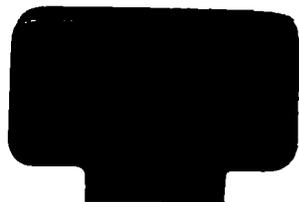


**Recommendations for Strengthening  
Science and Technology  
in  
Selected Areas of Africa South of the Sahara**

Prepared for the  
International Cooperation Administration

Washington, D. C.  
July 1, 1959

**National Academy of Sciences—  
National Research Council**



RECOMMENDATIONS FOR STRENGTHENING  
SCIENCE AND TECHNOLOGY  
IN  
SELECTED AREAS OF AFRICA SOUTH OF THE SAHARA

July 1, 1959



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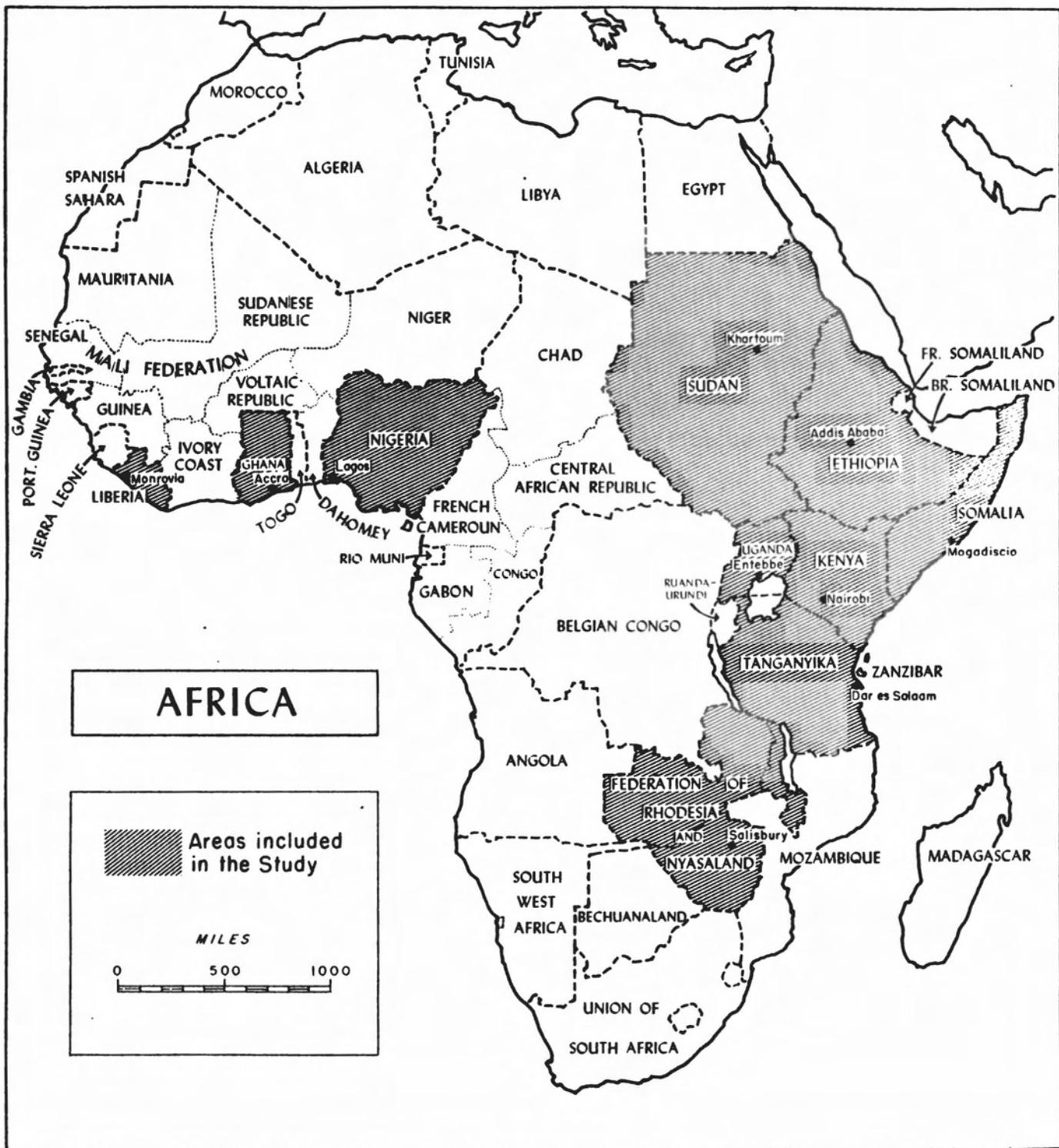
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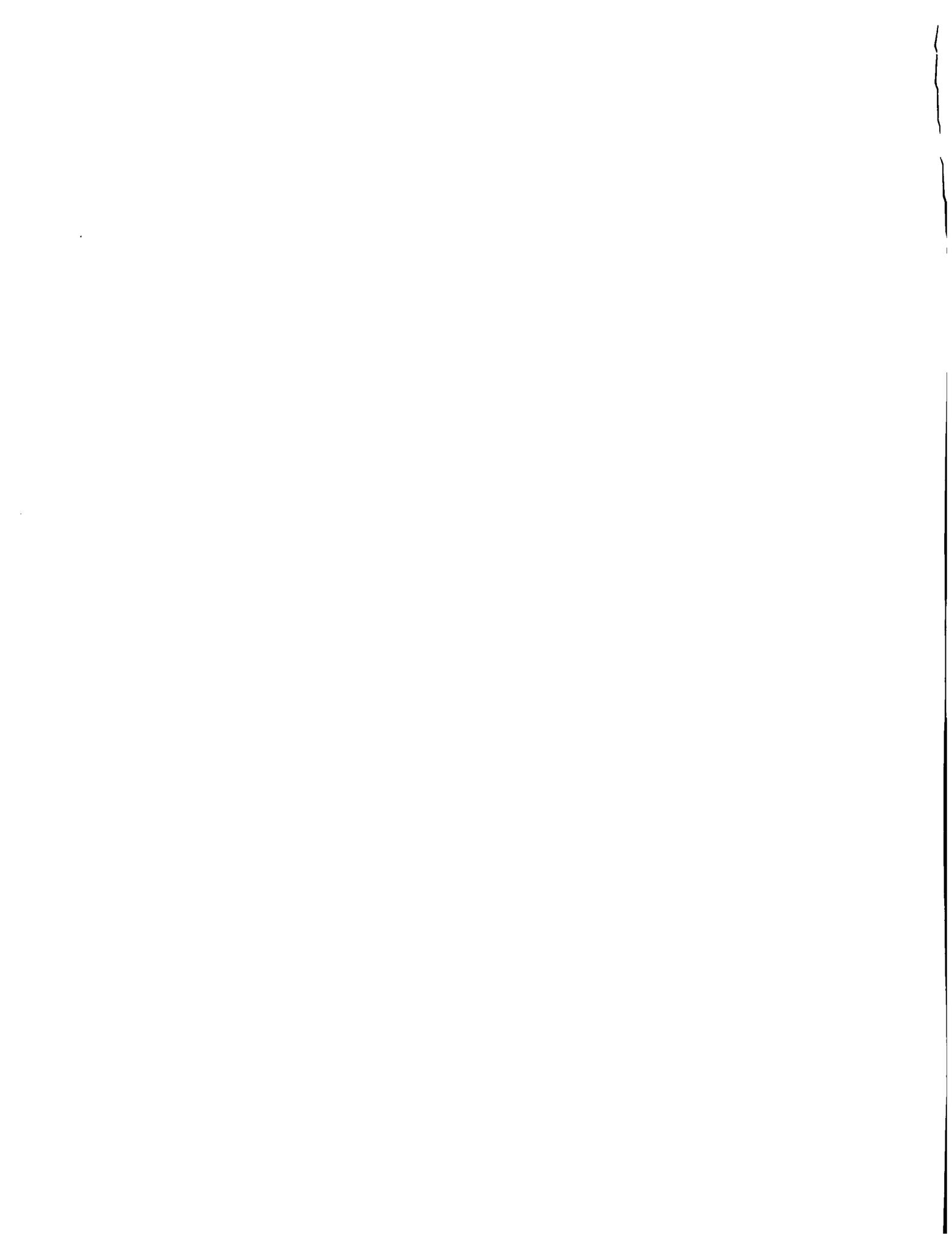
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## INTRODUCTION

Africa South of the Sahara is a generic designation. Used geographically, it applies to an area which is much larger and includes a wider variety of political units than the one under consideration here.

In this report, Africa South of the Sahara refers specifically to:

Ethiopia, an independent Kingdom, and Eritrea, federated with Ethiopia;

The Federation of Rhodesia and Nyasaland, consisting of Northern Rhodesia and Nyasaland, Protectorates, and Southern Rhodesia, a self-governing Colony;

Ghana, an independent member of the British Commonwealth of Nations;

Kenya, a Colony and Protectorate;

Liberia, an independent Republic;

Nigeria, a Federation of three Protectorates, a federal district at Lagos, and the Cameroons Trust Territory;

Somalia, a UN Trust Territory;

The Sudan, an independent Republic;

Tanganyika, a UN Trust Territory; and

Uganda, a Protectorate.

The area covered by this study is about equal to that of the continental United States, and has a total population about half that of the U.S.A.

A number of the recommendations herein are applicable generally throughout tropical and sub-tropical Africa, and the hope is that certain important technical assistance projects may ultimately become entirely regional in character.

Many of the most basic problems in Africa are common to wide geographical areas, and efforts toward their solution must therefore be made

on broad fronts if the results are to be truly effective. In any attempt to apply the benefits of Western science and technology account must also be taken of the historical, social, and political developments of the nations concerned.

The countries considered in the study require heavy investments in education and development which will not directly increase the national income. With the exception of Ghana, they are not in the fortunate position of having surplus wealth from industry or agriculture to invest in educational and research programs. If such programs are to be strengthened, there must be constantly increasing national income from agricultural, industrial, and related developments. It is, therefore, of inescapable interest to the scientist that every potential resource for the economic development of the area be fully utilized.

For the present and for a considerable period in the future, there should be attractive opportunities for foreign investment in the rational development of Africa's natural resources. The exploitation of metallic or nonmetallic minerals, fuels, and water resources is an excellent method for capital production. The value of these resources can be assayed and often proven attractive for foreign investment. Although agricultural resources are less susceptible to rapid exploitation and less sure than mineral deposits and oil reserves, they can nevertheless be improved, with major benefits to national economy. Similarly, biologic resources such as forests and fisheries can be managed in ways to produce substantial income.

Africa's greatest resource, however, is manpower - now largely illiterate and untrained. The rate at which it can be further developed and utilized will establish the tempo of progress. Every effort should be made to encourage Africans to engage in private and public enterprise

of all dimensions. Local human resources should be developed and utilized to the fullest possible extent in support of national and local enterprise for the exploitation of natural resources, the manufacture of goods, and the development of services. Eventually there will be vast opportunities for entrepreneurial activities by Africans that will create employment and wealth and, at the same time, reduce the outflow of foreign exchange for the purchase of goods and materials that can be produced locally.

None of these developments will be possible, however, without a significant increase in the numbers of Africans qualified to fill positions of national responsibility. A natural result of independence is the desire to replace expatriates with nationals. Unfortunately, none of the emerging nations of Africa has enough well-trained nationals to fill the gap left by the exodus of expatriates. These individuals, together, represent a long tradition of foreign service and a volume of man years of experience which cannot presently be provided from any other source. Thus, while various forms of foreign aid can be extremely useful, the countries of sub-Saharan Africa will probably have to face a period of austerity before they have developed the trained manpower to meet national requirements. Nevertheless, with the sympathetic and effective assistance of foreign countries, it can be expected that over a period of years sufficient numbers of trained nationals will become available to satisfy local needs.

The present report is in no sense intended to be an economic survey of sub-Saharan Africa. Although concerned principally with science and technology, the judgments reached and recommendations made must have sound economic bases. This fact has been kept in mind throughout the study, and all of the recommendations are believed to have economic validity in that, although substantial sums of money would be required to implement them,

they can in the long run be expected to repay these amounts many-fold to national economy.

On the assumption that economic growth will continue, it is possible to establish specific subject matter fields and disciplines that should be given major consideration by foreign aid agencies. These are described in the sections listed as Education, Medical and Public Health Services, Agriculture, Natural Resources, and Engineering, Technology and Industry. This survey does not purport to be a comprehensive study of education in sub-Sahara Africa. However, the obvious need for educational developments at all levels necessitated the inclusion of a section on this subject. The scientific areas of concern are treated individually in an effort to establish priorities and opportunities for effective assistance. Each section is followed by a series of recommendations that reflect combined judgments as to the types of projects or programs that might be undertaken by foreign aid organizations with greatest expectation of significant and continuing benefit. Although the several disciplines are discussed separately, they have also been considered collectively, and the recommendations have been chosen in large measure because of their relationship to other disciplines and the possibilities of integration for multiple benefits.

During the course of the present study every effort has been made to draw upon available knowledge and experience through the examination of literature and direct contact with key individuals in Africa and elsewhere. It was not expected that a series of dramatic, new needs and opportunities would be brought to light. The objective has been the evaluation of the present situation and the identification of long-range

opportunities for the application of patterns of technical assistance in support of further progress. It is believed that the most significant opportunities are to be found primarily in the fields of agriculture and public health. As a consequence, emphasis has been given to these disciplines on the assumption that progress on these two fronts is most basic to economic growth and social welfare. It is clearly recognized that collateral developments in education and the technologies are essential, and it is hoped that special attention will be given to these needs as rapidly as significant opportunities for technical assistance are identified.

The procedures involved in the study and preparation of the final report have been as follows:

(1) The accumulation, compilation, and analysis of available material in science, technology, and related subjects in the geographic area under consideration;

(2) The appointment of a body of scientific consultants who have travelled extensively or lived in Africa and are qualified to evaluate local and regional situations and reach valid conclusions;

(3) Consultation with large numbers of competent scientists and educators with personal experience in a wide variety of projects established in Africa;

(4) Consultation with representatives of agencies and organizations that have interests or activities in one or more sectors of Africa;

(5) A series of conferences among the individuals most directly concerned with the survey in order to exchange information, compare ideas, and then reach the joint conclusions upon which this report is based;

(6) Meetings with the Steering Committee of the survey in order to report progress and to obtain consultation and advice.

## II. EDUCATION

Africa's greatest single resource is its manpower, and its greatest single limitation is the dearth of trained manpower for the multitude of responsibilities and action programs necessary to sound social and economic progress.

Illiteracy figures for Africa are in themselves startling but their implications are alarming. It is axiomatic that in areas where the illiteracy ratio is high, standards of living are usually low. Equally obvious is the fact that illiterate populations represent human waste in the sense that they are incapable of furnishing the considerable numbers of leaders required for the scientific, educational, cultural, and political development of their countries. Perhaps the most important contribution that foreign countries can make to the future well-being of Africa is support to educational programs whose object is to train an ever-increasing number of Africans for a wide variety of national responsibilities.

Throughout sub-Sahara Africa facilities for the education of indigenous populations are conspicuous by their paucity. The majority of Africans receive no formal education in the Western sense. Only a small proportion obtain an elementary education covering from one to several years, and still fewer manage to experience from two to four years of secondary or vocational training. The group receiving the benefit of university education is minute.

Even though the existing educational systems and institutions vary widely in kind and quality, in toto they are entirely inadequate to serve the present, still more the future, educational needs of the region. This situation cannot be changed radically within a short period of time, since educational advances can only be deliberate, at best. Moreover, they are

largely dependent on a continuing supply of qualified teachers, and there is now a critical shortage of teachers in Africa.

Granted, however, that the educational systems must have time to evolve, it is still possible to make significant progress in providing increasing numbers of Africans with training at educational levels compatible with their capacities. This would require, in the first instance, substantial gains in elementary, secondary, and vocational education on which could be based improvements in college, university and professional training. Prompt action and heavy financial investments could be expected to pay sizable dividends within a reasonable period of time in the form of a growing body of individuals qualified to accept important social, economic, and scientific responsibilities.

Ultimately, of course, the educational systems must become national responsibilities, and it is not to be expected that external agencies can satisfy more than a fraction of the total requirement. They can, however, assist in developing sound patterns of instruction, and provide the temporary services of expatriate teachers as well as limited amounts of equipment and supplies. Such efforts, in conjunction with national programs, should soon begin to strengthen local school systems and to increase the numbers of qualified personnel for teaching assignments at various levels. As these programs expand and become self-perpetuating, the gap between the demand for well-trained graduates and the supply will begin to close.

Thoughtful decisions must be reached as to how limited foreign aid funds can best be utilized in the existing situation. Any magnitude of support available at present could readily be absorbed by each of the educational strata. Ideally, foreign aid should be concentrated on the training of selected specialists to fill important posts of leadership and influence;

selection cannot function, however, in the absence of large numbers of candidates. Although an attempt should be made to stimulate the rapid development of patterns of elementary and secondary education through local initiative, the assistance available from foreign countries should be concentrated primarily on the training of teachers and of students at the university and postgraduate levels for future responsibilities in science, technology, and related fields of human endeavor.

Educational levels and patterns differ among the several countries in sub-Sahara Africa. The recommendations which follow are broad but are believed to be basic to sound educational progress. In addition there are opportunities for strengthening selected institutions in each of the several countries of concern, and these should be carefully examined with respect to possible support through foreign aid. Typical examples are contained in the selected list which follows.

Liberia. The Booker Washington Institute is reasonably well located, has a fair plant, and could be greatly strengthened with commensurate benefits to Liberia.

Cuttington College, a higher level school, has been rendering useful service to various aspects of education in Liberia and, if given additional support, could materially expand its program.

The University at Monrovia is totally inadequate and will require substantial support and reorientation to become a reasonable facsimile of the National University. A careful study would have to be made of this institution as well as of the recently announced plans for the establishment of a second university in Liberia before any decision was reached regarding possible aid to one or both.

Ghana. The Kumasi College of Technology has a substantial plant and staff. Its curriculum is directed toward vocational, subprofessional and, to a degree, professional training. A careful examination of its potentialities for the training of students in a variety of technical subjects would be of value. Critical support to this institution should be most helpful in training badly needed subprofessional technical personnel in a variety of disciplines.

The University of Legon and its College of Agriculture at Achimota represent the principal institutions of higher education in Ghana. A new and imposing plant plus a well-qualified staff of expatriate and African scientists suggest that the university will play an important role in all future educational developments in Ghana. There are appealing opportunities in the university for both strengthening and enlarging the offerings in related field of science and technology.

Nigeria. The College at Ibadan in Western Nigeria is the leading institution of higher learning in the country. It is reasonably well supported and has an excellent physical plant and a small but good staff. The School of Agriculture is attempting to widen its program and probe more deeply into the problems directly affecting local food production. As a consequence, aid to this section of the College could be expected to provide continuing and increasing benefits to agricultural production and the training of qualified personnel. Other sectors of the college are rendering signal service to the training of Liberian students and with additional support could expand their programs.

The Vom Station for animal research is another logical site for the application of foreign aid. This station, which already has substantial facilities and staff, could readily be built into a major livestock

and research center dealing with the broad spectrum of problems in livestock, poultry health, and management. At the same time its training facilities could be expanded to take care of a greater number of students.

With foreign aid, the Medical School and hospital at Ibadan could strengthen their services to the nation in the fields of medical education, research, and medical practice.

Sudan. The Shambat Institute of Vocational Agriculture near Khartoum is concerned with the training of selected young Sudanese in various aspects of agricultural practice. The school has a basic core of buildings and equipment and, if provided with supplementary support, could be expected to make its training program still more effective.

The College of Agriculture and the Medical School of the National University could be materially strengthened through the provision of additional well-trained staff, essential equipment, supplementary buildings, and substantial support to research programs. Here again, major capital funds and continuing support to research and teaching programs are required.

As presently constituted, the College of Veterinary Medicine at Khartoum is entirely inadequate. Staff, equipment, and plant must all be reinforced if this institution is to serve the professional needs of the Sudan and, in some measure, of the surrounding area.

Ethiopia. The Vocational School of Agriculture at Jimma has already benefited from technical assistance programs through a contract with Oklahoma State University. Continuing and increased support to this institution would be most productive. The expansion of the Jimma School curriculum to include vocational training for rural girls would be a most useful addition to its program.

The Imperial College of Agriculture at Alemaya offers training at the college level to Ethiopian students. Operated under a contract with

Oklahoma State University and ICA, this institution has developed to a point at which it now has a substantial plant and field and laboratory program. Every effort should be made to continue this collaboration over the next five to ten years. During this period it would be well to consider the possibility of establishing a School of Home Economics in order to train Ethiopian girls for public service in rural areas.

The University College of Addis Ababa offers training in engineering and related technologies and the sciences. This institution could be materially strengthened by U.S. collaboration through technical assistance projects.

Kenya. General university education is not available in Kenya and students from the area go principally to Makerere College in Uganda. An appealing possibility for technical assistance would be the establishment of an agricultural institution similar to the one at Alemaya in Ethiopia through a contract with a suitable U.S. land-grant college.

Kenya offers vocational instruction to Africans and is currently developing a diploma school at Siriba. Substantial additional support to this effort could be expected to expand and strengthen its program for the training of Africans in agricultural science and practice.

The University College of Kenya (formerly the Royal Technical College of East Africa in Nairobi) offers courses in engineering and related sciences to a growing body of students. Some foreign aid has already been provided, and future support could be invaluable in permitting the school to enlarge its curriculum and student body.

The Veterinary Research Institute at Kabete participates in the training of veterinary students in collaboration with Makerere College. It operates on a limited budget and could profit greatly through assistance in

the form of additional staff and financial aid to research and teaching programs.

Uganda. Higher education in Uganda is centered at Makerere College where there are especially important opportunities for further assistance to the Schools of Agriculture, Veterinary Science, and Medicine.

Rhodesia. In Southern Rhodesia a University College has been established at Salisbury. Well-planned, with a small and competent staff and adequate land and facilities, this institution could soon become an important factor in the training of Africans for a variety of future responsibilities. Special opportunities for assistance exist in the development of the School of Agriculture and its experiment station.

The areas under French, Belgian, and Portuguese influence have established a number of institutions dealing with university and professional education. It is to be expected that these will require further development in the future and that others may come into being in response to need. An excellent example is Lovanium University, a dynamic, young institution which has already made substantial investments in plant and staff. Its program includes the basic sciences, agriculture, medicine, nursing, humanities, and social sciences. Many of its graduates can be expected to become the future leaders of the African community in the Congo. Although Lovanium University has had substantial support from Belgium and more recently from the Government of the Belgian Congo, important possibilities for its future development, especially in the field agriculture, are still unexplored. It would appear that under mutually satisfactory conditions there will be significant opportunities for collaboration with the university through foreign aid activities. Should there be opportunities in the future for collaboration with this and other institutions in French, Belgian and Portuguese

Africa through technical assistance, it would seem desirable to give them sympathetic consideration.

### Recommendations

#### 1. Primary and Secondary Education

Universal elementary education is the ideal of organized nations. Although rarely attained, it remains a goal toward which continuing progress can be made. The obstacles to universal elementary education are many in the underdeveloped countries, and may include lack of teaching personnel, inadequate systems of transportation and communication, and, inevitably, insufficient finances for the construction of school buildings, the purchase of teaching aids, and the payment of salaries. All of these are present in sub-Saharan Africa, and any substantial advance toward universal education will require heavy investments of funds over a period of many years.

It is essentially impossible for any foreign assistance agency to supply even a significant fraction of support needed for primary and secondary education. Rather outside agencies can only seek critical opportunities to stimulate local developments and provide support in areas and disciplines which would tend to catalyze increasing educational efforts by government.

##### (a) Voluntary Agencies

Ideally, primary and secondary education should be under public auspices. In many underdeveloped areas, however, voluntary organizations have made significant and lasting contributions to the education of youth through the establishment of a wide variety of mission and other types of schools offering elementary or vocational instruction. It is believed that, with proper encouragement, the resources of these voluntary educational agencies could be combined into an important base upon which to build systems

of public instruction. Ultimately it is to be expected that there would be a shift from the mission-type school toward the public school. Throughout the transfer period voluntary agencies could be most helpful, both in the provision of teachers and in other forms of collaboration. The establishment of a public school system would not obviate opportunities for private instruction especially where private schools offered vocational or other forms of complementary curricula.

(b) Expatriate Teachers

During the next decade at least, sub-Sahara Africa will require an increasing number of qualified teachers to man a variety of schools at the elementary and secondary levels. Until sufficient numbers of Africans are trained as teachers, progress must depend to a major degree upon the availability of teachers from other countries. An important type of foreign aid would be the provision of additional elementary, secondary, and vocational teachers for periods of two to three years to fill teaching posts wherever the needs are most pressing.

(c) Teacher Training Centers

A major contribution which foreign aid agencies could make to primary and secondary education in Africa would be the strengthening of existing schools for the training of teachers and the establishment of new ones. These would be expected to be comparable to the normal school or teachers colleges in this country and would be dedicated to the training of Africans for posts as teachers at all levels through the secondary or high school. A program of this sort would provide the most rapid and effective means of developing an increasing corps of qualified African teachers. Currently, there are especially appealing opportunities in Liberia, Ghana, Nigeria, and Ethiopia.

The United States is especially well qualified to offer this sort of service to public education in Africa. Funds spent for the establishment of these institutions and the provision of temporary expatriate staff could be expected to confer substantial long-range benefits on the countries concerned.

(d) Vocational Training

The scarcity of skilled labor, technicians, and artisans is everywhere apparent in Africa, and a wide variety of economic developments will necessarily be retarded until there are sufficient numbers of Africans trained as carpenters, plumbers, builders, masons, mechanics, machinists, electricians, etc. Although various types of vocational education are now being offered in Africa, the sum total is not large. The establishment of trade schools in several central locations would be a major contribution to the local economy, and would create a pattern that could be further developed by government and local enterprise. In rural areas requirements would include buildings, equipment, and foreign teachers who would remain in residence for sufficient periods of time to enable them to train their replacements from among qualified African graduates.

2. University Education

There are relatively few institutions of higher education in sub-Saharan Africa. At least several are excellent in terms of standards of admission and the training offered. Their plants and resources are limited, and collectively they cannot be expected to handle increasing enrollments indefinitely. With additional support the established colleges and universities could be further strengthened and somewhat expanded in order to handle a larger body of students. However, it would seem desirable and inevitable that certain new institutions of higher learning come into being in sub-Saharan

Africa in response to future need. These will require substantial assistance and will provide opportunities for foreign aid agencies, philanthropic organizations, and other interested groups, to contribute materially to the advancement of higher education in Africa.

(a) Scholarships and Fellowships

During the period in which university systems are evolving, there will unquestionably be need for a sizable number of fellowships and scholarships for the training of Africans overseas. Appointments should be in response to demonstrated needs for trained personnel in the parent country. The bulk of the trainees might necessarily fall into the undergraduate category, with smaller numbers at the postgraduate and professional levels. Estimates of the numbers of qualified candidates who will become available each year during the next decade vary, but they are certainly substantial. Limitations to this program would appear to be available funds, the absorptive capacity of Western institutions and the employment opportunities for scholars upon their return. It should be pointed out that the absorptive capacity of foreign universities is not simply a matter of space; of at least equal importance is the additional financial burden imposed by a heavy influx of foreign students. Any contemplated fellowship and scholarship program should go beyond tuition and fees and provide for total costs to the university.

A smaller but highly useful project would be the appointment of scholars and fellows from this country to study for a year or more in Africa. This arrangement would have the dual benefit of associating Americans and Africans in a university atmosphere in Africa and of providing training experience for a number of Americans who might later become interested in careers in foreign service.

Essential to the success of an overseas training program for Africans would be the establishment of an appropriate organization to handle all details. These would include: selection of properly qualified candidates in those fields where local needs and opportunities are most apparent and pressing; arrangement for their admission to institutions offering appropriate types of training; handling of travel and other administrative details; establishment of a system of visits in order to provide continuing contacts and encouragement; and finally, participation in an effort to assist trainees in obtaining useful employment after their return home. The success or failure of fellowship programs depends entirely upon the skill with which they are organized and handled. Competent administrative organization is an essential requirement to this recommendation.

(b) Professional Education

See following sections of the report for discussion and recommendations.

3. Special Projects in Support of Education

(a) Educational Loan Fund

It is suggested that consideration be given to the practicability of establishing a loan fund for educational development, to be available to the countries of sub-Sahara Africa. As the demand upon local resources for the improvement of public school systems at all levels will be increasingly heavy, progress may be seriously retarded without this kind of outside assistance. Long-term loans at low interest rates could be expected to enhance the speed of these developments where this mechanism is clearly justifiable. The fund could be used for the multiplication of institutions offering general, vocational and professional education in response to growing need; and in view of the great educational needs throughout the

entire area, it is apparent that the magnitude of such a fund would be limited by available resources rather than by the dimensions of the opportunity.

(b) Documentation Centers

In support of educational developments it would be desirable to establish two documentation centers - one in East Africa, the other in West Africa - whose function would be the preparation, compilation, translation, and printing of substantial quantities of teaching and scholarly materials in English and in the native languages. Such centers would be extremely useful in the preparation and distribution of critical reading materials of all sorts designed to aid in expediting the educational process. They might be located in connection with an established university or in the capital cities under the auspices of ministries of education.

(c) Library and Information Centers

There is evident need for an information center in Africa for the collection, collation, and maintenance of published materials dealing with Africa in all its aspects. A major body of literature is already in existence, but there is currently no information center in Africa to which Africans and other interested persons can turn. A center in which all published material could be brought together and made available to scholars generally would be of enormous international benefit.

One such center could serve the entire area, but if it were established in East or West Africa there might ultimately be a demand for a second facility in the other area.

There is a perceptible and growing interest in Africa within the United States, as manifested by the increasing body of literature dealing with the African continent, the numbers of students specializing in African

studies and the University centers dedicated to them. The establishment of at least one major center in this country would be of the utmost importance. Associated with an appropriate university, such a center would not only have essential scholarly materials but would provide opportunities for research and training of utmost value to future cultural and scientific relationships between this country and those of Africa.

#### Summary

As will be evident from the foregoing, a major conclusion of this study is that the future development of sub-Saharan Africa depends, in the first instance, upon the rate at which progress can be made in strengthening education at all levels. There must be a definite trend toward general literacy, an expansion of elementary and secondary education, and increased emphasis on university and professional education if Africa is to make substantial economic advances within a reasonable period of years. Every other consideration is subordinate to that of education, and it should be a major area for planning and investment. Although foreign organizations cannot accept responsibility for financing the educational systems in Africa, they can apply available manpower and resources to important growing points so that these may develop to proper dimensions in support of social and economic progress. It is recognized that there are currently many agencies interested in education in Africa. It would be wise to identify all of these and the scope of their programs. Subsequently, there should be a degree of coordination which would make possible the most effective application of all available resources and eliminate the possibility of substantial duplication of effort.

The enormity of the need for educational progress on all fronts in sub-Saharan Africa is readily apparent. However, the solution of this

immense human problem is by no means obvious. It is clear, however, that under most favorable circumstances substantial amounts of time, intelligent planning, effort and money are prerequisite to sound progress. Educational advances that have been made in the West cannot be superimposed on the African scene, but the lessons learned can be utilized effectively in speeding educational developments in Africa.

An initial step is the expansion of the base of the educational pyramid. This requires time, patience, persistence, and those forms of aid available from foreign countries. At the same time, assistance can be provided to increase the numbers and improve the training of craft workers, technicians, professionals, and scholars.

A major consideration should be the strengthening of established institutions dedicated to the improvement of African education at all levels. Temporary staff, buildings, equipment, teaching aids and supplies are all essential needs. A vital supplement would be the appointment of a substantial number of fellows and scholars for training overseas during the period until indigenous institutions are in position to handle most of the national education need.

Important supplementary opportunities to the multiplication and strengthening of African educational institutions would be the establishment of centers for the preparation and translation of teaching materials and the collection of pertinent information. Still another and most important effort would be support to one or more major centers for African studies in Western universities.

### III MEDICAL AND PUBLIC HEALTH SERVICES

Progress in public health is linked inevitably with progress in education, agriculture and economics. The magnitude of many public health problems is a function of a lack of understanding or control of simple sanitary and environmental processes. The effects of diseases are quite frequently intensified by poverty, ignorance and dietary deficiencies. A program to improve the health of a nation or a region must of necessity be coordinated with parallel efforts in education and agriculture.

No society can achieve maximum utilization of its human resources unless it is in a healthy state both mentally and physically. Masses of historical evidence illustrate the fact that in communities where such conditions as malaria, hookworm, and deficiency diseases are rampant, human output is at a minimum. It is impractical to expect to develop agriculture, industries, and the educational and political structures necessary to social progress in debilitated, underproductive populations. In consequence, the application here of modern public health measures becomes of paramount importance.

In all of Africa a wide variety of human parasites and diseases have established their sway over indigenous populations. Many of these would readily yield to known public health measures if such measures could be generally established. However, a complex of a lack of understanding, insufficient personnel, and limited budget makes a selective policy necessary. In some instances, ad hoc immunization programs can be mounted to eliminate some epidemic diseases which are well known and have been brought under control in many parts of the world, e.g., smallpox, yellow fever, and diphtheria. More frequently it is necessary to undertake fundamental research and training as

a base for long-term, laborious, and meticulous programs involving all aspects of health.

Malaria, bilharziasis, enteric disorders, and intestinal parasites yield only when levels of sanitation have reached the point at which these diseases can no longer flourish. Deficiency diseases and their secondary effects disappear when dietary patterns and caloric intake reach adequate levels for normal development. Reaching such levels depends, however, upon significant improvements in agricultural production, and upon the distribution of necessary combinations of food elements at prices which can be afforded by the general public.

In Africa, public health problems are obvious but difficult to solve. Illiteracy, taboos, nomadic habits, and an almost complete lack of sanitary and environmental control in many areas militate against rapid and effective progress toward the control of most of the widespread pests and pathogens which plague the population. Medical and other supplies are expensive and frequently unavailable. Doctors, nurses, and medical assistants of all categories are in extremely short supply. As a consequence, it can be expected that increasing investments of money, time, and effort will be necessary to gain general acceptance of public health measures and to produce the personnel and materials necessary for the establishment of programs which will ultimately bring the major public health problems under some reasonable degree of control.

The increasing urbanization of African communities, although a complicating factor in itself, does permit the establishment of potable water supplies and sanitary sewage disposal systems. It facilitates market sanitation, food inspection, and food handling and control, and it permits ready access to large numbers of people by public health officers. It would seem, therefore, that one highly important approach to public health problems in

Africa is to attack them where the largest numbers of people are closely congregated. To do this is in the first instance a responsibility of the local and central governments.

The diseases in rural areas are more stubborn because of a variety of economic, ecological, and geographic factors. Scattered populations tend to be uneducated, inaccessible to medical practitioners and routine health measures, and to suffer more frequently from dietary deficiencies than do the city dwellers. They live under conditions of greater exposure to extreme changes of temperature and humidity, and they are commonly inadequately clothed and housed. Finally, rural populations usually lack the economic resources to purchase the goods and services which would aid in protecting their health.

#### Collection of Vital Statistics

Irrespective of whether one is dealing with disease in urban or rural areas of Africa, the outstanding obstacle to a rational approach to disease control is the complete lack of valid statistical data relating to the African population, and describing its distribution, birth rates, death rates, and incidence of disease in terms of mortality and morbidity. Available statistical information comes from (a) data based on inadequate notification of disease, largely derived from urban, civilized centers; (b) data gathered from epidemics; (c) data gathered from standard hospital information, or from research studies based on hospital populations; (d) data gathered from rural health centers with inadequate facilities for diagnosis; and (e) data secured by mobile medical units operating primarily in Ghana and Nigeria.

From these data it is clear that certain diseases exist in the area and that they exist in considerable quantity in terms of absolute numbers. Because of the fragmentary character of the data, it is not possible to plan

a program based on the relative importance of the various diseases as they affect either rural villages or urban areas. Before any plan for control of disease in Africa can be soundly formulated, it will be necessary to establish studies in several areas of West and East Africa to secure substantial data based on actual incidence of disease in the African populations in both rural and urban areas.

### Development of Personnel

The second major obstacle to the development of a program for the improvement of health in Africa is the lack of trained personnel for the administrative services, the hospitals, and the rural health centers. This problem must be attacked in a long-range plan, and its solution is fundamental to the development of any type of control program. While it is necessary to defer definitive action for the control of individual diseases until the fundamental statistical data have been collected, it is clear that the development of personnel should be started at once in preparation for whatever programs are developed at a later date. The plan should include the training of highly-qualified professional physicians as well as of assistant medical officers and paramedical personnel.

### Professional Training

For personnel training at the fully-qualified professional level, sub-Saharan Africa today has the schools at Dakar, Ibadan, Kampala, Leopoldville, and Khartoum. In addition to these indigenous institutions, the various schools in the Union of South Africa train a small number of candidates from the area. A reasonable number of candidates go to schools in the United Kingdom, Western Europe, Egypt, Lebanon, and North America. For the purposes of this study, the schools at Dakar and Leopoldville are not relevant for a variety of reasons, including language and academic patterns.

The area under consideration is consequently served only by the schools at Ibadan and Kampala, where a very high level of medical education is being achieved. It is likely that within the next two to three years medical schools of similar quality will be established in Accra in association with the University College of Ghana, and in Salisbury in association with the University College of Rhodesia and Nyasaland.

At the present time the two schools in operation are producing no more than 30 doctors per year, and when fully developed, they will probably produce no more than 70 to 80. With the addition of students from new schools in the Federation and Ghana, the entire area will be producing no more than 130 new doctors annually within the next ten years. In addition, it is possible that as many as 100 physicians are being trained on fellowships in schools outside Africa.

It is clear that a yield of 230 physicians a year for this vast area and population will barely serve to provide medical care for private individuals and to staff, in a skeleton fashion, only the administrative health services and the district and regional hospitals. Presumably some of the graduates will reach a degree of training which will qualify them to take over posts in the medical schools and to fill posts in new schools which may develop in the coming years. A group of elite, trained physicians is absolutely essential for staffing at the highest levels in the health services of all these areas.

Teaching in the present institutions is oriented too much toward the development of hospital doctors and specialists. There is a very real need for the introduction of courses which will at least expose these future medical leaders to the problems of organization and development of realistic health services for Africa. Real emphasis should be put on the development

of field training centers in which these young physicians can spend a reasonable time before going forth to specialty training.

### Subprofessional Training

It is doubtful whether technical assistance programs at the moment can increase substantially the output of fully-trained physicians owing to the shortage of teaching personnel and of qualified candidates for training at this advanced level.

In view of the present grave shortage of professional personnel and of the likelihood that the production of fully-trained physicians will continue to be grossly inadequate for many years, all the territories involved - with the possible exception of Southern Rhodesia - will have to expand the development of subprofessional training. The aim should be to produce assistant medical officers capable of working under the supervision of fully-trained physicians, and paramedical personnel including nurses, midwives, health visitors, sanitarians, and technicians of all types.

Technical assistance programs can be of great value in helping to expand present subprofessional training centers like those seen in Kenya, and in starting new centers staffed in part by expatriates. Facilities for such training are now found at Salt Pond in Ghana; in the technical training center at Nairobi, Kenya; in the Haile Selassie I Public Health College and Training Center at Gondar in Ethiopia; and in the assistant medical officers school at Khartoum. A very fine four-year course is given at Nairobi, and excellent training is provided at Gondar (which at present can serve only Ethiopia) and in the school at Khartoum.

These are exceptions, however. The other centers are, in a very real sense, primitive. They urgently require both financial assistance and technical personnel to improve the depth of training for work in rural

health centers, sanitation, and specific disease programs in each of the countries under study.

### Specific Diseases

Owing to the lack of statistical data which will permit an evaluation of the various diseases of Africa in terms of priority, it is necessary to consider individual diseases largely on an a priori basis. Any approach to complete control must await both the development of statistics and of personnel.

#### Malaria

Without a doubt one of the most widespread diseases of Africa in terms of gross involvement of population is malaria. In sub-Sahara Africa, Plasmodium falciparum is the important parasite, transmitted for the most part by Anopheles gambiae and A. funestus. One of the current beliefs in Africa is that malaria is the major killer of children, but evidence from more recent studies would indicate that this is not the case. This view developed more from incorrect judgment than from valid statistical data inasmuch as there are no general valid data for death rates or causes of death in rural Africa.

Technically, the control of malaria through vector control differs between West and East Africa because of variations in climatic and environmental conditions and in the response to insecticides by the vectors, A. gambiae and A. funestus. In both areas, A. funestus has shown itself amenable to control by spraying with dieldrin, DDT, or BHC. On the other hand, A. gambiae has shown itself amenable to control by spraying over long periods only in East Africa. In West Africa, A. gambiae has shown a remarkable tendency to become resistant to dieldrin, particularly in Northern Nigeria and

Liberia. However, experiments are at hand which indicate that combinations of spraying with insecticides, aerial spraying with granular forms of DDT as a larvicide, and distribution of antimalarial drugs such as daraprim and chloroquin, can effectively control malaria in most of these territories, with reduction in parasite rates, morbidity, and transmission to significantly low biological levels.

Control of malaria in new irrigation areas, particularly in the intermediate levels of transmission such as are found in Kenya, Uganda, and similar places, is urgently necessary if these are to come into production agriculturally for the use of African populations. At the present time there are no plans for wide-scale malaria control by WHO or ICA in the region, with the exception of relatively small sections in Liberia, Ethiopia, and the southwest corner of Uganda. Southern Rhodesia has successfully brought under control almost 95 per cent of the country and is now in the process of an eradication program in conjunction with the Union of South Africa on its southern borders. In East Africa there are facilities for training technical personnel for control programs in the malaria center at Amani.

Technical assistance programs in Africa must give careful consideration to undertaking control projects, at first in areas of special interest, such as irrigation districts, and slowly in all sections of this region. While there is some doubt as to the importance of the disease from a mortality point of view, it seems clear, from the African's reaction to the disease itself, that malaria should and must be controlled to the highest degree possible over the coming ten years.

### Nutritional Disorders

In children, malnutrition in general and kwashiorkor in particular are grave problems throughout the area and are of particular concern in the

rural sections. While kwashiorkor is associated with a low intake of protein and the weaning and post-weaning period up to five years, the over-all problem is linked with social and educational factors within the African population, with the orientation of African families to feeding and weaning babies, and with agricultural deficiencies in food production, distribution, and technology. An attack on the problem of malnutrition by health measures cannot succeed without concurrent efforts in agriculture and education.

Contributions from the health services will come largely through the development of adequate village health programs which will be, in turn, dependent upon the development of rural health personnel in the broadest sense, as well as on the development of increased pediatric and maternal and child health services. Various food supplements of vegetable protein combined with small amounts of animal protein are now available, but effective feeding of these supplements must await the development of economic information regarding the African population, as well as the initiation of coordinated educational and social changes in the African villages.

### Bilharziasis

From available data it would appear that bilharziasis is a disease which is still invading the African population and becoming increasingly important month by month and year by year. Its importance will become overwhelming over the next ten years as larger areas are brought under irrigation, and as fish ponds and other schemes of this type are extended.

Little is known of the epidemiology of bilharziasis in the African setting. There is a particular deficiency in knowledge of the ecology and biology of the snail vector, and almost nothing is known as to how this disease can be controlled. A possible exception is Southern Rhodesia, where the health services are attempting control in an area of over 24 million

acres - largely in the white-settled section - through a cooperative program of spraying copper sulphate with the assistance of large-scale farmers. In other places, attempts to control through spraying of copper sulphate or sodium pentachlorophenate have given variable and usually discouraging results.

Any approach to the control of bilharziasis depends on the development of sound epidemiological studies of the vector and of the transmission of the disease in the African population. Such studies will involve a concerted attack from the research as well as the applied point of view by ecologists, water biologists, malacologists, protozoologists, toxicologists, sanitary engineers, and medical practitioners.

The problem has been further complicated recently by the demonstration by American workers in conjunction with Kenya health authorities that baboons are naturally infected in association with infected human populations. The ultimate goal of control through sanitation alone cannot now be deemed the final answer and one must turn to a combined attack on the snail vector and chemotherapy; success will be possible only through education and intensive and prompt research.

### Tuberculosis

Tuberculosis is widely distributed throughout the area. Existing data based on surveys made by WHO teams in West and East Africa and on studies by tuberculosis services of the various territories indicate that the incidence of infection ranges from 0.6 per cent to a high of probably 3 per cent of the African population. Even at the low incidence of 0.6 per cent the absolute numbers involved in any area are enormous and far greater than can be treated on a hospitalized basis. Consequently, one must turn to ambulatory control and chemotherapy through the use of PAS, INH, and streptomycin singly or in combination.

Many good studies are now being carried on both in West and East Africa which demonstrate that ambulatory control through these measures is feasible and successful. Large-scale application of such control measures, however, will have to await development of suitable personnel through training schemes oriented to paramedical services. Pending such availability, a start in establishing the services can and should be made in selected areas. The emphasis should be on research into methodology and on training, pending the development of a sound network of health centers and services.

### Enteric Diseases

Enteric diseases, whether of bacillary, viral, or parasitic origin, must form a large problem both in terms of mortality and morbidity in children and adults. A curious point in regard to diarrheal diseases in Africa is the relative lack of concern or knowledge of their importance or incidence. Statistics from hospitals and health centers indicate that diarrheal diseases, particularly in the infant, are a serious cause of death and morbidity, but there seems to be no direct concern in any of the territories for relating these hospital findings to village studies of the role of these diseases in the resident population.

Again, a control program must await village studies to develop appropriate statistics upon which to base a judgment of incidence, as well as of related social and educational customs. In most of the areas under review, a start has been made in developing potable water supplies both in urban and rural areas, as well as a start in many villages toward proper disposal of waste. The over-all progress of sanitary engineering programs must depend upon the development of personnel and of a system of health services to promote and supervise sanitary installations.

## Trypanosomiasis

Trypanosomiasis as a human disease has become relatively unimportant because riverine control of G. palpalis and chemoprophylaxis have been effective in controlling large clinical outbreaks in the African populations. Nonetheless, large areas of Africa are not habitable either for humans or domestic animals because of tsetse flies. In view of the fact that greater areas of Africa must be brought into production for cattle and food crops, the disease in animals and in humans remains an important problem.

The problem, however, is one that properly should be the primary concern of the veterinary and agricultural sciences, since the basic economies of food production are such that it is economically feasible to consider tsetse fly eradication by insecticides or by naturalistic methods of clearing, etc. In view of the low level of human infection, it is doubtful whether such expenditures could be justified for the human disease alone in competition for the funds needed for serious diseases in the African population. Consequently the agricultural sections of this report deal in detail with the trypanosomiasis problem.

## Other Diseases

Diseases such as yaws, leprosy, onchocerciasis, loiasis, and Guinea worm are all present throughout the area and are of considerable importance.

Yaws has been brought under attack by the injection of penicillin on a mass basis through mobile units of the WHO and UNICEF programs over wide areas. Current programs seem to be adequate in terms of eventual coverage, as well as in terms of available personnel.

Leprosy, because of its peculiar social implications, has been a frontal point of attack by the various mission groups in Africa, as well as

by the government services. While the problem remains a serious one, it is probable that current efforts are maximal in relation to present personnel and health services. Further attack would logically become an integral part of the over-all development of health center services and rural village programs.

Onchocerciasis has been successfully attacked at least in Uganda in the Nile River Valley and should be a subject for continued scrutiny and control where the opportunity affords itself in limited areas. The major issue to be determined in respect to onchocerciasis is the question whether the disease is the major cause of "river blindness." Where this proves to be serious, it is possible that control measures would be justified in competition with needs for other diseases. Where blindness is not a serious result of the disease, one would anticipate that control would receive a relatively low priority except in areas where the nuisance of intense fly populations and skin irritations have driven populations off productive agricultural and fishing reserves.

#### Summary

With unlimited funds and personnel medical science, within a relatively short time, could made great progress toward the solution of the public health problems of Africa. World medical science has progressed to the point where methods and materials are available, which, if generally applied, could be expected to eliminate or at least contain most of the major diseases which now infect the African people.

Personnel and funds of the magnitude necessary are not and cannot be expected to be available except on a long-term basis. Moreover, it would be inappropriate to concentrate solely on disease control at the expense of

the other human needs which are of equal importance. While it can be expected that public health campaigns will move ahead promptly and effectively in terms of their level of support, it is necessary that these be coordinated with improvements in diet, housing, education, and the other components which together are the essentials of sound progress.

### Recommendations

The following recommendations for programs in medicine and public health are oriented to the long-term development of statistical data which will in turn permit the long-range training and provision of personnel for urban and rural health services.

#### General

(1) Where ad hoc proposals of short-range potential are undertaken, the personnel developed for such schemes should be trained along lines which will permit their later inclusion in the long-range development of health services.

(2) It is the opinion of the survey committee that programs in the area should be based where possible on existing institutions, and every effort should be made to utilize existing personnel.

(3) There is an extreme shortage of expatriate personnel with adequate training for work in technical assistance programs. Consequently, every effort must be made to utilize fully such personnel and to train a new corps for expanding needs.

(4) It is clear that there will be need for new technical personnel to supplement existing staff. Whenever possible such personnel should be placed in existing institutions in association with individuals having extended experience.

(5) It is hoped that the major breakthrough in program in these territories will be a reorientation of personnel practices of technical assistance agencies so that technicians going to the field are prepared to spend whatever number of years are necessary to achieve a successful program.

(6) New personnel drawn from United States or the United Kingdom or elsewhere must have a period of indoctrination in the problems of Africa, and those in medicine will almost certainly require at least six to nine months of re-education in the fields of tropical disease.

### Specific

#### 1. Development of Field Training at the Assistant Professional and Paramedical Level

It is essential that strong continuing support be given to existing and future medical schools, since fully trained physicians are essential for the direction of paramedical personnel and for the development of adequate health services. However, there is no prospect within the next fifty years of producing sufficient fully-qualified physicians from indigenous personnel to provide medical care for the population. Whatever the disadvantages, the area must turn to assistant medical officers working in cooperation with health visitors, technicians, and sanitarians, for coverage of the medical care and public health projects.<sup>1</sup>

Training of assistant medical officers and paramedical personnel should follow the high standards established at Nairobi or Gondar. Courses for assistant medical officers should include four years of training with

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<sup>1</sup> The one exception to this statement is Southern Rhodesia, which at the present time has a reasonable ratio of indigenous doctors to population insofar as white physicians are concerned and where there is an increasing program to develop African physicians in the schools of South Africa and in a future medical school at Salisbury.

adequate practical courses in the basic sciences, practical clerkships, and thorough training in principles of sanitation and environmental health.

Nursing and technical courses should cover a minimum of three years and emphasize practical application and prevention. All training centers should emphasize the team approach through combined field training in village health.

Consequently, it is recommended that the training centers mentioned below be expanded or developed.

#### A. Liberia

(At the present time there are in Liberia only three Liberian physicians, and a few expatriates from Europe. The development of some type of rural health service is urgently needed.)

It is suggested that a training center for assistant medical officers, health visitors, technicians, and sanitarians be developed at the site of the Liberian Institute of the American Foundation for Tropical Medicine at Harbel, outside the Firestone Plantation. An alternate site would be in conjunction with Cuttington College, where it is anticipated that the Lutheran Church will also develop a hospital facility. Fundamental courses in science and laboratory experience could be given at either site in existing or expanded facilities and could utilize, with reasonable travel, the ICA-Liberian Health Center and Midwife Training Center at Gbanga for field training and for field investigations.

Such a training center would have to be staffed by foreign personnel, although material assistance could be obtained in the nursing and technical fields from personnel now trained and available in the ICA-sponsored laboratory training course and nurses school at Monrovia.

Various estimates have been suggested relating to cost. It seems likely that capital costs for laboratories and housing would be in the range of \$300,000, and annual operating costs at the level of \$150,000 per year.

## B. Ghana

The existing center in Ghana at Salt Pond is training only senior graduate male nurses for assistant medical officer positions. In a period of nine months they are given a brief review of diagnostic procedures of the more common ambulatory diseases and a review of technical procedures for laboratory diagnosis. The facilities for training health visitors, health educators, technicians, and sanitarians are inadequate.

It is essential that the program at Salt Pond be expanded so that young secondary school graduates may enter as students in the assistant medical officer category or in advanced courses for nurses, technicians, and sanitarians. It is probable that the Ghana government can and would furnish a few indigenous personnel to assist in the training. However, it will be essential for available expatriates and technical personnel from the United States to assist in expanding the program so that the sciences are taught in some depth and so that field studies can be made to orient the training program in the proper way.

Salt Pond is strategically located. A district hospital is available at Takoradi for clinical experience. A good health center is within reasonable distance at Swedru for both field investigations and field training.

One may presume that some pressure may be exerted to locate such a center at Korle Bu in Accra. This would seem to be undesirable because it would expose workers from rural areas to the temptations of urban life and because the facilities at Korle Bu will be completely occupied for graduate and perhaps undergraduate training of fully-qualified physicians.

Present physical facilities at Salt Pond are inadequate for the needs for laboratory training and scientific courses. Probable capital

costs would be in the range of \$100,000 for increased facilities, and recurrent costs at a level of approximately \$250,000 per year. Such a center could logically serve the region, and furnish training for Sierra Leone, Gambia, and perhaps Guinea.

### C. Nigeria

At the moment, Nigeria, for all practical purposes, is without training facilities for assistant medical officers or for paramedical personnel to develop village health work. The subprofessional training center in the Northern Region has recently been closed, and the WHO maternal and child health training center in the Eastern Region has not yet been staffed to a level which enables it to train personnel even for maternal and child health.

It is quite likely that as training facilities are developed in this country of 40 million people it will be necessary to establish separate subcenters in each of the three regions, for political reasons as well as the gross magnitude of the number of personnel which will have to be provided.

The single place in Nigeria which seems at the moment equipped to embark on an over-all program like those at Gondar or Nairobi is the University College and its subsidiary facilities at Ibadan. The University and government are presently developing an Institute of Hygiene and an Institute of Child Care and Nutrition near the University Hospital which could serve as the base for a modern and productive training center for assistant medical officers and ancillary personnel. Such a site has particular appeal since it would have opportunities for field training and investigation in the complicated urban situation of Ibadan, in adjoining villages which are now becoming the focus of epidemiological studies by the medical school,

and in the center of Ilesha-Imesi, a three-hour drive from Ibadan, where sound outpatient facilities and a base for village investigations have now been established.

One would hope that such a center could serve for reorientation of the fully-qualified physicians in the University College, as well as for the primary teaching of assistant medical officers and paramedical staff. It could serve equally well the large nursing training center operated by the University College Hospital. It offers the added advantage of having a reasonable number of qualified teachers, both expatriates and Nigerians, and the ancillary assistance of the Institute of Agricultural Economics and the Agricultural School. This center would serve all of Nigeria at the start, and, hopefully, would train qualified teachers for additional centers in the Northern and Eastern Regions.

Capital costs might well be somewhat less than elsewhere, but one should probably anticipate an expenditure of around \$75,000. Recurrent costs would certainly be in the range of \$250,000 per year, with additional costs as centers in the other regions come into being.

#### D. Uganda, Kenya and Tanganyika

These three territories are grouped together because they now share common training centers for development of personnel in the health field as well as in other areas. They differ, of course, in their present and future political orientation inasmuch as Kenya is a country largely developed through white settlement and controlled by the white population, while Tanganyika and Uganda are semi-independent colonial territories in which present and future land ownership and control is and will be under the Africans.

The medical faculty at Makerere College is currently able to accept all qualified candidates for full professional training in medicine. The planned expansion of teaching facilities could be expected to take care of the demands of the three territories over the next ten years.

The technical training institute at Nairobi is of the highest quality and can and does train subsidiary and subprofessional personnel for work in health centers in the three areas. However, with increasing orientation in Tanganyika and Uganda to the development of health centers, there will be an increasing need for expanding these facilities at an early date. Perhaps the best way technical assistance could operate with respect to this institution would be to provide assistance for more rapid development of health centers in Uganda and Tanganyika and fellowships for training personnel at the Nairobi center.

The most urgent and challenging prospect for the development of personnel in these territories is the current program in Kenya for training village leaders in health and agriculture.<sup>1</sup> The government has in action a Better Living Institute at Kitui which is staffed by personnel recruited by the British Red Cross to train young African women of leading village families in the principles of health, sanitation, child care, and agricultural development. These students return to their villages to carry on developmental projects within their villages under supervision of the center. The program in turn is coordinated with the government services through health centers and agricultural training centers. The program has been remarkably effective in promoting better health and agriculture in the villages and the government now hopes to expand the project to cover all of Nyanza through the development

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<sup>1</sup> Dr. A. J. Walker, D.M.S., Kenya

of nine subcenters. The purpose of the subcenters is to continue the current program, and within three to four years, to serve as training centers for health visitors, sanitarians, etc.

The estimated cost per subcenter would be a capital investment of \$16,000 for buildings and \$3,000 for transport, with recurrent annual costs of \$5,000 for personnel and maintenance. The total cost for the nine centers would be approximately \$180,000 for capital costs, and recurrent annual costs of \$45,000 over a period of five years. Such a network of centers could train tribal personnel for health and agricultural work, would form a base for the development of health center services and agricultural extension, and, finally, would provide an excellent field training area for key personnel from Tanganyika and Uganda.

#### E. Ethiopia

This country has no indigenous schools for training fully-qualified physicians. Qualified candidates for training now can easily be placed at the American University of Beirut, or in other centers in Europe, the United Kingdom, and North America.

Plans are under way for the development of a new medical school at Addis Ababa and for the expansion and revision of the small private Italian school at Asmara to a level which would permit it to serve Eritrea.

Provision for training subprofessional assistant medical officers and ancillary personnel is more than adequate in the excellent program at Gondar. This center should clearly be continued and if possible expanded to permit training of Africans from other areas, specifically, individuals who could return to their own country to teach in similar institutions. Presumably this center could also serve Somalia when it becomes independent this year.

While the center has been developing well-qualified personnel to staff rural centers, the government has been financially and administratively unable to create the health centers necessary to take up the current output of the school. To avoid a disastrous failure of this training center from lack of placement of graduates, technical assistance agencies should formulate a program for the development of new health centers as rapidly as possible and for the supervision of programs in these centers for a period of at least five to ten years.

Costs of such developments cannot be accurately estimated, but certainly would range between \$50,000 to \$100,000 per center plus supervisory personnel from the Gondar staff or other sources.

Currently the program at Gondar also lacks a real orientation to the problems in Ethiopia as they actually exist, since basic studies to develop such data are lacking. As recommended under Point 2, below, an investigation unit should be established at Gondar to work within the training center and the health units developing studies of the village problems for orientation and teaching as well as for programming of the centers.

#### F. Sudan

The Sudan has had for some years both a medical school and an assistant medical officer school competent to train all the physicians and subprofessional personnel which the Sudan can currently absorb. Owing to increasing financial and political problems, it is altogether likely that the basic staff of both the medical school and the subprofessional training center at Omdurman will have to be maintained through personnel provided by technical assistance programs.

The most urgent need, however, is to assist the Sudanese government in its over-all financial position so that young physicians and

subprofessional personnel can be placed in service throughout the provinces.  
In the Sudan the problem is one of long-range financial assistance rather  
than one of technical training.

2. Development of Fundamental Statistical Data  
(Relating to Incidence of Disease, Deaths,  
Births, Sanitary Status, Economic Status,  
Dietary Status, and Agricultural Production  
in Rural Communities)

Almost without exception the present training programs in West and East Africa are being undertaken without basic information as to the situations which will be faced by health workers when they are placed in rural or urban centers. Experience to date in such centers as the Haile Selassie I Public Health College and Training Center at Gondar, the technical training center at Nairobi, and the technical training center at Salt Pond in Ghana indicates that the responsibilities for training are so great that it is not possible for the staff at the same time to undertake basic studies in the villages to develop such information.

It is recommended that suitable investigative staff be provided to work in conjunction with training programs in the development of basic statistical data and in the evaluation of various approaches to control of the diseases and deficiencies found in the villages. Such a staff should consist of at least one epidemiologist (physician), one entomologist, one parasitologist (at least technician level), two health visitors (nurses), one sanitary engineer or sanitarian, and suitable technical staff.

An analysis of one such program at Ibadan, Nigeria, indicates that the annual recurrent costs will be in the range of \$85,000 per year based on current staff salaries at the normal university college scales, and capital costs of approximately \$25,000. These costs would presumably be increased if American personnel are also utilized, and allowance should be made for

salary differentials in this respect. In most of the areas it would be necessary to construct housing for field personnel. The cost of housing would probably be at the level of \$25,000 per unit.

Since investigative studies are recommended in conjunction with training centers for assistant medical officers and paramedical staff, the locations suggested for them are the same as those shown under field training stations in the preceding section.

### 3. Professional Postgraduate Training

#### A. Western African Region

A regional need in all of West Africa is for a center of graduate study in tropical disease and public health which could serve as an extension of a foreign institution. For the West Coast of Africa the associated institution should probably be the School of Tropical Medicine of Liverpool.

Most of the physicians in West Africa, expatriate as well as indigenous, received their training in the modern centers of Europe and the North American continent. They have had little or no training in the fields of endemic and epidemic diseases prevalent in Africa, and almost no orientation to the development of preventive services, particularly in the field of maternal and child health and in the specialty of pediatrics. At the present time there is no likelihood that the indigenous universities could or would develop such a training center, and personnel are not available within the areas of West Africa for the staff.

It is proposed that technical assistance be provided to establish a branch of the Liverpool School of Tropical Medicine, preferably at Ibadan or Lagos, to which graduates of the local universities and personnel of the local health services could go for a six-month to one-year period of re-training in problems relating to disease and its control in Africa.

Such a center could serve as a base for extensive research into the problems of African disease and for developing new patterns of health center care, sanitation, and village development. Perhaps most important of all, it could also serve as a graduate center for producing ever-increasing numbers of personnel, both professional and paramedical, for work on problems of pediatrics and preventive care.

The tie to the Liverpool School of Tropical Medicine would make it possible to recruit first-class academic staff with tenure in an established school. Hopefully, after a period of years, West African personnel would be trained to take over and carry on under local and regional auspices.

Costs are difficult to estimate for such a project. Certainly recurrent costs for staffing would be in the range of \$150,000 to \$250,000 annually, and capital costs, depending on availability of present structures, would range from \$600,000 to \$900,000.

B. Federation of Southern Rhodesia, Northern Rhodesia, and Nyasaland

The reaction of the government of the Federation and the government of the individual territories to the development of subprofessional personnel as substitutes for fully-trained doctors is a negative one. This territory, by and large, is one of white settlement with the African population largely under the domination of the white group. Southern Rhodesia alone has well over 600 physicians of indigenous white origin, and the authorities feel that they can produce sufficient physicians over the next few years to handle the needs of the white population and to develop increasing services in the African areas. There is also a plan to start a medical faculty at the integrated University College of Rhodesia and Nyasaland. If this comes into being, it is probable that the Federation could

within the next few years produce sufficient qualified professional personnel to handle the most urgent needs.

Perhaps the best opportunity for technical assistance in health within the Federation at the moment is in the development of a medical school along the lines recently recommended by the Nuffield Committee.<sup>1</sup> Such a school would set new patterns for training of African physicians, would closely parallel American orientation to community medicine, and would offer a unique opportunity for assistance through staffing and through a university-type contract. Certainly in Rhodesia today personnel are not available for the development of a medical school. Although funds for the major costs may well be found from Rhodesian sources, assistance in the form of teaching personnel would be most useful pending the training of indigenous teachers.

#### 4. Specific Disease Projects

##### A. Institution of vaccination programs and training of corps of personnel for continued vaccination programs in smallpox, yellow fever, diphtheria, pertussis, and tetanus

In the area under consideration there is a complete lack of a routine program for the most elementary vaccination procedures. Admittedly the long-range development of such a program must await the creation of a modern system of health centers throughout the countries. In view of the continued and excessive number of cases of smallpox, limited but important outbreaks of yellow fever, and continuous infections of diphtheria, pertussis, and tetanus, it would seem desirable to establish mass and routine programs as an educational wedge into health improvement against these diseases.

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<sup>1</sup> The Central African Journal of Medicine, Vol. 5, pp. 145-172, 1959

The problem is particularly urgent on the West Coast of Africa. Various proposals have been put forth for undertaking wide-scale vaccination, directed at the start against smallpox. Facilities are available in Lagos for the production of smallpox and yellow fever vaccine. Facilities for producing the other vaccines would have to be created.

It is considered appropriate to recommend that a long-range vaccination program over a period of years be undertaken on a western regional basis against smallpox and where indicated, against yellow fever. The development of personnel for such a program should be done in such a way as to leave behind a corps of trained vaccinators to continue year-by-year vaccination of newborn children and revaccination of children entering school. This corps could also advance to a program involving diphtheria, pertussis, and tetanus.

Such a program would include Nigeria, Ghana, Sierra Leone, Gambia, and Liberia - an estimated population of over 47,000,000. It will be necessary to establish a regional organization, a director and country directors, administrative personnel, and appropriate logistic training. This program for smallpox and yellow fever will cost approximately ten cents per person or an approximate total of \$5,000,000.

The Nigerian authorities of the Northern Region have suggested that the program be started there, utilizing as vaccinators census personnel who will become available after the proposed census of Nigeria in the first two weeks of June, 1960. It is proposed that this program cover approximately 19 million people in this area, using 50 vaccinators for each district on the basis of one for 2,000 people, and obtaining them from the 14,000 enumerators who will be in the field doing a census prior to this operation. Transport, vaccine, and vaccinating kits can be furnished by the government. The government would require assistance for salaries at

the level of \$182,000. The total cost of the program for 19 million people would be \$518,000 or approximately 2.8 cents per person.

The training of more permanent vaccinating personnel for all of Nigeria could subsequently be extended to the other countries of the West Coast.<sup>1</sup>

#### B. Tuberculosis

There is urgent need for the establishment of a training and investigation center for the West Coast of Africa which could work out methodology for ambulatory care and control of tuberculosis in the African towns and villages using combinations of PAS, INH, and streptomycin. Such a center could train personnel in case finding, contact follow-up, and treatment. At the present time in Ibadan at the University College there are personnel under Doctor Lauckner in the Department of Medicine who have plans to initiate such a center in Ibadan-town with extension to the surrounding rural villages. Supplementary personnel in the form of health visitors, tuberculosis epidemiologists, and some laboratory technicians, plus equipment, would be needed. Such a project would serve a population of over a million people and could train substantial numbers of personnel of all grades. They would have to cope with over 6,000 cases of open tuberculosis and an unknown number of contacts and new cases.

It is estimated that initial nonrecurrent capital costs would be \$45,000, with an annual recurrent cost for personnel, transportation, etc. of \$50,000.

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<sup>1</sup> Dr. N. Leitch, Medical Adviser, Northern Region, Nigeria

### C. Malaria

One cannot anticipate starting regional or even country-wide malaria programs at the present time in sub-Sahara Africa owing to technical problems as well as personnel shortages. In this area, however, particularly in East Africa, there are urgent reasons for instituting local and extensive control measures where large-scale irrigation schemes are being developed, in order to provide increased opportunity for native African agriculture. Such irrigation districts are now being established over considerable territory in Uganda and Tanganyika. Evidence indicates that native African production in these schemes will not be substantial unless early and prompt measures are taken to control the development of A. funestus and A. gambiae transmitted malaria.

The two territories have at the present time facilities for training personnel at Amani under Dr. Bagster Wilson of the East African Institute of Malaria and Vector-Borne Diseases. Dr. Bagster Wilson has demonstrated that malaria transmitted by both vectors can be controlled by house spraying with dieldrin combined with the distribution of antimalarial drugs. Neither of the governments of these territories can finance wide-spread control programs from their current resources which are already over-extended in development of new agricultural areas for African populations. The authorities feel, however, that they could undoubtedly support the continuation of such programs in five to eight years as the African population begins to produce and makes a contribution to government expenditures as well as to the gross national product.

The need in this instance is one of straightforward financing of malaria projects which will contribute directly to increased agricultural production and to land resettlement of the African population. The cost is

estimated by Dr. Bagster Wilson as 2.5 shillings, or 35 cents per capita per year. In all probability the programs recommended would involve approximately two million persons and an expenditure of \$700,000 annually. The long-range goal of such a project would be control of malaria throughout the territories, very much on the basis of the program now achieved in Southern Rhodesia.

While West Africa probably cannot launch into large-scale malaria control at the present time, it is altogether likely that it will have to undertake limited schemes where irrigation and reservoir projects are established. In any event it will be essential to continue training malaria personnel on a regional basis for the programs now under way in Liberia and in the major urban areas of the West Coast.

Fortunately there are good facilities for such a training center in Lagos which served previously as the headquarters for Dr. Bruce Chwatt and the malaria services of Nigeria. This center has the physical facilities but would require new training personnel at all levels. In all probability redevelopment of this training center on a regional basis would involve sums approaching \$100,000 annually.

## SUMMARY OF RECOMMENDATIONS

1. Development of Field Training at the Assistant Medical Officer and Paramedical Level:

	<u>Capital</u>	<u>Annual</u>	
Liberia	\$300,000 (Unit)	\$150,000 (Unit)	
Ghana	100,000 "	250,000 "	
Nigeria	75,000 "	250,000 "	
Uganda, Kenya and Tanganyika	180,000 "	45,000 "	
Ethiopia	100,000 "	-	
Sudan	(Long-range support)		

2. Development of Fundamental Statistical Data:

\$ 25,000 (Unit)      \$ 85,000 (Unit)

3. Professional Postgraduate Training:

West Africa	\$900,000	\$250,000	
Federation of Southern Rhodesia, Northern Rhodesia, and Nyasaland	(Possible contribution to Medical School)		

4. Specific Disease Projects:

(a) Vaccination Program:			<u>Total</u>
West Africa			\$5,000,000
Nigeria, Northern Region			518,000
(b) Tuberculosis:	\$ 45,000	\$ 50,000	
(c) Malaria:			
East Africa	-	700,000	
West Africa	-	100,000	

#### IV. AGRICULTURE

The genesis of agriculture permitted the establishment of stable populations, and these, in turn, were the base from which education, the arts, science, and industry could slowly develop into the present day political and cultural organization of the world community. The health and welfare of mankind is clearly dependent on adequate quantities of suitable food-stuffs to sustain life. Population increases of from one to two per cent per year must be balanced by comparable increases in agricultural production if even minimal health requirements are to be maintained. Social progress and scientific advance depends to no small degree on an adequate dietary standard and the improvement of agricultural production. In broad terms this means improvement in the quantity and quality of plant and animal products for food, for export, and in support of industrial development. The future progress of sub-Sahara Africa is no exception to the rule. The economic growth of the region is to a major degree dependent on these improvements.

A successful agricultural industry depends, first, upon available natural resources; second, upon human capacity for their rational development, and third, upon the economic factors which govern the production, marketing, and utilization of agricultural commodities. In this discussion of the agricultural potentials of Africa South of the Sahara, the following subjects will be treated in some detail: climate, water, soil, plant production and protection, animal production and protection, and agricultural education.

## Climate

The humid tropics are famous for the lushness of their vegetation and for their production potential of heavy yields of tree, forage, field, and food crops. This potential has been successfully exploited in many parts of the world in the growing of sugar cane, coffee, cocoa, rubber, bananas, rice, fibers, oil crops, and grasses. In contrast, the non-plantation crops have not been so highly developed and, in fact, most food production in the tropics is often at a subsistence level. To improve the techniques of tropical food crop production generally would mean enormous economic gains with commensurate benefits in the dietary patterns of Africans.

Agriculturally, tropical Africa is fortunate in having an abundance of solar energy throughout most of the year. When other conditions are favorable, almost continuous cropping can be practiced in many parts of the area. Temperatures are conducive to plant growth, without the extreme fluctuations which in the temperate zones limit crop production to clearly defined growing seasons. Theoretically, the humid tropics, and the dry tropics with irrigation, represent the highest known agricultural potential and under proper management could yield enormous economic dividends.

## Water

Water is the most important single factor in the future development of agriculture in Africa. Annual floods with resultant soil losses are common in many parts of tropical Africa, while in others drought conditions prevail. The irregular distribution of rainfall and the lack of control of water courses in flood stage are both important deterrents to stable agricultural practice and indeed to the local development of urbanization. It is of basic importance to the economic growth of sub-Sahara Africa that

immediate and persistent attention be given to water resources and their management to insure, insofar as possible, adequate and continuous supplies on a multipurpose basis.

Enormous benefits could be expected from the increased use of irrigation. Necessary for this would be the utilization of present water supplies from lakes and rivers and the establishment of impoundments for the collection of run-off or river waters. These developments would require heavy investments and should be undertaken only on scientific evidence that the expense would be fully justified by future gains in production, power, and industrial water supplies.

### Soil

It is impossible to generalize about tropical soils because they represent such a broad spectrum of origin, types, and physical and chemical properties. However, in extensive areas of sub-Sahara Africa the soil, in combination with abundant sunlight and rainfall, provides a basis for highly successful agricultural production. In contrast, in other regions the soils are relatively infertile or their usefulness is limited by inadequate water. In still others the soils, because of their structure and composition, are exceedingly difficult to adapt to conventional agricultural practice.

A substantial amount of work has been undertaken in some parts of Africa on soil surveys and classification. The surveys do not cover the entire area, nor are they uniform. Nevertheless, they are extremely useful in emphasizing the importance of a more complete inventory of the soils of the entire region which can be used in planning sound production programs.

The proper management of soils is critical to a stable and continuous cropping system. As might be expected, rather primitive management

systems are established throughout much of tropical Africa, and these have led to practices which are uneconomic and, in the long run, destructive. Cultivation by the cut-burn-plant-abandon system is tolerable only when population pressure is essentially nonexistent. When population increases begin to require the continuous use of land for crop and animal production, the real magnitude of the destructive effect of shifting cultivation becomes apparent. Significant and sometimes irreparable damage has often been done, with permanent loss to the economic potential of the area.

Basic to the problem of soil management and its improvement is the corollary problem of land-holding patterns. These vary widely throughout Africa, ranging from communal systems in which there is no private ownership, through the reservation, to the freehold and the latifundia. Obviously, it is difficult to impose upon a people a system of land tenure different from that to which they have been accustomed for many generations. Historically, such changes have usually followed social revolution or military conquest. However, it is absolutely essential that greater attention be focused upon land-holding systems in an attempt to stabilize agriculture practices, to protect the soil and vegetation, and to stimulate private enterprise for economic benefit.

### Plant Production and Protection

The areas of Africa adapted to conventional agriculture offer appealing opportunities for a wide variety of crop plants and domestic animals. Cereals, legumes, fruits, forage, and forest crops all grow luxuriantly and yield heavily under proper management. At present there is an understandable emphasis on the crops which are traditional and rustic in the sense that they are well adapted and require minimum effort. Mixed stands are

common, fields are usually underplanted, seed beds are poorly prepared, plant varieties are unimproved, and protection from pests and diseases is unusual.

The most pressing need is for greater production of basic food crops to provide an adequate diet for an increasing number of inhabitants. The improvement of plant materials and of the management of traditional food crops should be emphasized first. As production and quality improve and economic benefits follow, it will be possible to diversify agricultural patterns to bring about dietary betterment with commensurate nutritional benefits. In sub-Saharan Africa there are great opportunities for the improvement of maize, sorghum, the millets, and rice, for significant increases in the production of a variety of leguminous food crops, and for the expansion of acreage in citrus and other tropical fruits, oil crops, and vegetables.

Although the improvement of food production is of primary importance, Africa offers great opportunities for increasing the average yields and quality of commodity crops as well. Rubber, cocoa, coffee, coconut, palm oil, and certain specialty crops are well adapted to various parts of coastal and sub-Saharan Africa, and with proper planning and management could be exploited much more effectively. Increased production would result in substantial economic gains for an indefinite period into the future. The plantation cropping system, in appropriate locations, would have the dual benefits of efficiency and of bringing into economic utilization extensive land areas which might otherwise long remain unproductive jungle. The expansion of plantation cropping would require careful study with respect to the optimum system to be employed, i.e., government ownership, concessions, leaseholds, or cooperatives.

As the local economy evolves, it will be possible and desirable to introduce complementary crops which may become the basis of local private

enterprise. Africa can readily support the larger production of a *variety* of fiber crops, essential oils, drugs, tobacco and tea.

Genetic stocks of a wide variety of food and other crops now *exist* which could be used with great benefit. Immediate advantages might be gained by the introduction of certain improved varieties, and genetic modifications would further adapt them to local conditions. The proper management of elite plant materials would result in rapid and significant gains in average yields, with parallel dietary and economic benefits.

It is axiomatic that the methods which lead to greater plant production intensify the hazards of attack by plant pests and pathogens. Modern agriculture rests on the philosophy that the carrying capacity of the soil must be continuously increased so that greater annual yields can be expected. In practice this means that larger numbers of high-yielding plants are crowded more closely together and artificially fed and watered. This technique creates a massive medium for the growth of pests and pathogens. Modern agricultural practice therefore includes heavy emphasis on the prevention or control of attacks by pests and pathogens. The use of disease-resistant varieties wherever possible, soil treatment against soil-borne organisms, and of dusts or sprays applied to the growing crop, are the more important methods of protection. These measures, combined with general sanitary practices, have reduced the enormous tolls which virulent pests and pathogens have taken in past years from agricultural production.

Unfortunately the same beneficent temperature and rainfall which encourage luxuriant plant growth in the tropics encourage with equal effectiveness the growth and development of enormous numbers and varieties of fungi, bacteria, nematodes, and viruses. It has been estimated that at least 25 per cent of the agricultural production of tropical Africa is lost

each year through the destructive effects of pests and pathogens. A most important activity would be projects for the control of major agricultural pests and diseases.

### Animal Production

Vast acreages in the tropics are especially well adapted to animal production, and this is certainly true in much of Africa. Broad savannas and plains in both West and East Africa support a rich variety of wild life. This wild life, which has flourished in the past and to a considerable extent still flourishes, is striking testimony to the adaptability of the area to the production of livestock. In many locations the application of the plow would be ultimately destructive to land which is fundamentally adapted only to grass cover. The proper management of these areas could yield vastly increased quantities of protein foods for human nutrition.

Livestock management in Africa is now more conspicuous by its absence than by its practice. Patterns of ownership and management of livestock are primitive, and the contribution of livestock to human diet is minimal. There is no easy solution to the problem; it is one which requires study and action leading to the economic utilization of pasture resources for maximum protein production.

An examination of the cattle population in Africa reveals a wide variety of indigenous genetic material with various admixtures of exotic blood imported from the West and the East. Some research is in progress, and it would be desirable to expand the study of the quality and potentials of indigenous cattle in Africa. Such a study would provide further information on adaptability, fertility, potential productivity for meat and milk, heat tolerance, disease and pest resistance, nutritional requirements, and

other important considerations. Decisions could then be made with respect to the establishment of breeding and management programs for meat and dairy animals especially adapted to conditions in the several regions of sub-Saharan Africa and the handling and distribution of animal products.

From many standpoints poultry husbandry offers one of the simplest and best ways to obtain rapid increases in protein supplements for the African population. Evidence already indicates that adapted types and breeds are available which could flourish in many parts of Africa under appropriate systems of management. Subsequently, some modifications through breeding might result in still further improvements.

It is essential that vast improvements be made in livestock management in sub-Saharan Africa if this resource is to be utilized effectively in dietary and economic patterns. Most important is progress in feed and forage production and the management of range and pasture areas. The stabilization of grazing patterns would support the production of dairy as well as of meat products and would justify breeding programs. There should be concurrent projects on the improvement of sheep, swine, goats, and poultry, and on their management.

### Animal Health and Protection

A major deterrent to livestock production and management in sub-Saharan Africa is the complex of parasites and diseases which annually take a heavy toll of domestic animals. Most of the common diseases of cattle, sheep, and poultry are rife, and a number that are peculiar to this or a few similar areas. The presence of large numbers of a variety of wild life in certain sectors of Africa further complicates the animal health picture.

Epidemic diseases of livestock which are only partially controlled cause heavy annual reductions in the quantity of meat and meat products.

Furthermore, bovine trypanosomiasis, rinderpest, and contagious bovine pleuropneumonia effectively eliminate the possibility of developing export markets for animals and animal products. This is a serious matter because there would be substantial opportunities for Africa to export meat and hides if they were not barred by quarantine regulations.

If livestock production is to prosper in sub-Saharan Africa, the important epidemic diseases must be brought under control. This fact has been recognized and several veterinary research institutions are working on a variety of livestock diseases. International agencies have participated in regulatory programs, especially on the control of rinderpest in the Sudan, Ethiopia, Kenya, Uganda, and Nigeria. A considerable body of useful information has been accumulated, several vaccine production centers have been established, and a number of regulatory campaigns are in progress or in prospect. These all are important but there is need for continuing intensive and extensive research, for more general application of sanitary and prophylactic measures to minimize the dangers of infection, and for widespread regulatory campaigns directed toward the elimination or control of specific diseases. Programs of this type in conjunction with collateral projects in breed improvement, livestock management, and nutrition, would yield important economic benefits.

The health and productivity of poultry and livestock in sub-Saharan Africa could be greatly improved with reasonable promptness. To do so would require substantial additional support for existing research institutions to enable them to increase staff, add to their equipment and broaden their research programs. In some areas it might be necessary to establish new research centers as rapidly as funds and personnel become available. Foreign aid agencies could make major contributions by furnishing additional

technical specialists, and funds and equipment for the study and control of major livestock pests and pathogens.

### Agricultural Education

As emphasized in the section on Education, trained individuals in various professional branches of agriculture are greatly needed. A good deal could be accomplished through the technique of sending scholars and fellows abroad for instruction in soils, agronomy, plant breeding, entomology, plant pathology, agricultural economics, animal husbandry, and veterinary science. This procedure would be helpful on a temporary basis, but ultimately undergraduate, graduate, and professional education in the agricultural sciences must be available in Africa. It is, therefore, important to strengthen the colleges and universities which now exist and to establish new institutions in certain critical areas.

### Recommendations

The bewildering array of agricultural problems of obvious importance to sub-Sahara Africa represents both a challenge and a danger to foreign aid efforts. The challenge lies in the multitude of opportunities; the danger is that funds and manpower may be so diluted that too little progress is made on too many fronts. To avoid this dilemma, it is essential that clear-cut decisions be made as to the areas of greatest need and opportunity and about the development of a pattern by which these can be most successfully aided.

#### 1. Agricultural Experiment Stations

One of the greatest contributions which the United States has made to the progress of scientific agriculture is the origin of the U.S. experiment station system. The network of research and experiment stations

in this country has over the years laid the base for agricultural advances at a cost which is insignificant in relation to the economic benefits which they have made possible.

It is fully recognized that there are experiment stations already established in sub-Sahara Africa. Some of these are excellent and have contributed significantly to the local production of cotton, cocoa, and certain other crops. It is nowise suggested that these stations should be replaced or absorbed. Rather, it is believed that there is need and opportunity to supplement research in progress through the establishment of several stations at critical locations dedicated primarily to the study and improvement of food crops and animals most basic to local dietary needs and patterns. These stations would deal with land management, soil fertility, rotation patterns, irrigation, disease and pest control, crop and animal breeding, harvesting and processing practices and all aspects of agricultural economics. It is not possible to transpose the results obtained in the U.S. experiment station system directly into the African situation. However, the development of a comparable pattern of research centers in sub-Sahara Africa would be one of the greatest contributions which the U.S. could make to the African people.

Properly organized and developed, these centers would provide a continuing source of information and materials adapted to the areas in which they are to be produced in quantity. They would serve as introduction and testing stations, as sites for varietal improvement through breeding programs, as locations for studies on soil management and fertility, and as livestock centers for research and experimentation on the management of domestic animals. The role of the proposed experiment stations as training centers for Africans is at least of equal importance to their role as research establishments. Each would provide opportunities for the utilization of significant

numbers of African personnel as employees and in-service trainees at sub-professional and professional levels. Eventually some of these individuals would begin to assume full responsibility for the station program, and others would be available for assignment elsewhere in response to growing need.

An appealing feature of this recommendation is the fact that much of the work undertaken at each station would be to some degree common to that of others. The stations would form a network of research centers for the improvement of basic food crops such as the cereals - corn, wheat, sorghum and millet; the pulses - beans, peas and forage legumes; vegetable crops; poultry; and dairy and beef cattle. These are the crops and animals vital to the improvement of dietary patterns throughout the area, and by working on them at each of the several centers, information, materials, and personnel could be exchanged as needs and opportunities arose. As these stations develop, they could add such activities as work in the field of agricultural engineering and irrigation, economic studies, and experiments on plantation or other complementary crops.

Once the stations were well established and producing information and materials of definite value, it would be possible to organize an agricultural extension service to link experimentation and production. It is vital to the economic and nutritional improvement of Africa that as rapidly as possible new methods and materials be made available to agricultural producers so that they may strengthen their economic position and standards of living, and at the same time increase their contribution to national income and food supplies.

The sites for the agricultural experiment stations would necessarily have to be chosen with careful attention to the needs of the area in which they are to be established. Wherever possible, they should be

associated with an agricultural college so that ultimately the three principal facets of agricultural science would be brought into phase, i.e., education, research, and extension. If, however, there does not at the moment exist an opportunity to combine a station with an existing agricultural educational institution, the station should be established with the expectation that at an appropriate later stage, agricultural education would be brought into the picture.

It is recognized that in some instances it may be possible to strengthen an existing agricultural research center, but it is expected that it will also be necessary to establish several in their entirety. Priority should be given to Liberia, Ethiopia, and Eastern Nigeria.

#### Budget

The creation of an agricultural experiment station is a costly operation and its maintenance a heavy continuing expense. However, they are essential to the economy of agricultural nations and historically have contributed to the national income to such a degree that by comparison their cost is negligible.

It is estimated that each station should contain at least 600 acres of arable land, with the possibility of substantial expansion if it is decided to go into animal husbandry, which requires extensive pasture acreage. It is assumed that government would provide the land for station purposes. Buildings would include offices, laboratories, farm buildings, shops, and housing.

The minimum requirement for the capital cost of buildings, equipment, and machinery is estimated to be in the neighborhood of \$2,500,000. Staffing requirements, labor, maintenance, supplies, etc., might readily require an average annual budget of \$500,000.

It is considered that at least ten years would be required to establish these stations, to get their programs organized and under way, and to produce materials and information for extension into rural areas. Within this period it would be possible to create a small extension service that could grow as its work expands and becomes in greater demand. It is estimated that extension activities would require an initial annual budget of approximately \$250,000 and that this budget would increase in direct proportion to the degree to which the extension service ultimately covers the country concerned.

In summary, the establishment of a single station and its maintenance over a ten-year period might well require investments totaling \$10,000,000 to \$15,000,000. If technical assistance agencies could convince each government of the importance of the establishment of a central station of this sort, and were willing to contribute substantially toward its original costs and subsequent maintenance, the ultimate results would be a series of major contributions to the national economy and to the health and welfare of considerable sectors of Africa's population. Eventually, it would be expected that other stations or substations would be established by government as needed, patterned after the central station described here.

## 2. Tsetse Fly Control in Central Africa

The importance of the control of the tsetse fly in Africa is so well known that persuasive arguments are unnecessary. Although man and certain domestic and wild animals are all susceptible to certain forms of trypanosomiasis, the most important aspect is that related to animal husbandry. The problem has confronted the authorities throughout much of Africa for a great many years, and a substantial amount of research and experimentation has been done. However, much of this work has been

localized, and it has not yet been possible to mount regional campaigns based upon sound scientific evidence. All those international and national agencies with interest in this problem in Africa should be brought into the scene. The fields represented would include agriculture, medicine, economic entomology, ecology, basic biology, and engineering.

It is recognized by the scientific community in Africa that a number of conflicting considerations are involved in the control of the tsetse fly and that these should be evaluated and resolved as a basic step toward decisions about a concerted attack on the fly vectors of bovine trypanosomiasis. Many individuals feel that the eradication of the fly without parallel developments in animal husbandry and management might do more harm than good. Some believe that tsetse fly elimination requires the destruction of game in infested areas, whereas others say that such drastic measures are not necessary. Many persons think that the financial requirements of an all-out attack on the tsetse fly make such a campaign impractical. They believe rather in spot control and in the thesis that the normal progress of urbanization and land clearing for villages, pasturage, and crop production will cause the vector species to retreat and ultimately disappear through ecologic imbalance.

It is clearly evident that there are sufficient numbers of questions and doubts to justify a most careful examination of the problem and an evaluation of possibilities for regional tsetse fly control. It is, therefore, recommended that a project be established with the following steps and dimensions:

(a) Establish a small committee for the purpose of identifying all agencies and individuals directly or indirectly concerned with the tsetse fly control problem in Africa.

(b) Arrange a meeting of appropriate representatives of agencies and disciplines for a broad discussion of all facets of the problem, a critical examination of factors and theories, and the elaboration of a sound program in support of research, experimentation, and operations. Insofar as possible the program should be built on existing institutions and personnel. The operations should be designed to produce further critical knowledge, to test methods, and to make significant progress toward effective control. All three approaches should be undertaken simultaneously and improved and expanded as new information and material become available.

A major consideration for decision at this meeting would be the selection of a coordinating agency which would take general responsibility for the implementation of the program, its integration on a regional basis, and its continuing evaluation. It is suggested that this might best be accomplished through the employment of an international team of specialists during the period of the project. This team would necessarily have to be accepted by all the agencies concerned as a coordinating scientific body with free access to each project and with authority and funds to recommend various projects and to support them to assure their continued productivity.

(c) It is estimated that the program should be set up on a six-year basis with biannual review for the purpose of evaluating progress and deciding on future orientation.

(d) It is recommended that the preliminary study begin as soon as possible in 1959 and that the meeting of the international working party be held by early 1960 at the latest. If possible, 1960 should be the first budget year, and the international program should be in full activity by the beginning of the second fiscal year.

(e) The countries immediately concerned would be Liberia, Nigeria, Ghana, Ethiopia, Kenya, Uganda, Tanganyika, the Sudan, and the Federation of Rhodesia and Nyasaland. French, Belgian, and Portuguese authorities may wish to cooperate and participate at an early date.

### Budget

It is estimated that approximately \$100,000 would be necessary to set up the program and to arrange and hold the initial international meeting in Africa. Best current estimates as to program costs suggest that \$1,000,000 to \$1,500,000 could readily be committed during the first year and \$2,000,000 to \$3,000,000 during each of the succeeding years. These estimates necessitate a total budget of from \$10,000,000 to \$15,000,000 over six years. It is expected that by the end of this period conclusive evidence would be available as to the most effective and economic methods for the control of the tsetse fly; that a considerably larger body of individuals with useful knowledge and experience in the field would be working on tsetse fly control in Africa, and that important progress would have been made in the elimination or the control of the fly throughout large sectors of tropical Africa. It is believed that after six to seven years, the regulatory aspects of tsetse fly control could readily be continued as part of the agricultural program of the several governments acting individually and in concert. A reserve fund of \$2,000,000 would be useful in facilitating final transfer of responsibility during the seventh year, on the assumption that this process had been begun during the fifth year of the program.

### 3. Soils Survey

An inventory of the soil resources of Africa is vital to future agricultural development. This fact has been recognized in some quarters,

and a number of projects have been, or are, under way in certain countries, notably Ghana and Kenya. Here again, however, there is great opportunity for a regional approach through sound programs already in progress that could be strengthened and related to each other and to others that might be initiated, in order to obtain broad coverage. It is visualized that this project would comprise a general survey and mapping of the soils of sub-Sahara Africa to identify the important types and their distribution and to determine their agricultural potentials.

The suggested organization for this project is a long-term contract with an appropriate agency that would undertake to organize and conduct a survey and to produce base maps which would be the foundation for future soils studies and more precise investigation. These maps would provide a body of information which would be invaluable to future development of agricultural economy and for the rational utilization of existing soil types.

#### Budget

It is difficult to estimate the cost of a program of this dimension, but it is believed that an investment of \$10,000,000 to \$12,000,000 over a six to seven year period would result in a reconnaissance soil map of the area under consideration. It would be possible to include a plant cover survey within this project with little increased cost and significant benefit.

#### 4. An Inventory of Crop Pests and Diseases in Africa

Sufficient evidence is already available to certify to the fact that tropical Africa contains a wealth of indigenous crop pests and pathogens, a number of which have already caused serious losses to crop production. Up to the present, attention has been concentrated mainly on those

that constitute an economic threat and very little is known about the enormous variety of pests and pathogens which lurk in tropical Africa as potential menaces to future production not only in Africa but in other countries where susceptible crops are grown.

Here again the regional approach is essential since there are no political barriers to the movement of pathogenic microorganisms. It is suggested that a corps of scientists be recruited to mobilize and direct a study during a period of from three to five years which would have as its object an inventory of crop pests and pathogens in Africa. These individuals, through direct action and collaboration with local institutions and scientists, would accumulate available knowledge, information, and specimens, and expand this effort to major dimensions. The ultimate object of the study would be to produce an annotated check list of the crop pests and pathogens of the entire area, and to establish central depositories and information centers at one or two locations in Africa.

#### Budget

It is estimated that the total cost of this survey might be \$4,000,000, and it is suggested that the Food and Agriculture Organization of the United Nations would be an appropriate contract agency for this task.

#### 5. Animal Pathology

Animal health problems in Africa are many and severe, and they distinctly limit the production of animal proteins for human diet and animal products for export. This fact has long been recognized, and a number of agencies have been or are engaged in research on problems of animal health in various sectors of sub-Sahara Africa

A basic cause of poor health in livestock in Africa is malnutrition, and investigation of this situation could best be handled through the

agricultural experiment stations which have been recommended. It is not proposed that these stations serve also as veterinary units, because of the highly specialized nature of the study and control of epidemic and other diseases of livestock and poultry.

Rather, it is recommended that effort be made to strengthen those establishments already in Africa which are dedicated to studies leading to the prevention and control of animal diseases and to the extension of results obtained to important livestock areas. Significant work is already in progress on rinderpest, contagious pleuropneumonia, and trypanosomiasis, as well as on a number of the more common ills of domestic animals. Substantial reinforcement of these institutions through the provision of funds, personnel, and equipment to permit them to expand their coverage both scientifically and geographically, could be expected to have significant beneficial effects, not only in Africa, but in other areas where similar conditions prevail.

#### Budget

It is difficult to estimate total requirements under this recommendation, but it is quite obvious that operating funds, equipment, and personnel could all be utilized effectively, and that there are opportunities for the establishment of several additional research institutions. Initially, it would appear that the animal disease research laboratories at Muguga, in Kenya, and Vom, in Nigeria, are among the strongest in East and West Africa, and could take greatest immediate advantage of further support. These institutions are already research centers and important producers of vaccines. They could become more active on a regional basis with substantial supplementary support. If support were made available to each through foreign assistance agencies at the rate of a minimum of

\$500,000 per year during a seven to ten year period, additional staff could be recruited, laboratories and other facilities could be improved, programs could be expanded, and long-range economic benefits fully justifying this level of support could be expected to follow. With further assistance, these institutions could develop or expand training programs for veterinary assistants and technicians, for whom there is a growing need.

Aid to veterinary research in Ethiopia is an important consideration in view of the position of this country as a producer of livestock. There are opportunities also in the Sudan for the strengthening of its animal health program with significant benefit to production.

#### 6. Vocational Schools of Agriculture

A fundamental educational need in agriculture for sub-Saharan Africa is training at the vocational level for a large number of Africans. There is no single standard that can be generally applied throughout the area, but vocational or farm schools should be developed at levels and in situations compatible with the local requirements. In some instances, these might be quite elementary, whereas in others it would be possible to bring trainees to levels at which they would be able to serve as farm foremen, machine operators, shop foremen and artisans, and managers of dairy and poultry plants. The training of sufficient numbers of persons at the vocational level would be of enormous importance in the successful establishment of agricultural experiment stations, seed production farms, poultry and livestock units, and extension services.

There are currently in existence a number of vocational schools of agriculture for Africans in the countries of sub-Saharan Africa. These vary in size and importance but a number could be substantially strengthened with beneficial results. These schools need personnel, additions to plant,

equipment and supplies, and funds for the purchase of flocks and herds. It would be desirable also to establish vocational schools of agriculture in rural areas where there is need for an increasing number of young farmers or farm foremen.

#### Budget

It is not possible to provide a specific budget in support of this type of project, but it is known that several vocational schools training 100 to 200 students have cost from \$500,000 to \$1,000,000 to construct and require an annual budget of approximately \$150,000. If it were possible to earmark approximately \$10,000,000 over five years for vocational education, significant contributions could be made to the training of skilled workers in many fields of agriculture.

#### 7. Professional Agricultural Education

In sub-Saharan Africa, there are University Colleges at Accra, Ghana; Ibadan, Nigeria; Kampala, Uganda; and Salisbury, Southern Rhodesia. Each of these has an agricultural department which does now or eventually will offer London University degrees in agricultural science. Because of the capital support which has gone into plant and facilities, and the quality of the professional personnel at these institutions, it can be expected that they will continue to produce a small number of well-qualified graduates in the agricultural sciences. It is to be expected that larger numbers of students eligible for university training in agriculture will be seeking admittance in the years to come. If properly supported, the aforementioned university colleges could train substantially larger numbers of students for important national responsibilities.

There are national agricultural colleges at Khartoum in the Sudan and near Harar in Ethiopia. The first is a completely national entity

whereas the college at Alemaya, Ethiopia, is operated under a contract with Oklahoma State University. Both are rendering useful service to agricultural science in the respective countries and could advantageously use additional and continuing support.

There is need for the establishment of new agricultural colleges in several countries of Africa South of the Sahara. Each would of necessity include an experiment station in its plant and program. These colleges would have as their stated goal the training of agricultural scientists whose orientation would be toward the improvement of agricultural production through direct participation in programs of plant breeding, disease and pest control, soil management, agronomy, livestock production and management, agricultural economics, and related fields. These are the individuals who would one day man the experiment stations, direct extension programs, and guide projects directed toward the improvement of crop and livestock production. It is expected that selected graduates would be sent abroad for advanced training toward the graduate degree, after which they would return to positions of greater responsibility in the agricultural framework of their countries.

When possible and appropriate, it would be desirable to consider the establishment of a college of mechanic arts (engineering) in association with the college of agriculture in order that this important discipline may develop hand in hand with agriculture. For best results the college of engineering should combine training for students in the several engineering technologies with engineering and experiment station activities in such fields as hydraulics, irrigation, farm machinery, construction and architecture.

It is recognized that the establishment of agricultural colleges is an expensive procedure, especially if they must be built entirely de novo.

It is further realized that there must be local enthusiasm and participation to the maximum degree possible for an institution of this type to be successful. It is essential that each college of agriculture be directly linked with an experiment station and extension service for maximum benefit to production.

It is implicit in all the sections dealing with education that wherever feasible young women should be given educational opportunities commensurate with their abilities and ambitions. African women represent a relatively untapped resource and one which could be enormously developed with great cultural and other benefits. The least privileged women in Africa tend to be those in rural areas. The more that can be done to improve their knowledge and understanding, the better will be their future role as homemakers, teachers, or industrial employees. It is especially important to consider the possibility of offering training in the general field of home economics, and this would readily be accomplished in conjunction with the establishment of vocational and professional schools of agriculture.

#### Budget

Financial requirements are difficult to estimate, but as an example the minimum cost for the establishment of an agricultural college with appropriate land, buildings, equipment, staff and maintenance over a ten-year period might be in the order of magnitude of \$12,500,000.

#### 8. Veterinary Education

There are two schools of thought with respect to veterinary education in Africa. One believes that this field represents a great vacuum which could only be filled by the establishment of one or more first-class

schools of veterinary science in the area. Opposing this opinion is the belief that during the foreseeable future the cheapest and most effective way of training veterinarians is through a system of scholarship or fellowship awards by which selected individuals are sent abroad for a period of study sufficient to enable them to win the D.V.M. degree. All tend to agree that there is need for the training of veterinary assistants in Africa who would be essentially subprofessional and qualified to carry on a variety of regulatory and other tasks related to veterinary science under the direction of qualified veterinarians.

In view of the importance of livestock in Africa, and the heavy losses which annually result from a wide variety of animal diseases, it is evident that there is need for greatly expanded and intensified veterinary services. It is doubtful that large numbers of qualified veterinarians could be immediately absorbed into the local economy, but it is certain that there is need for substantial increases in numbers. Probably it would be best to step up the process of sending selected students abroad for veterinary training, and, at the same time, it would be well to seek opportunities for strengthening the presently established schools at Khartoum in the Sudan, Makerere College in Uganda, and its correspondent institution at Kabete in Kenya. This would be on the basis of prior understanding that these schools would be willing to handle a reasonable number of students from the several countries of sub-Saharan Africa. Eventually it may be desirable to establish a school of veterinary medicine in West Africa possibly in Nigeria.

#### Budget

Veterinary education is extraordinarily expensive, and it would certainly require several million dollars over a five to ten year period

to bring the present Veterinary School in Khartoum to the level of modern colleges of veterinary medicine in the West. Investment in the Veterinary School at Makerere over a five to seven year period would pay significant dividends in the form of research results and increased numbers of well-trained personnel.

Summary of Recommendations

	<u>Minimum Number Of Units</u>	<u>Unit Cost</u>	<u>Estimated For 10 years</u>	<u>Total</u>
Agricultural Experiment Stations Establishment	3	\$ 2,500,000	\$ 2,500,000	\$ 22,500,000
Annual Recurring Costs		500,000	5,000,000	
Extension Service Average Annual Recurring Cost	3	500,000	5,000,000	15,000,000
Vocational Schools of Agriculture Establishment	2	1,000,000		
Annual Recurring Costs		150,000	3,000,000	5,000,000
Agricultural Colleges Establishment	3	7,000,000		
Annual Recurring Costs		700,000	15,000,000	45,000,000
Veterinary Education Establishment	1	7,000,000		
Annual Recurring Costs		1,000,000	10,000,000	17,000,000
Tsetse Fly Control International Meeting and Ten-Year Program				15-20,000,000
Soils Survey Seven to Ten Year Program	1	1,500,000	15,000,000	15,000,000
Inventory of Crop Pests and Diseases	1			4,000,000
Animal Pathology Seven to Ten Year Program				5-7,000,000
				<hr/>
				\$ 149,000,000

## V. NATURAL RESOURCES

In a search for ways to support the further economic growth of sub-Saharan Africa it is essential that careful consideration be given to existing resources and their rational utilization for public benefit. Since specific agricultural resources are discussed elsewhere, this section will deal with the renewable and nonrenewable resources collateral to conventional agriculture. The first can be best considered under the categories of forest, wildlife and marine and fresh-water resources; the second as mineral resources, including nonmetallic minerals, metals, fuels and water.

### FOREST RESOURCES

It is unfortunate that vast forest resources of Africa have already been destroyed or seriously damaged. Uncontrolled cutting, burning and grazing, as well as other abuses, have resulted in such extensive ecologic changes that repair of the damage will be extremely difficult. On the other hand, there are significant possibilities not only for the protection and rational utilization of the forest reserves still available but also for the reforestation and the management of selected areas to insure continuing and increasing national income from this important biologic reservoir.

There are currently two primary uses of forest products in Africa: firewood, quantitatively the more important, and timber and wood products for domestic use and export. A third use, still largely potential, is pulp for the paper industry.

The proper protection and development of forest resources in appropriate areas could be expected to provide several major and continuing benefits to the countries concerned. From the long-range point of view,

forests contribute to society by protecting and stabilizing soils and preventing erosion, and by protecting water courses and a variety of species of wild life which are forest dwellers. Forests also offer opportunities for the economic utilization of considerable areas which are unsuitable for conventional agriculture by reason of soil type or structure, limited rainfall, or topography. In addition, with proper management, forest resources provide substantial quantities of strategic materials for domestic utilization and for export.

It is admittedly difficult for foreign agencies to carry out major and effective campaigns designed to support forest improvement and management in Africa. Such agencies can and should, however, consult with the governments concerned on the importance of forest science, and aid them by the conduct of careful inventories of forest resources and the subsequent proposal of projects designed to protect and expand those resources. Provision should also be made for the proper management and utilization of forests as a renewable resource, and for the training of personnel who would ultimately have the responsibility for all aspects of forest research and development.

### Recommendations

#### 1. Inventory of Forest Resources in Africa

The forests of Africa have thus far received scant attention. This is especially unfortunate in view of the fact that much of Africa is ideally suited for wood production, including a variety of pulp and paper species. As sub-Saharan Africa continues to develop, there will be increasing demands for forest products and, in consequence, an intensified need for forest protection, management, and utilization. Ultimately, it

will be necessary for Africa to develop greater interest in forest products laboratories and industrial developments based upon forest products.

An inventory is essential to the future economic development of Africa's wood industry, but for the parts of Africa dealt with here a complete, intensive survey of the forests is scarcely justified at this time. Of more immediate help would be an extensive, nondetailed examination of the forest resources and the potentialities of forestry measures required in the solution of a number of Africa's major problems. Later, in the areas that include forests of high exploitation possibilities, intensive surveys should be made, based on aerial photographs.

The type of inventory recommended here would provide a prompt appraisal of the more pressing forestry problems and information on the extent, value, and condition of the physical resources as well as on forestry work already done. Included in the inventory would be proposals regarding the forestry measures required in specific situations.

It is recommended that a small but distinguished group of foresters be contracted to conduct such an inventory of the forest resources and forest possibilities of sub-Saharan Africa. During a considerable period of travel and exploration, this group would be able to describe and estimate the value of the current total resource and recommend a program for the protection of the remaining resource and the development of new forest areas. The group would also recommend studies which should be undertaken in connection with forest development; suggest tree species which should be multiplied or introduced; and identify those types of wood-using industries which should be supported. It would also make recommendations regarding the establishment of needed institutions for the development of forest science and the strengthening of currently established institutions.

With a staff of eight or ten experienced men, this inventory could be accomplished within eighteen months. Two of the foresters should be range specialists, for in Africa overgrazing and poor range management are among the leading causes of soil degradation and local water scarcities. The United States has gone farther than any other nation in working out sound range practices, especially in regions of low rainfall, and a substantial contribution could be made to soil conservation and livestock production by integrating forest and range management on the wild lands of Africa.

It is estimated that an operation of this sort would require a minimum of \$350,000 over an eighteen-month period to cover travel expenses, stipends, perquisites, special equipment and clerical and printing costs. It is suggested that a most effective way of obtaining a completely authoritative inventory would be through a contractual arrangement with an appropriate agency with adequate staff and facilities.

## 2. Forest Research and Training Centers

To be effective, the inventory of forest resources in sub-Saharan Africa must be supported by action programs. These programs should include such activities as reforestation, forest protection, forest product research, and the training of range and forest personnel. This multiple approach is believed to be essential and to be best accomplished through the establishment of permanent centers in critical locations in Africa. Specifically, it is proposed that a minimum of two and a maximum of four forest research and training centers be established in sub-Saharan Africa either by building on existing institutions or, where necessary, by the creation of new ones. Four locations are suggested for consideration: at the School of Forestry in Monrovia, Liberia; at the Forest Research Center in Ibadan, Nigeria; at

the East African Agriculture and Forestry Research Organization in Muguga, Kenya; and in Ethiopia, possibly at Harar.

Each center would comprise a research and experimentation center, training facilities, adequate land for nurseries and experimental plots, facilities for range management studies, and ultimately a products laboratory. In-service training could be offered for qualified individuals in various aspects of forest management, as well as advanced training and practice for graduates in forestry or related biological sciences.

It is estimated that to establish an independent center of the type described above would require a period of several years and a capital investment of approximately \$2,500,000 on the assumption that land would be provided by local government. Annual costs of maintenance and operation might reach \$250,000. Substantially lesser amounts would be required in those instances where the center could be developed in conjunction with existing institutions.

#### Summary of Recommendations

	Unit Capital Cost	Annual Recurring Cost
1. Inventory of Forest Resources 18-month period	\$ 350,000	
2. Forest Research and Training Centers (2 - 4)	\$2,500,000	\$250,000

## WILDLIFE RESOURCES

Although significantly depleted, the wildlife resources of sub-Saharan Africa are still substantial, especially in East Africa. There are conflicting opinions, however, as to the value of these resources and their ultimate destiny.

Indigenous populations have long regarded wild animals as a natural source of food and will not lightly abandon this tradition. Other groups think of wildlife as occupying areas otherwise available for conventional agriculture, and accordingly wish to eliminate wild species from land that might conceivably be used for crop or livestock production. A third group considers wildlife to be a "permanent" reservoir of infectious diseases and parasites and, as such, a menace to animal husbandry. These persons suggest that wildlife must eventually disappear because of population pressures and the demand for food.

The arguments of those who seek to protect wildlife run as follows: animal health problems can be resolved without destroying wildlife; wild animals, properly managed, represent an important and continuous protein resource; certain areas should be reserved for wild plant and animal species; the wanton destruction of wild animals is morally wrong; and finally, these forms in their natural habitat constitute an important source of income because of the numbers of tourists who wish to hunt them with gun or camera.

Most people, it is believed, will agree that forms of wildlife should be preserved under circumstances where they are both cultural and economic assets to the country concerned. It may be, therefore, that a system of parks or reserves, such as those already in existence, will have to be developed as permanent wildlife sanctuaries. Elsewhere, owing to population pressures, it will ultimately be impossible for man and wild

animals to dwell together. Once long-range plans had been made for the preservation of wildlife in a series of sanctuaries especially adapted for this purpose, it would be desirable to decide on methods of management, harvesting, and public utilization of wildlife for recreation and other purposes in order to maintain these biologic forms of life on a permanent basis. If these steps are not taken, there will unquestionably be a gradual depletion of numbers and species, leading in the end to the extinction of many.

Major opportunities for foreign aid programs to participate in this matter are not apparent. Decision and action must evolve primarily out of local and public concern. Obviously, support to projects dealing with livestock, health, and nutrition would be indirectly useful as regards wildlife, but it does not seem practical to recommend specific action on the part of foreign aid agencies in the field of wildlife preservation and management. It is believed, however, that conservation organizations, foundations, and other public-spirited groups might make significant contributions through support of studies, stimulation of interest, and the dissemination of knowledge concerning the importance of the protection and rational use of wild animal species in their native habitats.

## FISHERIES

The potentials for developing the protein resources in the in-shore, offshore, and fresh waters of sub-Saharan Africa appear to be most encouraging.

In view of the serious protein deficiency which exists in Africa, it would be highly desirable to strengthen commercial or other fishing operations. This could significantly increase the contribution of marine and fresh-water resources to local diets and provide a source of foreign exchange as well. A wide variety of fish, crustacea, and mollusks inhabit both coasts. Abundance varies regionally, depending on the extent to which oceanographic processes enrich the surface waters. However, except in Angola, Southwest Africa, and the Union of South Africa, virtually all of the sea fishery resources are under-exploited. Fish farming in estuarine waters and mangrove swamps has been introduced in recent years, but the opportunities in this method of production have hardly been touched. Finally, there are extensive areas of lakes, rivers, and inland swamps which in some regions are exceedingly rich. The annual catches in African lakes are reportedly as high as 110 to 188 pounds an acre. With scientific aquacultural techniques, the yields of fresh-water ponds should be much larger.

Improvement of fisheries will depend first of all on greatly increased knowledge about the species - their distribution, ecology, habits, abundance, and rates of growth and replacement. Only on such a basis can a science of fishing and fish farming be devised appropriate to the species and the local conditions. In addition, facilities for preserving, storing, transporting, and marketing fishery products are urgently needed. As fish become more available at competitive prices, changes in dietary patterns

indicated for some areas can probably be accomplished with appropriate educational effort.

It is not to be expected that any sudden, dramatic change can be made in the pattern of indigenous commercial fishing and fish utilization in sub-Saharan Africa. Nevertheless, it seems quite clear that, with proper planning, steps can be taken to begin an evolution from the present situation to one in which important economic and dietary benefits will accrue.

### Recommendations

#### 1. Fisheries Inventory

It is suggested that a contractual relationship be established with either the U.S. Fish and Wildlife Service or a department of a university which is interested in the development of fishing resources and which could undertake a special assignment. This assignment would be a careful review of existing knowledge about marine and fresh-water fishery resources of sub-Saharan Africa, an analysis of sociological and economic problems relating to the development of fisheries, and an assessment of possibilities for increasing the annual catch and utilizing it in diverse ways for direct local benefit and the production of foreign exchange. The group assigned this task should consist of a marine fishery biologist, a fresh-water fishery biologist, a fishery technologist, a commercial fishery operator, and a sociologist. This group, in collaboration with appropriate Africans, should make a thorough preparatory study leading to the elaboration of long-range plans for the future development of African fisheries resources.

It is estimated that the cost of such an operation as described above over a period of one year would be approximately \$200,000 for travel, stipends, special equipment, clerical assistance, and publication.

## 2. Fisheries Institute

It is anticipated that one early result from the fisheries inventory would be a recommendation for the establishment of a fishery institute on the west coast of Africa. Of the several possible locations, Lagos and Accra appear the most promising. The institute would be expected to deal with scientific and practical problems in the development of offshore, inshore, and fresh-water fishery resources, the development of action programs based on sound information and evidence, and the training of Africans for a variety of responsibilities within the total program. It appears desirable for the institute to be established initially through contractual relationship with a comparable entity in a Western university. Thereafter however, it should have closer relationships with similar organizations in the United States, Western Europe, and Latin America. Ultimately, it would become a completely African entity, perhaps within seven to ten years. It is to be expected that the institute would be the prototype of a similar one which would eventually be founded on the East Coast by Africans.

The establishment of an institute such as the one proposed would require an estimated capital investment of \$3,250,000 for plant, housing, equipment, vessels and gear, and aquariums and ponds. Annual maintenance and operating expenses of the institute and its appendages are estimated to be on the order of \$350,000.

If the fishery institute could be made an appendage of an existing educational institution, both would be strengthened as a result. From the beginning the institute should be thought of as an international center available to Africans from the adjacent countries.

There will also be appealing opportunities for the establishment of fresh water fisheries institutes in sub-Sahara Africa, and consideration

should be given to such developments as opportunities arise. Sites for fresh water fisheries centers might be on Lake Victoria, in Kenya, or Uganda, the Kariba dam in the Federation of Rhodesia and Nyasaland, and in Northern Nigeria perhaps in the Lake Chad region.

### 3. Commercial Fisheries Loan Fund

An ad hoc possibility in support of intensified fisheries operations off West Africa would be the encouragement of a foreign fishing company to carry out commercial operations off the coast. Given the appropriate permission and guarantees, such a project might be expected to produce substantially increased quantities of varying types of catch.

A second ad hoc project would be the establishment of a loan fund for entrepreneurs desirous of establishing small fisheries operations with fleets of small boats primarily for inshore operations. It is suggested that initially a fund of \$5 million, available to entrepreneurs from the several countries concerned, would be adequate for this purpose.

#### Summary of Recommendations

	Unit Capital Cost	Annual Recurring Cost
1. Fisheries Inventory One Year Period	\$ 200,000	
2. Fisheries Institute	3,250,000	\$350,000
3. Commercial Fisheries Loan Fund	5,000,000	

## MINERAL RESOURCES <sup>1</sup>

Mineral resources, including water as well as the metallic and nonmetallic minerals and the fuels, are fundamental to economic development. In underdeveloped countries they can be especially significant as a means of attracting foreign capital. Frequently no other resource can so readily produce surplus income to finance further development. Corollary benefits include the availability for other purposes of the communications provided primarily to service mines, and the introduction of native populations not only to regular labor habits and a money economy but also to the use of tools and machinery that form the basis of industrialization.

The utilization of mineral resources can promote economic development in two distinct ways. The first, and generally the more important in underdeveloped countries, is through the earning of foreign exchange. In the initial stages, exports of mineral products consist wholly or chiefly of unprocessed raw materials which can readily be sold abroad either because they are scarce in the more highly developed countries or because they can be produced cheaply enough to compete with raw materials from other sources. Lower costs of production may be the result of cheaper labor or the fact that mineral deposits are richer, or larger, or more favorably situated for cheap mining. In general, only those minerals with a high ratio of price to weight can at first compete in distant markets. With the passage of time, however, improved communications, exhaustion of other sources of supply, and local processing of raw materials to increase their price-weight ratio make additional ores and minerals competitive.

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<sup>1</sup> See also Appendix 4 for additional information.

The second way in which mineral resources can contribute to economic development is through exploitation for local consumption. Resources appropriate for domestic use rather than export include the mineral fuels (in which the area as a whole is deficient), construction materials (stone, gypsum, asphalt, cement, etc.), fertilizer materials (phosphate, potash, etc.), many industrial and chemical minerals, and water for consumption, irrigation, and power. Certain countries already make considerable use of many of these and others are developing local industries. By and large, however, it is in this field of domestic consumption that the greatest need exists and in which the greatest advance can be made.

#### Recommendations

Technical assistance in the raw materials field should concentrate on providing the basic data needed for orderly planning of economic development. Base maps are essential in all planning for land use, whether for soils or forest surveys, roads, railroads, hydroelectric or water storage projects, etc. Topographic map coverage is inadequate for the needs of sub-Saharan Africa. Although modern technology has enormously speeded up the mapping process through use of aerial photographs and specialized instruments, major efforts by large corps of highly trained personnel are still required.

Each country of sub-Saharan Africa has at least the nucleus of a mapping and surveying staff in its governmental service, and assistance from foreign countries should certainly be designed to work with these services. Detailed and up-to-date information is not available, however, on which to base plans for specific projects. Such information can probably best be obtained through a series of field projects.

## 1. Survey of Present Status of Mapping

It is recommended that a team of three experts be sent to Africa to survey the capabilities of individual countries and to plan for specific help where definite needs can be identified. It is anticipated that such needs may include equipment, technical personnel, assistance in organization, and training of local personnel, on the spot and perhaps also in the United States or elsewhere.

The team should probably include a geologist experienced in the metallic and nonmetallic minerals, a fuels geologist, and a topographic engineer. It is envisaged that as much as a year might be required for the completion of the survey and preparation of an administrative report, although definite projects generated during the study could be started immediately. Expenses for such a survey by three for one year might be in the general range of \$75,000 to \$90,000, including overhead.

## 2. Study of Water Resources and Development

In much of Africa water presents a special problem, one whose significance is emphasized by agricultural experts, foresters, and sanitation and health experts alike. Because of the multiple aspects of water resources and their utilization, a highly specialized group of scientists is required to investigate them and to make specific proposals. The study would be made from the points of view of the control and utilization of water for agricultural, industrial, and social purposes. To this end the study group should comprise as a minimum, a water geologist, an hydraulic engineer, a sanitation engineer, and an irrigation engineer.

This study would probably be for one year at an estimated cost of \$75,000 to \$90,000.

### 3. Inventory of Mineral Resources for Agricultural Development

Agricultural experts have stated that the soils of Africa are deficient in many respects and would need large quantities of fertilizers and soil conditioners to sustain the yields required by expanding populations. Such materials must be obtained locally, if at all possible, to permit their economic use.

It is recommended, therefore, that a special survey be undertaken of the mineral resources available to assist agricultural development. A first step should be a review of all the pertinent literature, followed by visits to each of the countries concerned to obtain additional information from local sources. Data are needed on the potash, phosphate, and limestone resources, as well as on the potentials for acid manufacture for processing phosphate rock and of ammonia manufacture for nitrogenous fertilizer. Specific project recommendations for additional work can confidently be expected to result from such a survey.

To implement this survey we recommend initially a team of two experienced men. The work may require eighteen months, including time for literature search, travel, and report preparation. Assuming direct costs in salary, expenses, and travel of \$20,000 per man per year, this survey should cost \$60,000 plus the necessary overhead of \$30,000 for backup services.

### 4. Survey of Mineral Resources of Liberia

Except for the iron deposits, basic data on the mineral raw materials resources of Liberia are almost entirely lacking. Nevertheless, mineral production (chiefly iron ore) now earns 25 per cent or so of Liberia's foreign exchange, and this contribution to the economy will almost surely increase substantially. Although it seems entirely likely

that a geological survey of Liberia would discover other mineral resources important in the country's economy, the government's small Survey Department lacks both the facilities and the trained personnel for such an undertaking.

Inasmuch as a definite need seems apparent now, it is believed that such a survey could be started prior to completion of the general surveys recommended above. The recommendation is therefore made that assistance be offered Liberia to enable it to increase the effort devoted to an inventory of its total mineral resources. It is suggested that initially a one-year mission of three technical experts would be appropriate. One should be an economic geologist with wide experience in igneous and metamorphic geology and mineral deposits, another should be expert in water problems, and the third should be familiar with the techniques and execution of base maps.

Costs for one year would probably be in the range of \$75,000 to \$90,000. Depending on the success of the first year's work, additional time and perhaps men might be desirable. In any case, up to one additional year should be planned for report writing by the party leader. This could probably best be done in the United States.

### Summary of Recommendations

For initial studies of the mineral raw material resources of Africa South of the Sahara to support economic development:

<u>Project</u>	<u>Man Years</u>	<u>Cost</u> <u>(Salaries, Travel, Overhead)</u>
1. Survey of Present Status of Mapping	3	\$ 90,000
2. Study of Water Resources and Development	3	90,000
3. Inventory of Mineral Resources for Agricultural Development	3 (2 for 1 1/2 yrs.)	90,000
4. Survey of Mineral Resources of Liberia	4 (3 for 1 yr., — 1 for 2nd yr.)	<u>120,000</u>
	13	\$390,000

Additional funds should be allowed for implementing projects that will be recommended by these surveys. No estimate can be given of the amount of such funds.

## VI. ENGINEERING, TECHNOLOGY, AND INDUSTRY

Engineering and the sciences related to it are basic elements in economic growth and as such are essential in sub-Saharan Africa for progress in agriculture, public health, and social development in general. In this region, growth in the wealth and well-being of the people depends on the establishment of a suitable agriculture - as has been discussed previously - and upon the development of domestic industry and foreign trade.

Here as elsewhere, engineering is a key factor in economic and social development. It underlies the most obvious opportunity for immediate industrial advance in sub-Saharan Africa - the encouragement of the extractive industries. The health of the people, both rural and urban, depends on engineering for the establishment of safe water supplies, of sanitary facilities, and of suitable housing developments. Industry and agriculture both require appropriate transportation facilities - airlines, waterways, railways, highways and roads. Also essential is rapid communication made possible by telegraph, telephone, and radio networks. In the quest for advance in these and other fields, the engineer must play a crucial role.

It is a rather simple matter to demonstrate the need for an enormous variety of engineering developments throughout sub-Saharan Africa. However, it is much more difficult to establish orders of priority and to design integrated programs which will make maximum use of available funds and personnel for technological progress.

During the current study it was only possible to obtain firsthand general information and impressions with respect to needs and opportunities for technological developments in Africa. These have been supplemented by

the examination of reports or other studies directed more precisely to the field of engineering as it applies to the African scene. No attempt will be made here to recommend specific engineering projects or programs. Rather, effort is made to emphasize the areas and disciplines within which there is need for further study and suggest certain approaches.

### Education

It will perhaps suffice to say that statements made with respect to the educational situation in sub-Sahara Africa in an earlier section apply equally to the fields of the engineering sciences. It is quite clear that consideration must be given to the training of Africans at various levels of technology from vocational through the subprofessional and professional. In the interest of prompt forward progress a substantial amount of training will necessarily have to be carried on by overseas institutions in direct response to demonstrated need for engineering specialists for national responsibility.

Ultimately the bulk of training in the several fields of technology will have to be provided within the African community. It is therefore desirable and necessary that a serious and continuing effort be made to strengthen indigenous institutions for the training of technicians and engineers and to establish additional institutions when and where there is evidence of need and adequate economic support.

The disciplines in which there is especially apparent need include the crafts, technicians, supervisors, architects, and professional engineers. A combination of formal education and in-service training would be invaluable in the preparation of young Africans for responsibilities in the fields of technology. A useful adjunct would be the establishment of an engineering

division at each agricultural experiment station that may be established in Africa in the future.

### Engineering Practice

1. Sanitary Engineering. The science of sanitary engineering is highly developed in the West and its more general application to sub-Saharan Africa could be expected to provide multiple benefits in terms of health and comfort. Development programs in the fields of water supply and sanitary engineering should be undertaken on a wide scale in order that the objectives of medical science, public health, and industry may be achieved. Pilot water supply and sewage disposal projects for both rural and urban areas might be established to obtain information and provide patterns for further expansion. Intimate association between sanitary and civil engineers, architects and city planners is an obvious essential to successful urban and suburban developments.

2. Transportation Engineering. This broad field will continue to be an area of growing importance in Africa for many years to come. Highway systems, railroads, waterways, and airlines are all in a relatively underdeveloped state, and the rate at which improvements can be made will determine economic progress. The rational exploitation of mineral and other resources for the creation of wealth can only proceed in phase with the growth in transportation facilities. Therefore, careful attention to and investments in such facilities are basic to economic growth.

3. Hydraulic Engineering. The whole field of water resources and their utilization are of great current and future significance to the economic growth and well-being of the African community. A careful examination of water resources and problems and sound plans for their development and utilization are of major importance to every aspect of social

welfare. Agriculture, community development, industrialization, transportation and communication all depend to a substantial degree in Africa on the successful economic application of principles of hydraulic and electrical engineering to available resources.

4. Architecture and City Planning. There is great need and opportunity for improvements in the design and construction of public, private and industrial buildings, the increased use of indigenous materials, the construction of furnishings and city planning for graceful living in Africa. Substantial progress has already been made along certain lines, but this could be greatly improved with public benefit. Ultimately it would be hoped that imaginative, indigenous architectural designs would enable Africa to develop its present and future population centers along lines best adapted to the local scene and requirements.

A distinct advantage which accrues to the field of engineering in underdeveloped countries is the fact that many engineering enterprises can be expected to produce income. Thus they often have real appeal to national and foreign investors under appropriate circumstances. It is not to be expected that foreign aid agencies can satisfy any significant proportion of the need for technological developments in Africa. They can, however, through loans, ad hoc projects and contributions to the training of indigenous personnel catalyze national movements toward technological improvements compatible with economic possibilities.

#### Regional Engineering Training and Experiment Centers

The establishment in sub-Sahara Africa of a network of regional engineering training and experiment centers would provide a number of advantages to a technical assistance program. They would be focal points for research in Africa under African conditions, for the dissemination of

technical information, for advice and consultation to government and private agencies, and for practical training in a wide variety of badly needed craft and technical skills.

Like the engineering experiment stations of the land-grant colleges in this country, these centers would be associated with parallel activities in agriculture, public health, housing, transportation, and other fields. They would supplement and support the work in these areas, which impinge on the community more directly than does engineering, with technological research and skills that will speed development.

At these centers would be conducted research and investigations on problems of soils, water supply, sewage disposal, new materials, new industrial processes, the adaptation of indigenous materials and processes, and similar problems. They should begin to marshal engineering data on their region, recommend standards, and aid in testing.

Through these regional centers the technical assistance program would achieve vantage points in Africa. Through them could be learned assistance opportunities and needs on every scale, and in them would be provided a mechanism for measuring the effect of the program's contribution.

#### U. S. Research Center

A useful ancillary development would be the creation of an engineering center in this country which would devote a substantial proportion of its time and research effort to technological problems of the tropics.

In view of the high state of development of the engineering sciences in this country, a center oriented toward a study of engineering problems in the tropics could produce valuable information for application to the underdeveloped tropics. It could also serve as a training center

at which both Americans and Africans could gain experience and practice which would best fit them for responsible assignments in tropical areas.

Ideally, the research center should be located at an already established institution with a first-class engineering college and experiment station. This would combine the multiple benefits available at an educational institution with a specialized research training program of international importance.

## SUMMARY

A detailed study of education, science, and technology in Africa South of the Sahara would require the full-time efforts of a considerable staff of specialists over a period of several years. Extensive foreign travel would be involved as well as a careful search of the literature and discussions with representatives of the numerous organizations in Africa and elsewhere that are either interested or active in sub-Saharan Africa. The present study does not purport to be one of this depth. Its stated objective is to identify those problems of basic importance to the future development of sub-Saharan Africa which can be attacked to some significant degree through the techniques of foreign aid. Although the study itself has been limited to certain specific sectors of Africa, most of the recommendations are broadly applicable and, if carried out, could be expected to benefit a wide geographic area.

There are many facets of foreign aid and many agencies concerned in at least some measure with technical assistance. The first step in implementing the recommendations made herein should be the identification of all such agencies so that final decisions can be based on sound knowledge as to how, where, and when action should be undertaken, and by what organization or combination of organizations.

Not only must the projects initiated be vital to social and economic progress in the area, they must also take advantage of all available knowledge and skill and avoid unnecessary duplication, overlapping, and competition. The demands throughout the world upon available funds for technical assistance are so severe that waste in any degree cannot be tolerated.

In the course of the current study, it became increasingly evident that the rate of progress of the emerging countries of sub-Saharan Africa will depend completely upon the speed with which manpower becomes available to carry on the multitude of tasks essential to social and economic growth. The political evolution of the African community has moved far more rapidly than the social evolution, and as a consequence the new political entities are generally ill-equipped to handle the technical and scientific responsibilities so fundamental to their sound future development. This situation creates urgent and appealing opportunities for cooperation through technical assistance programs designed to meet the most important needs. Soundly conceived, planned, and established, such programs could over the years make substantial contributions to the local economy and at the same time provide opportunities for the training of large numbers of Africans. After a period of years the gradual withdrawal of the foreign partner could be initiated with the assurance that continuity and quality would be maintained by African personnel.

There is no area of human welfare in Africa which could not profit from foreign aid. However, realism directs the selection of those with the greatest potential, since there are limits to the financial aid and the manpower that can be supplied in support of technical assistance. The most obvious necessity is the strengthening of education at all levels so that the Africans may as soon as possible become the arbiters of their own destinies. Thus major emphasis must be placed upon ways and means to educate a very much larger percentage of the African population to the point where they can assume responsibility for the variety of tasks necessary to national well-being.

It would be a serious error to think of education as an end in itself. Aid to education must be directed toward providing more and more persons trained as teachers, medical doctors, veterinarians, specialists in agriculture, and engineers. This process would directly support technical assistance projects in related fields of science and would assure that these could eventually be manned by qualified nationals. Since agriculture, public health, and the technologies are inseparable components in the African scene, they must be developed simultaneously and integrated for maximum progress.

Next to education, in order of priority, is agriculture. It is clear that food problems have long been and continue to be a major obstacle to human progress. For economic reasons most of Africa must depend principally upon its own agricultural resources for food and for the variety of products which may be derived from crop plants and domestic animals. Currently the practice of agriculture by Africans is inefficient and unproductive, involving excessive waste of manpower and uneconomic utilization of available resources. Future social progress will be directly dependent upon the speed with which agricultural practice can be stabilized and modernized, and the degree to which food crops and animals and commodities for local consumption and export can be produced in a balanced system compatible with local resources.

Along with agricultural development there must be the rational use of renewable and nonrenewable resources including forests, fisheries, wildlife, and minerals. These can through careful management make direct contributions as income-producing resources or be utilized in support of agriculture, in the form of forest products, agricultural chemicals, and supplementary foods.

There are great opportunities for improving the general level of public health throughout much of sub-Saharan Africa. The absence of sufficient

numbers of qualified medical personnel, the lack of public health organizations and campaigns, and the educational and economic levels of rural peoples combine to perpetuate many of the contagious and epidemic diseases which have been stamped out elsewhere. Medical science has advanced to the point at which extraordinary gains could be made through heavy investments in personnel and funds. However, unless public health measures are accompanied by progress in understanding and the willingness to comply with regulations, they can be only partially effective. Since health is built upon diet, agricultural progress must complement and support public health practices.

Investments in the broad fields of technology will provide an essential base for progress in other fields. Emphasis should be placed on those industrial developments which will most rapidly increase national wealth and hence stimulate economic growth. Improvement of systems of transportation and communication, increased public, private, and industrial construction, exploitation of power resources - the multitude of applications of engineering to human welfare are vital to all aspects of social evolution. As in the case of agriculture, the engineering technologies are to a substantial degree dependent upon the proper utilization of natural resources.

The recommendations contained in this report have been selected as important elements of a broad pattern of technical assistance. Individually they can be expected to make significant contributions to the economic and social growth of sub-Saharan Africa. Collectively their impact would be of major importance to the continuing progress of the entire area under consideration. Individual recommendations have been expressed in units, with the understanding that the number of units could be multiplied according to the financial support available. Obviously, as experience is acquired, needs and opportunities for expansion and multiplication of unit efforts will become apparent. The financial requirements cited in support

of the recommendations in this report must be considered simply as estimates based upon available information.

Throughout the report emphasis has been placed upon the necessity for extreme care in the selection of projects, their preliminary planning, and final establishment in Africa. Also emphasized is the fact that these must have stable support and leadership over a sufficient period of time to assure their success and ultimate total integration into the local cultural pattern.

A great many Europeans during succeeding generations have devoted their lives and their talents to the cause of Africa. Among this group are many whose names will long be remembered for their contributions to education, medical science, public health, agriculture, engineering, the social sciences and the humanities. Under often difficult conditions they pioneered much of the economic development of Africa and created most of the institutions which serve it.

New groups are currently entering the African scene especially in the field of technical assistance. These can profit from an understanding of the objectives and accomplishments of the pioneer group. Opportunities for cooperation should be sought in an effort to build on strength and to make most efficient use of available funds and manpower in support of progress toward humanistic goals. There are of course many unfulfilled needs in sub-Sahara Africa, and in consequence significant opportunities for new programs and developments. When it is possible to relate these to existing organizations and to establish cooperative relationships, the long-range benefits to the growth of Africa will be enhanced.

In those areas where Africans have or will soon have control of their own political, social and scientific organization, there are appealing

possibilities for direct collaboration. Africans are already deeply involved in many of the current scientific and economic developments of sub-Saharan Africa. Wherever well prepared nationals are available, they should be given an increasing share of the responsibility for future progress on all fronts.

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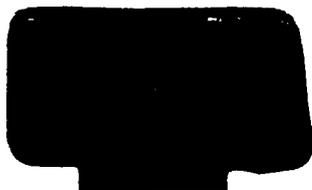
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