale du Ministère de l'Agriculture sur les projets de coopération scientifique dans le domaine agricole

La recherche agronomique est probablement l'un des secteurs qui se prête le mieux à une coopération scientifique régionale. D'une part parce que l'accroissement de la production agricole est une nécessité vitale, d'autre part parce qu'il existe dans la plupart des pays une structure plus ou moins étoffée dans le domaine de la recherche agricole. La conjugaison des efforts dans ce domaine pourrait porter ses fruits dans les délais assez rapides. Cette conjugaison des efforts peut se traduire par la mise en place de programmes concertés et par un échange systématique d'informations concernant les résultats obtenus et des problèmes rencontrés tant au niveau de la réalisation des programmes qu'au niveau de la transmission des acquis.

Pour que la coopération ait des chances d'aboutir il serait nécessaire :

1°) qu'elle porte sur des sujets prioritaires d'intérêt commun

2°) que chacun puisse y apporter une contribution efficace. Ainsi parait-il indispensable, qu'au moins dans un premier temps, de se limiter d'une part à des zones géographiques présentant des conditions écologiques et agroclimatiques similaires et d'autre part à des domaines dans lesquels chacune des parties dispose d'un minimum de moyens matériels et humains.

Compte tenu de ces remarques, la Tunisie pourrait envisager de renforcer sa coopération scientifique dans le domaine agricole avec les autres pays d'Afrique du Nord (Algérie, Maroc notamment) et éventuellement avec d'autres pays ayant des conditions climatiques similaires.

Quelques thèmes prioritaires pour lesquels la Tunisie pourrait apporter une contribution effective ont été énumérés ci-dessous, et il convient aussi de prendre en considération les données qui suivent.

Les programmes de recherche mentionnés ci-dessus sont du ressort de l'Institut National de la Recherche Agronomique de Tunisie (INRAT) et dans une certaine mesure de celui de l'Institut National Agronomique de Tunis (I.N.A.T.) dont certains enseignants participent aux projets retenus. La collaboration de la Faculté des Sciences de Tunis est également à retenir dans certains domaines.

En ce qui concerne l'objet de la matrice C il y a lieu de mentionner la collaboration de différents services étatiques ou para-étatiques chargés de la vulgarisation agricole.

La liste des principaux chercheurs qui travaillent dans les différents secteurs mentionnés est donnée dans le tableau ci-joint. Il y a lieu de remarquer que :

1°) Seuls les chercheurs nationaux confirmés sont mentionnés, il n'a pas été tenu compte des coopérants étrangers dont le concours doit être considéré comme temporaire.

2°) Il n'a pas été tenu compte des chercheurs en formation tant que leur affectation n'est pas confirmée.

3°) Les noms de certains chercheurs peuvent figurer dans deux projets différents, car on ne peut pas dissocier dans certains cas les recherches par discipline et les recherches par objectif.

Les locaux à usage de laboratoires ou de bureaux, ainsi que les équipements disponibles ne constituent pas dans l'état actuel un facteur limitant essentiel. Il n'en reste pas moins que de nouvelles constructions et de nouveaux équipements sont prévus notamment dans les domaines de l'entomologie et de la phytopathologie compte tenu des besoins nouveaux liés à l'extension de ces disciplines.

D'autre part en plus de l'infrastructure centrale, il existe un important réseau de parcelles expérimentales régionales dont l'amélioration est également prévue.

Il est difficile de préciser les moyens de financements consacrés aux activités mentionnées ci-dessus, car ces activités rentrent dans un programme plus global.

A titre indicatif il y a lieu de mentionner que le budget total de fonctionnement de l'I.N.R.A.T. se situe entre 600 et 700.000 Dinars par an et le programme d'investissement (construction et équipement) retenu pour la quadriennie en cours est de l'ordre de 1 million de Dinars ce qui correspond à environ 250 000 Dinars par an.

Les appréciations données ci-dessus sont de toute évidence trop sommaires pour constituer une base suffisante pour l'élaboration d'un projet de coopération régional. Leur objet est seulement de donner un premier aperçu des domaines prioritaires ou la Tunisie peut apporter une contribution efficace au progrès scientifique et technologique.

MATRICE A :

Recherche et développement expérimental par discipline (orientée-discipline)

1°) Etude du milieu cultural

(Principaux chercheurs - Spécialité - Niveau)

S.El Amami, Bioclimatologie - Ing. en chef.

A. Sifaoui, Agronomie générale - Doct.3è.cycle.

H. Rhaiem, Ecologie - Doct. 3è. cycle.

2°) Entomologie agricole et phytopathologie

(Principaux chercheurs - Spécialité - Niveau)

M. Cheikh, Entomologie - Docteur-Ingénieur.

K. M'Saddaa, Entomologie - Docteur-Ingénieur.

A. Jerraya, Entomologie - Doct. 3ème cycle.

B. Jamoussi, Phytopathologie - Professeur.

A. Mlatki, Phytopathologie - Doct. Ingénieur.

M. Mahjoub, Phytopathologie - Doct.3ème cycle.

M. Jerbi, Phytopathologie - Doct. 3ème cycle.

S. Mhani, Virologie - Ing. Principal.

3°) Sélection végétale

(Principaux chercheurs - Spécialité - Niveau)

A. Maamouri, Céréales - Ing. Principal.

M. Lasram, Arboriculture - Ing. Principal.

A. M'Hedhbi, Cult. Maraîchères - Ing.Principal.

MATRICE B :

Recherche et Développement Expérimental par objectif (orientée-mission)

1°) Amélioration des productions céréalières

(Principaux chercheurs - Spécialités - Niveau)

A. Maamouri, Génétique - Ing. Principal.

M.S. Mekni, Génétique - M.S.

A. Daaloul, Génétique - Ph. D.

M.E. Laamouri, Technologie - Ingénieur.

A. Sifaoui, Agronomie - Doct. 3è. cycle.

M. Jerbi, Phytopathologie - Doct. 3è. cycle.

2°) Amélioration

(Principaux chercheurs - Spécialités - Niveau)

M. Ben Dhia, Elevage bovin - Ing. principal.

M.S. Hadjej, Elevage ovin - Ing. principal.

M. Ben Ameur, Nutrition animale - Doct.3è.Cycle

H. Seklani, Prod. Fourragère - Ingénieur.

3°) Lutte contre la désertisation

M.S. Hadjej, Elevage ovin (aménag.parcours)
Ingénieur principal.

+ 3 experts étrangers : 1 Pastoraliste
2 Phyto-écologistes.

Note sur le Centre d'Etudes et de Recherches Economiques et Sociales (C.E.R.E.S.) de l'Université de Tunis

Ce Centre, créé en 1962, mène à bien des études sur des sujets tel que : la formation scolaire dans les liens avec les entreprises ; évaluation du taux de rendement de l'éducation; prévision de main-d'oeuvre, la fuite des cervaux ; la modernisation des campagnes tunisiennes ; l'exode rural et son impact sur le développement des villes régionales, etc. Des négociations sont en cours en vue d'une coopération avec d'autres pays pour l'étude de questions comme celles mentionnées ci-dessus.

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