REPORT BY THE
STUDY GROUP ON ANIMAL DISEASES
IN AFRICA

National Academy of Sciences
National Research Council
Washington, D. C.
April 20, 1965
Gentlemen:

The enclosed report has been prepared as the result of a request by the Agency for International Development that the National Academy of Sciences undertake a survey and evaluation of the rinderpest control program sponsored by the Commission for Technical Cooperation in Africa, and to evaluate other major livestock diseases as they relate to the rinderpest program and to livestock production in general, including the impact of disease control on such problems as marketing and processing, range and water resources, and the place of livestock production in the economic development of specific areas of West Africa.

In response to this request, the Advisory Committee on Africa organized a Study Group on Animal Diseases in Africa to conduct the actual survey, and a Subcommittee on Animal Diseases in Africa to review the Study Group report. This report has been reviewed and approved by the Advisory Committee on Africa and its Subcommittee.

Sincerely,

C. W. de Kiewiet, Chairman
Advisory Committee on Africa

Enclosure
REVISED
December 8, 1965

REPORT
of the

STUDY GROUP ON ANIMAL DISEASES IN AFRICA

This report has been reviewed by the
Subcommittee on Animal Diseases in Africa and the
Advisory Committee on Africa

National Academy of Sciences
National Research Council
Washington, D.C.
This report has been prepared and submitted under Contract AID/afr-211 between the Agency for International Development and the National Academy of Sciences.

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## Agencies and Organizations Involved in Livestock Production, Animal Health, and Veterinary Training in Countries in West Africa

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PREFACE

In response to a proposal by the Agency for International Development (AID), the National Academy of Sciences agreed to conduct a study of livestock diseases and related problems of livestock production in West Africa, with special reference to the rinderpest-control programs sponsored by the Commission for Technical Cooperation in Africa (CCTA).

The Academy established a study group on animal diseases which directed its efforts specifically to: (1) evaluation of the CCTA-sponsored rinderpest-control program; (2) evaluation of other major livestock diseases as they relate to the rinderpest program and to livestock production in general; (3) evaluation of the impact of disease control on other problems of livestock production, e.g., marketing and processing, and relation of disease to livestock numbers and available range and water.

In a more general way, the study group attempted to make observations and recommendations on the broader question of the place of livestock production in the economic development of specific areas in West Africa through: (1) appraisal of the prospects for expansion of production and marketing; (2) identification of problems that interfere with livestock production; (3) appraisal of the need to develop institutions to stimulate and support expansion; and (4) identification of means by which current and planned projects could contribute to increasing production and marketing of livestock.

In carrying out its work, the study group: (1) reviewed the available literature and held discussion meetings with specialists who have had experience with livestock diseases and, specifically, with rinderpest in Africa; (2) visited institutions in the United Kingdom and France to discuss rinderpest and other animal-disease problems with specialists who have had broad experience in livestock diseases and production in Africa and who were not available for consultation in Africa; (3) consulted in Brussels with the European Economic Community (EEC) to determine not only the immediate proposed support of the CCTA rinderpest-control program, but also the attitude of EEC toward continuing support of this program over an extended period of time and the scientific assumptions upon which the EEC is basing its policies; (4) discussed in Rome with the Food and Agriculture Organization of the United Nations (FAO) officials the FAO proposed regular program, extended technical-assistance programs, and possible involvement in U.N. Special Fund projects in livestock disease, production, and marketing; (5) consulted in Kenya with the personnel of the East African Veterinary Research Organization (EAVRO) and considered the relevance of current research and field programs in operation in East Africa to the problems of the West African region. This included, specifically, consultation with officials familiar with animal marketing in Africa; (6) visited institutions, laboratories, and administrative units in Central and West Africa involved in the first phase of the CCTA-sponsored rinderpest-control program to observe the extent of the progress made and to discuss the need and procedures for studies in program effectiveness and vaccination efficacy. The principal contact was with the rinderpest-program headquarters at Kano, Northern Nigeria. Other contacts were made at the Vom Laboratory, Northern...
Nigeria, and Farcha Laboratory, Fort Lamy, Chad; (7) visited principal laboratories and administrative headquarters for animal-disease-control programs in other West African countries, particularly those that will be involved in the second and third phases of the rinderpest-control program. These include Upper Volta, Ghana, Mali, and Senegal.

The study group received assistance from AID officials in Washington, as well as from those assigned to countries visited by the team. Travel arrangements and appointments with officials of the African governments and staff members of institutions visited were efficiently arranged.

A list of references is included for the benefit of those who may wish to pursue specific points in greater detail.

The study group appointed by the National Academy of Sciences is as follows:

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Introduction

This report attempts to evaluate the most significant aspects of the animal-health, livestock-development, range-management, livestock-marketing, and educational-development programs in the West African region. Several diseases, principally rinderpest, trypanosomiasis, and contagious bovine pleuropneumonia (CBPP) are of immediate concern to these programs. However, a number of other diseases and parasitic conditions existing in this and other regions of Africa also impede the development of a sound livestock industry. Foot-and-mouth disease, for instance, certainly equals rinderpest as a cause for the restricted trade in livestock products, and widespread parasitism results in huge, inadequately measured and documented losses.

Much of the study is concerned with the CCTA, now STRC (Scientific and Technical Research Commission) Project 15, which is one of the most extensive animal disease control programs attempted anywhere in recent years.

Considerable effort has been made to consult the most experienced and knowledgeable individuals available and to visit the most active institutions concerned with tropical animal health, veterinary education and training, and biologicals production, as well as West African ministries concerned with livestock production and development. Special attention has been given to the education and training activities under way in West Africa, particularly as they relate to providing personnel for the continuation of the disease-control programs as many experienced individuals retire from the scene. A very apparent lack of technically qualified nationals exists in every country of the region, and it is obvious that the assistance agencies are faced with the problem of filling personnel gaps to halt a serious regression in current and planned disease-control operations.

Personnel selected by the assistance agencies to stem this anticipated regression must duplicate, as nearly as possible, the capabilities and dedication of the experienced departing specialists. Even with the most favorable circumstances, it will be essential for the well-qualified animal-disease specialist to understand the problems and attitudes of new national administrators and technical specialists assuming the responsibilities of the operation of these programs and projects.

A number of countries are suffering declining economic stability. Some are responding too slowly to rising technical-service requirements or consider that available finances are more urgently required for other needs.

Without exception, the countries of this area require, for a number of years to come, technical guidance at levels equalling those provided prior to independence. Without exception, they also require a substantial increase in technical and financial support for education if they are expected eventually to take over the working-level management of their animal-health, production, and marketing systems.
The study group, familiar as its members are with the difficulties of finding competent personnel, even on the American scene, well understand the difficulties in recruiting and keeping competent personnel in Africa. A solution to this problem is vital to the future success of African assistance programs. Short-term expert consultants in particular disciplines are essential in laying the groundwork for developing programs and in searching out and helping to solve complex operational problems, but they cannot carry the vital burden of over-all project functions.

**Agencies and Organizations Involved in Livestock Production, Animal Health, and Veterinary Training in West Africa**

West Africa, as well as other areas of the continent, has recently undergone radical political, economic and social changes. The livestock-development and animal-health projects in the entire West African region are directly influenced by emerging organizations, institutions, and local governmental agencies, as well as by international technical- and economic-assistance bodies, such as the Agency for International Development (AID), the European Economic Community (EEC), the Commission for Technical Cooperation in Africa (CCTA), the Foundation for Mutual Assistance in Africa, the Department of Technical Cooperation (U.K.), and several philanthropic foundations. In addition, the former colonial powers have maintained technical and economic support at varying levels in each of the countries of this region. These assistance activities are rapidly being withdrawn in many instances (25, 33, 47, 48, 49, 57, 103, 119, 127, 152).

This, of course, presents critical problems of support for maintenance and for personnel capable of effective operational management. Reduction in the numbers of animals inoculated, possible periodic shortages of vaccines, and even breakdown in the operation of field units are potential situations that contributing organizations must now face. Virtually all these potential problems are amenable to solution through prompt provision of adequate technical personnel. If continued support for the remaining phases of the rinderpest project or other CCTA animal-disease research efforts are proposed, these efforts must be given priority over development of new biologicals-production or research laboratories, which are difficult at this stage to staff and operate. However, there is a clearly apparent need for modest diagnostic facilities, including mobile units coordinated with specific field programs, and this need has apparently been overlooked or at least subordinated in favor of programs that hopefully might produce spectacular results.

Since the EEC and, to a more limited extent, the individual European governments are involved in the major financial support of the animal-disease-control program, a much more critical appraisal on a coordinated basis should be made of the total resources available to counteract obstacles as soon as they arise. Meeting the growing need for the additional diagnostic facilities mentioned above and supplying new or replacement equipment can be planned. But to ensure effective planning and to anticipate future needs, agencies must employ qualified veterinary staff in the field. (33, 57, 63, 128, 152)
It is essential that the organizations involved take note of trouble spots that actually or potentially impinge on operational projects, as well as of opportunities that may arise for furthering progress of the projects as they are reported by technical staff in the field. It should be possible to avert circumstances that may obstruct progress and to take advantage of possibly unanticipated circumstances that might help to advance the solution of problems if alert appraisal of these situations is recognized. (119, 152)

Internal Agencies

International. The newly created Organization of African Unity (OAU), which embraces 34 African states—essentially all the independent nations of the continent—has a major role in the perpetuation and development of programs related to animal health and livestock development. The recent proposal by the OAU (Cairo, July 1964) for the establishment of a Fifth Commission envisages assumption of responsibility for certain purely technical programs formerly carried out under the CCTA and one of its subsidiary agencies, the Inter-African Bureau of Animal Health. The possibly complicating and limiting factors associated with this re-orientation of cooperative technical assistance are apparent. If these are to be averted, funding systems must be established, technical autonomy preserved, and qualified staff recruited (48, 57, 60, 103, 114).

Regional. A number of alliances and associations have been established among various African countries. The most significant of these alliances in West Africa is the Convention of Association between the EEC and the African and Malagasy States, in which 13 states, formerly in the French colonial area, are involved in programs that concern this study. Over two-thirds of the financial support for regional projects such as the rinderpest Project 15 arise from the European Economic Community through its Fund for Economic Development. In addition, France provides support on a bilateral basis for two major laboratories, Dakar-Hann, Senegal, and Farcha, Fort Lamy, Chad. The remaining funds are derived from multiple sources, including AID (25, 33, 57, 89, 106, 127).

National. Each of the countries involved in projects of concern to this study has established or reorganized ministries and institutions. Some have maintained systems similar in structure and operation to those prevailing prior to independence; others have made radical innovations. But all are faced with a serious lack of experienced and qualified staffs. Many of the current veterinary systems in the area operate only theoretically and lack the financial support needed to function. Countries such as Sierra Leone, Gambia, Liberia, Guinea, Mali, Niger, Togo, Dahomey, and Mauritania have far too few veterinarians—many have less than five—to carry out organized and supervised programs. A few operating systems subsist on an interim basis, virtually dependent upon funds from external sources that may or may not be forthcoming for future fiscal periods (3, 7, 38, 40, 81, 82, 97, 119, 135, 146, 147, 148).
The CCTA ended its responsibilities for a number of projects at the close of 1964. The activities previously undertaken by this organization are incorporated in the STRC (Fifth Commission of OAU) as of January 1965. There is hope, but no assurance, that its technical and scientific autonomy will be preserved. Responsible personnel in the West African area are apprehensive that the technical and scientific principles under which such an organization must operate— that is, the Fifth Commission's functions—may be subject to possible political decisions of the OAU governing structure. (48, 59, 60, 103, 114)

The Inter-African Bureau of Animal Health (IBAH), a unit of the CCTA, has for many years efficiently produced the valuable quarterly Bulletin of Epizootic Diseases. This bulletin, which compares favorably with the most respected scientific veterinary publications in the world, has been the sole formal veterinary communication medium for the countries of Africa south of the Sahara, and has produced a wealth of scientific and epizootological information that otherwise might very well have remained unpublished. (57, 59, 103, 114, 119)

The continuation of this valuable service is essential. Failure to maintain publication of the bulletin, with its high-quality reporting and dissemination of information would deprive the countries of Africa as well as other countries of the world of an important tool in the struggle against diseases. (48, 60, 103)

Organizations involved in assistance programs should undertake jointly to ensure the perpetuation of this journal and its reporting services under the aegis of the Fifth Commission of OAU. A concerted effort by a body of qualified experts, including members from each of the international agencies contributing assistance to the regional projects of this area, must be made to advise and encourage coordinated action on the part of governments concerned. A similar purpose was at one time served by the Scientific Council for Africa South of the Sahara (CSA), and it may be that another such body will be formed by the OAU. In any event, such a body will need the consultive services of qualified technical people. (48, 59, 60, 103, 106)

Consideration should be directed toward establishing a working academic relationship between the Scientific Council for Africa and the newly organized STRC of the OAU during the interim period when the new organization will be incompletely staffed and without funds. Support for liaison by an advisory group would facilitate transferring the responsibility for guidance in selecting priorities for funding research and projects to this new organization, and would aid in its selection of qualified members. Without viable STRC activity, succeeding phases of Project 15 and other projects are in jeopardy.

European Economic Community (EEC). The EEC is currently the strongest and most permanently committed agency involved in the support of development
programs in the 18 associated states of Africa. Through its European Development Funds (FED), it is entering a second five-year plan for financing and executing projects, many of which are directly or indirectly related to animal health and livestock development. Thirteen of the 18 associated states are involved in various parts of the five-year plan, but no provision is made within the EEC for support of programs in adjoining states, which are vital to the ultimate success of several regional projects. These regional projects include rinderpest control, contagious-bovine-pleuropneumonia investigation and control, trypanosomiasis research and control, water and fodder conservation and utilization, livestock marketing, operation of biologicals-production and disease-investigation laboratories, and educational development. Several of the 13 associated states of the region under study receive temporary support from agencies other than EEC. The four former British colonies of the region currently obtain some support for projects that concern this study from the United Kingdom and external agencies, but they are largely dependent upon national financing, and available funds have in some cases been dissipated. The prospect for adequate future support is remote. Some countries, such as Guinea and Mali, are receiving technical and monetary assistance from West Germany (33, 63, 89, 106, 152, 160).

Agency for International Development (AID). Finances for animal-health and livestock-development programs, veterinary education, and projects related to livestock in West Africa involve several millions of dollars in grants or development loans, including funds committed to Phases I and II of the regional CCTA rinderpest-control projects, funds committed to the construction and development of an Animal Disease Laboratory for diagnosis, research, and vaccine production in Mali, and proposed support for veterinary education in Nigeria, which, hopefully, will provide space for the students of other English-speaking countries of the region. In addition to these major expenditures, a number of bilateral programs exist between AID and several other countries. These also relate to the animal-health and livestock-development programs for the region as a whole. Unfortunately, some of the more costly projects, particularly those concerned with education and some laboratory construction, have little promise of contributing to the immediate requirements of Phases II and III of the rinderpest project or to the research and development necessary for CBPP and trypanosomiasis control. The problem of maintaining continuity in the development of effective animal-health programs and the ultimate objective of providing an infrastructure through which each country can develop qualified personnel and create adequate laboratory and field services needs to be met, either through direct support or through inter-service support by negotiations with a number of agencies or organizations. (20, 32, 57, 87, 103, 107, 119, 156)

Rockefeller Foundation. The Rockefeller Foundation supports educational development at university level and research in parts of West Africa. Veterinary medicine is one of the disciplines included, and the Foundation has participated in the establishment of a veterinary preclinical training program at the University of Ibadan. The Foundation's continuing interest in educational development through support for fellowships and research grants is also a major contribution to the long-range objective of establishing a cadre of competent people to take over responsible positions within government services and institutions (119, 123, 129).
Others. Several other philanthropic and charitable agencies provide support to schools, institutions, and libraries; these agencies encourage educational advancement and provide a source of scholastically prepared individuals for more specialized training and research. If future needs are to be met, it is essential to coordinate the assistance resources to assure more effective utilization of those individuals capable of advanced work. In many cases a planned program for support of educational programs for promising individuals would produce a desirable continuity in the training process (26, 123).

Biologicals—Production, Research, and Training Institutions

Biologicals Production. Three long-established laboratories in West Africa--Dakar-Hann, Senegal; Vom, Nigeria; and Farcha, Fort Lamy, Chad--have produced and supplied adequate amounts of reliable rinderpest vaccines for many years. Each of these laboratories, to increase production to levels necessary for programs such as Project 15, have required some additional equipment and limited increases in their professional and technical staffs. With the advent of tissue culture vaccine (TCV) in 1962-63, total requirements for all West Africa could even more readily be supplied from these three institutions. With respect to vaccine supply, the most critical problems for a program such as Project 15 have been in connection with the development of means for distributing vaccines to countries and areas that do not produce their own. The existing laboratories are also capable of producing vaccines for other diseases, including contagious bovine pleuropneumonia, anthrax, blackleg, and rabies, in quantities that are adequate for programs under way or immediately contemplated in West Africa.

However, laboratories and facilities are only a part of the requirement for effective long-term production of reliable vaccines or other biological products. Efficient continuing training is also essential. The staffs of many existing institutions in Africa are gradually being replaced by Africans. If their activities are to be effectively maintained, it will be necessary to expand in-service training as well as to stimulate further training at other laboratories and institutions in Africa.

In the considered judgment of almost all veterinary experts, the three major veterinary laboratories (Vom, Farcha, and Dakar-Hann) in West and Central Africa have the physical facilities and the basic equipment needed for West Africa's animal-health-control programs as conducted during the past decade and for those contemplated through 1968. As in the past, there will be modest requirements for supplementary equipment or replacement of outdated or worn equipment. (13, 87, 115, 119)

The critical problem has been recruiting and maintaining competent professional staffs, and this problem is becoming more acute as foreign personnel continue to leave the region. The creation of new, elaborate institutions will dilute the activity of existing institutions and overextend the distribution of essential, qualified personnel. (118, 159, 165)
The most logical and practical allocations of funds from external agencies for laboratory support of animal-health programs in West Africa can be made for the maintenance of the major existing laboratories and the recruitment and stabilization of qualified professional personnel to operate these facilities until such time as the governments of the region can provide competent nationals to operate them. (118, 159)

Research. Basic facilities for research exist at the three main laboratories named earlier, as well as in laboratories in Nigeria at the University of Ibadan, the Ghana Academy of Sciences in Accra, and in certain laboratories in other areas of West Africa.* However, available facilities in many of these laboratories are not being fully utilized because they lack certain equipment and personnel. The most critical deficiencies are in personnel, and the situation is rapidly deteriorating. Thus, the most valuable avenues for laboratory support are through existing institutions where continuation of sound research activity might be maintained through some form of financial subsidization, effective utilization of existing staff, and recruitment of well-qualified replacement personnel. (2, 7, 13, 38, 59, 118, 119)

The opportunities for basic and applied veterinary research in West Africa are endless, but a few research problems stand out as immediately critical in the solution of disease and parasite conditions that seriously curtail effective livestock production (13, 46, 50, 119).

There is need to support the current work on tsetse-fly population sterilization and perhaps to undertake other new fundamental approaches to the vector problem, including studying the influence of settlement on reducing the tsetse-fly population.

In contagious bovine pleuropneumonia, an analytical study of the foci of infection should be made. This study should incorporate basic investigations of the quantitative and possibly the qualitative antigenic differences in the various strains of *Mycoplasma mycoides*, comparison and further development of diagnostic tests, and practical systems of carcass examination at slaughter points. There is also great need for a continuing comparative study of several types of CBPP vaccine currently in use and the relative effectiveness of several vaccination methods. Research now under way regarding immunological characteristics of CBPP strains should continue to receive support (46, 52, 119, 124, 151).

The incidence of streptothricosis is apparently increasing, taking a heavy toll in some areas. Control of this disease depends on expanded research dealing with the mode of transmission and with chemotherapy and other preventive measures (4, 5, 46, 68, 119).

*The names and functions of the principal West African veterinary and animal-health training institutions appear in Appendix D.*
Numerous other microbial- and parasitic-disease conditions require research attention as soon as financial resources and competent personnel are available. Calihoop diseases result in serious losses and impair the development of vigorous growth in young stock. Anthrax undoubtedly takes a heavy annual toll, but little attention has been directed toward defining endemic areas or toward providing regular immunization to exposed animals. Brucellosis and tuberculosis are known to exist, but further studies are needed to determine incidence and to locate principal foci of infection.

Blood parasites other than trypanosomes, transmitted by ticks and other arthropods, result in substantial losses through death and debility. Internal parasites, such as liver flukes, lung worms, and intestinal parasites, cause huge losses throughout the region. Cysticercosis and other somatic parasitic diseases not only result in debilitating conditions among animals, but also pose a threat to human health, and have at least some potential restrictive influence on external marketing of livestock products (6, 41, 46, 50, 62, 97, 99, 119).

Training Institutions.* A number of institutions for training animal-health assistants, technicians, and vaccinators exist throughout West Africa, and many more are being established. Nigeria, Ghana, Chad, Senegal, and Dahomey all currently operate such facilities, and Mali and Niger are planning similar institutions (Appendix D). These training facilities are generally associated with existing laboratories or colleges and as a rule do not require elaborate facilities. In most of these institutions, there is a real need for adequate student housing and boarding facilities. There is also need for modern training devices and library material. The major current problem facing institutions of this type is maintaining competent staff in those already in operation and recruiting new staff for those in the process of development (3, 26, 34, 38, 53, 118, 121, 122, 123, 143).

Laboratory-Animal Facilities. The problems of laboratory-animal management in the tropics are well known. Virtually all the laboratories visited experience difficulty in raising enough laboratory animals for diagnostic testing and research activities. The problems are often compounded because of the lack of institutions devoted to raising and supplying replacement stock.

Feed is a major problem because few sources of balanced prepared laboratory-animal rations exist. The high cost of imported supplies may periodically strain the financial resources of existing institutions.

In planning new modern laboratories, particularly those for research in biologicals production, full consideration should be given to maintenance of adequate laboratory-animal facilities. In most cases, this involves relatively costly air-conditioning systems and higher operating costs than would be anticipated in a similar establishment in a temperate climate.

*Professional veterinary education is considered on pages 29-32.
Failure to provide adequate laboratory-animal facilities in the design of proposed institutions is a serious oversight—one that might hinder achievement of objectives.

Where support for future laboratory-animal facilities is considered, it would be wise to review and observe the methods and systems recently inaugurated at the Ghana Academy of Sciences' facilities in Accra under a joint Ghana Academy/U.S. National Institutes of Health program. At least a part of the problems associated with care and feeding of laboratory animals under tropical conditions has been approached in a practical and efficient manner at this institution (2, 134).

Disease-Control Programs

Rinderpest

Rinderpest has been a serious plague of bovine animals in Africa and elsewhere for many years. Beginning in the late nineteenth century, rinderpest epizootics have swept through Africa, at times decimating animal populations. The serious losses among the herds of pastoral peoples probably account in part for their tendency to maintain herds in excess of their actual requirements. The survival of a few animals allows the herdsman to rebuild his herd. This keeping of "insurance" animals will not change until the herdsmen of the major livestock-growing areas of Africa are assured their animals will be protected against animal diseases (46, 50, 110).

Rinderpest control, originally Project 15 of the CCTA, has made encouraging progress in Phase I of a three-phase program to extend from 1962 to 1968. During Phase I, 1962-63, more than 10-million cattle, or about 80 per cent of the bovine animals, were vaccinated in four countries of West Africa (Cameroon, Niger, Nigeria, and Chad)—far more than the 6-to 7-million vaccinates previously anticipated. Phase II, which involves Upper Volta, Mali, Ivory Coast, Ghana, Togo, and Dahomey, as well as the countries participating in Phase I, is scheduled to begin in September, 1964, and end in September, 1967. Several of the new countries scheduled to participate in Phase II are faced with more difficult problems than most of those encountered in Phase I. These problems relate to obtaining vaccine supplies, recruiting and organizing field staff, and supplying field equipment. The problem of vaccine availability is essentially one of funding for purchase and distribution of vaccine. The problem of providing staff is more acute. The first annual report on Phase II by the Director of Project 15 indicates less success than was obtained in Phase I, but looks optimistically to improved conditions in the second year of operations. Phase II of the project, begun in September, 1964, has progressed at a slower rate than Phase I. In some areas, the number of animals vaccinated has been substantially less than had been expected. By far the greatest vaccination activity has occurred in Mali, Niger, and Upper Volta, where a total of nearly 4-million animals were vaccinated between September, 1964, and March, 1965.
Phase III, for which funding commitments are not yet firm, is scheduled to begin in 1966. It will involve extension of the program into Mauretania, Senegal, Guinea, and Sierra Leone, and possibly Gambia, as well as expansion of Phase II programs in Mali and Ivory Coast. It is necessary to begin studies immediately of the required funding for Phase III if resources are to be utilized effectively and the unnecessary delays experienced in Phase II are to be avoided (57, 70, 87, 119).

Although no great problem exists in availability of subprofessional field staff, a serious situation is created when certain trained nationals from one country are employed within the boundaries of another because certain non-technical arrangements for inter-country service are apparently difficult to work out. If these problems are to be overcome, periodic discussions between the project coordinator and the assistance agencies involved are essential (70, 119).

Furthermore, the 26 qualified veterinary field supervisors from 11 nations, now working under the auspices of STRC, are not enough to provide adequate supervision of the activities in all the countries involved in future operations. Veterinary personnel, financed through EEC funds, cannot be used in countries that are not members of the 18 associated states. Countries such as Ghana, which have limited numbers of qualified veterinary personnel, will have inadequately supervised field operations unless external assistance agencies provide personnel. Sierra Leone and Gambia may be faced with similar problems when they come into the project. It is courting disaster to operate field vaccination programs without adequate veterinary supervisory personnel, and too much has been invested in the project to ignore this requirement. Recent veterinary graduates, capable of working in the "bush" under the direction of STRC coordinators, can fulfill a part of this need. A minimum of two field veterinarians (and possibly four) will be needed to assure successful immunization in these regions.* The costs are not excessive, involving only an estimated $15,000 to $20,000 per man year. (70, 119)

At least three laboratories (Dakar-Hann, Senegal; Vom, Nigeria; and Farcha, Fort Lamy, Chad) are especially equipped and staffed to produce all the vaccines required in West Africa at a low cost, and the expanded production capacity results from the development of tissue-culture-vaccine techniques originating in laboratories at Muguga, Kenya, and Vom, Nigeria. The significant problems related to rinderpest vaccine are effective refrigeration for field distribution, and, particularly in the case of TCV, adequate serological testing of vaccinates to certify immunity in vaccinated animals. (64, 65, 66, 67, 70, 115, 119)

The first problem can be solved by courier delivery service from laboratories to points of issue and use in each country. Such a system

*As of October 9, 1964, negotiations with Canada provided this requirement to Ghana. However, as of January 25, 1965, these specialists were unable to function because of lack of transportation and field refrigeration equipment. (152)
of rinderpest outbreaks in areas of vaccination. Since TCV produces virtually no clinically apparent vaccination response, it is important that representative numbers of vaccinated animals be subjected to immunological testing. Some serum samples were collected from vaccinated cattle in Nigeria during 1964. Results of serum neutralization tests conducted at Vom confirm that a high percentage of these vaccinated cattle are immune. A system of serologic testing should be enlarged in Phase II of the program, and it is desirable to establish systems for organizing and supporting the field services necessary to collect serum samples from representative numbers of cattle assembled for vaccination. Responsible individuals recognize the need for conclusive evidence of immunity, and are prepared to support schemes for facilitating the collection and testing of representative serums from vaccinated animals in current and previous phases of the campaign. It is also necessary to organize expeditious transport of such samples to laboratories where arrangements have been made for conducting suitable tests. To facilitate this essential testing system, vacutainers, needles, and needle holders and serum vials should be supplied to the STRC coordinator to permit efficient mobilization of samples. A relatively simple hemaglutination-inhibition (HI) test has been developed that may reduce the cost and most of the tedious effort now required for serum-neutralization (SN) tests for determination of anti-body response.

Some countries, currently dependent upon vaccines from the three operating laboratories, are experiencing difficulty in obtaining supplies as a result of currency valuations. Most of the countries in this position have relatively small livestock populations, but these susceptible cattle represent a threat to the success of the program. If an insurmountable problem of payment for vaccine does arise, the program must not be jeopardized, and steps should be taken to subsidize purchase of vaccine if alternative arrangements cannot be made. (33, 70, 87, 119)

If Phase II is effectively carried out, the outlook for success comparable to that achieved in Phase I can be expected. However, serious delays have occurred in the initial stages of Phase II, and if similar future delays are to be avoided, it is imperative that the planned division of responsibility and estimated funding of Phase III be inaugurated immediately. The estimated requirements of each participating agency and each government must be spelled out as accurately as possible at an early date in Phase II. Failure to carry out Phase III, now scheduled to begin in September, 1966, would inevitably lead to a regression in the status of rinderpest control. If Phase II is ultimately as successful as Phase I, the coordinator considers that Phase III might very well be started a year earlier, that is, in September, 1965, thus considerably reducing the overall operational costs. Furthermore, immediate attention must be given to establishing succeeding phases which would involve development of rinderpest control in the Sudan, Ethiopia, and Somalia comparable to that already achieved in other areas of East Africa and that currently under way in West Africa. If effective control of these areas is not accomplished, the threat of reintroduction of the disease into clean areas is very real and the economic consequences to improved livestock production may be fully as serious as they have been in the past. (70, 87, 87a, 119, 152)
As it does not appear likely that Ethiopia will be ready for inclusion in the program as early as the Sudan and Somalia, it has been suggested that Ethiopia be considered as a separate phase. It should be noted, however, that the suggestion that Ethiopia participate in the rinderpest control program has met an unfavorable reaction to the effect that an extensive program is unnecessary in view of the large numbers of cattle and a reported generalized over-grazing of the land and non-utilization of the animals. It should be pointed out that disease-control programs of regional nature cannot wait for development of ancillary sciences or programs and that, in the past, progressive animal-disease control has accelerated progress in other fields.

It should be recognized that, under intensive control conditions, the progress in the elimination of rinderpest is initially rapid, but as the programs progress, the time necessary for weeding out the isolated and remote foci of infection may be substantially extended. (11, 12, 111)

Responsibility for continuation of the rinderpest project quite obviously rests in part with the countries involved, with European countries and agencies participating in the initial phases, with such other organizations as the United Nations Food and Agriculture Organization, and with certain philanthropic organizations that have, in large measure, encouraged and supported the project. It is not too early for all the participants to begin planning for management of this project so that the Fifth Commission of the OAU can be prepared to assume and carry out the responsibilities previously fulfilled by the CCTA. Delays in planning will delay the campaign against rinderpest and will jeopardize faith in proposed multilateral projects for the control of other serious diseases such as trypanosomiasis and contagious bovine pleuropneumonia. If African nations are to meet the protein needs of their people, control of these diseases, as well as vastly improved livestock management, are essential. The fact that countries may not be fully prepared at this time or that external support may not be fully available at this time, should not preclude development of technically sound planning for expanding future programs. (11, 33, 48, 57, 60, 63, 70, 87, 119)

It is impossible to measure accurately the monetary loss that will occur if future phases of Project 15 are allowed to terminate or stagnate. Almost certainly, a regeneration of the disease after a lapse will result in an added operational expenditure as great as that involved in the preceding phases. (33, 87, 119, 152)

Many experts believe that the ultimate eradication of rinderpest from Africa will only be possible when the true nature of virus survival in nature is understood. In current and future planning, consideration must be given to support for research on the role of wildlife, as well as sheep and goats, in the perpetuation of the virus and the mechanisms involved in the transmission of the virus from a smoldering state in nature to susceptible game-animal or domestic hosts. (11, 12, 111, 119) A solution to this problem may be essential for ultimate effective control of this disease, and support for such a study might be considered a wise investment to protect past and future expenditures for the control of rinderpest.
Trypanosomiasis

Trypanosomiasis is one of the greatest factors limiting the development and marketing of cattle in West Africa. Severe clinical manifestations of trypanosomiasis are often intensified by intercurrent disease, parasitism, or other "stress" factors. It occurs enzootically in all areas of tsetse fly infestation, which amounts to nearly a third of the entire continent of Africa. Permanent animal husbandry is difficult in heavily tsetse fly-infested areas; the result is a periodic concentration of cattle in the northern tsetse-free areas, which leads to overgrazing and erosion of land, and, not infrequently, to starvation of animals. In West Africa, nearly half of the available land is uninhabitable for cattle except during the brief periods of tsetse fly inactivity, and generally these areas are those otherwise most ideally suited to animal raising. Trypanosomiasis is also one of the greatest deterrents to efficient marketing of livestock, since tsetse infestation either periodically precludes movement of animals or causes severe losses in the process (18, 42, 43, 43a, 84, 97, 110, 119, 144, 162).

The West African Institute of Trypanosomiasis Research (WAITR), the Nigerian Ministry of Animal and Forest Resources, Tsetse and Trypanosomiasis Unit, and similar organizations in other countries have accomplished a great deal in tsetse fly and trypanosomiasis research and in the establishment of pilot tsetse-fly-control programs. Application of currently known trypanosomiasis-control methods would contribute much to livestock development (7, 18, 27, 29, 30, 42, 43, 43a, 144, 149, 150, 158, 162).

A great deal of money is involved in the establishment of marketing systems that include mechanical transportation of livestock or livestock products. Yet there is little evidence that any effort has been made to correlate marketing programs with tsetse fly control despite long-standing recognition by many experts that effective movement of animals to rail heads or to population centers depends on the establishment of tsetse fly-free corridors through which the animals can pass.

Further extensive investigation of the possible resistance or natural immunity of Ndama and other "dwarf" breeds of cattle is of questionable value in the light of past scientifically recorded investigations. Some critical experimental evidence has confirmed that dwarf breeds are only partially resistant to trypanosomiasis infection, and that, when subjected to heavy fly exposure, especially under conditions of stress, they too break down with serious clinical manifestations of the disease. Under any circumstances, the dwarf breeds are basically uneconomical; that is, they are low producers and slow maturing. The average carcass weight of mature dwarf cattle (five years or more) is about 240 pounds, and their utilization as anything other than meat animals is not practical. Research efforts and funds currently allocated to further development of this breed could probably be more productively used for other purposes. Some consideration might be devoted, for instance, to improved goat husbandry, since these animals are little plagued by the tsetse fly (28, 42, 72, 97, 139).
Attention should be directed toward planning efficient trypanosomiasis-control or tsetse fly-control programs so that organizations can participate effectively in such ventures when the countries of this region are ready to initiate them. Basic systems for effective tsetse fly control have been established in many areas of Africa, and these systems may well be applicable to areas of West Africa where increased animal productivity and efficient marketing are integral parts of current objectives. Total costs per acre for recovery of substantial-size tsetse fly-infested areas have been recorded between 0.05 and 0.28 U.S. cents, depending on the type of terrain, the fly species involved, and the systems applied. Thus, where land is actually needed for livestock or agricultural production, the costs of recovery are, at least in selected areas, economically feasible (7, 18, 29, 43, 97, 150, 158, 162).

Tsetse fly-control procedures on the fringes of the fly belt have been very successful, but control in areas more ecologically favorable for Glossina spp. requires much more rigorous measures that are more difficult to implement. Provision of the hoped-for fly-free corridors from the cattle-producing areas of the north to the heavily populated areas of the south where meat is needed may not be possible at the present time. Nevertheless, evidence exists that substantial areas can be recovered economically from tsetse fly infestation and that, if such recovery is coupled with a rational farming colonization that implements cultivation and bush control, the area will remain free of this pest.

With increasing human population and consequent expanding food requirements, there is an obvious need to bring more land into cultivation. It is essential for governments and external assistance agencies to consider tsetse fly control a necessary factor in the over-all long-range agricultural development of new land areas. Such developments would also enhance practical market movement of animals (7, 18, 29, 43, 84, 97, 110, 149, 150, 158).

Intensive exchange of information and coordination of fly-control work is not evident in Northern Nigeria. The two programs—one controlled by the Ministry of Health and the other by the Ministry of Agriculture—in contiguous areas in the northern territory in Nigeria are quite different, even though the ecological habitat and species complex are essentially the same. Both programs have been very effective in controlling the flies, but the Ministry of Agriculture program used much less insecticide and required much less time per unit of land. The Northern Nigeria Ministry of Agriculture program is based on a selective spraying system designed for maximum effect on the particular fly species involved. Greater coordination of policy and systems would seem desirable (149, 150, 152).

Excellent research personnel have provided much valuable information on the ecology, taxonomy, and control of tsetse flies, but the widespread resignations of these highly trained scientists are leaving serious gaps in the research potential. If progress is to continue in tsetse fly control, further studies on the ecology and feeding habits
of particular species in certain areas are necessary. Retention of experienced personnel is very important, and increased opportunity for exchange of information between research and control personnel must be facilitated. Recently (24-28 November, 1964), the Tenth Meeting of the International Scientific Committee for Trypanosomiasis Research (ISCTR) met in Kampala, Uganda. This was a highly technical meeting and one in which significant trypanosomiasis research and control information were presented. It would be highly desirable for well-qualified professional representatives from the United States participate in future meetings of this nature.

Studies involving the sterility principle in tsetse fly control, financed by AID research funds and implemented by the U.S. Department of Agriculture, have been undertaken recently in East Africa to determine whether they can contribute to effective tsetse fly control. These studies should be expanded. Extension of East African work to West Africa and coordination in their efforts might accelerate the utilization of new techniques in tsetse fly control programs. Many areas of trypanosomiasis and tsetse fly research are worthy of further investigation. Some of those under way at the West African Institute for Trypanosomiasis Research have, for some time, been curtailed as a result of withdrawal of funds and personnel. Consideration should be given to support of the more promising research, particularly in those areas where competent personnel are available. The possibility of including entomological research in U.S. university contracts might be considered. Such research could be accomplished at relatively little cost under the direction of a U.S.-based senior scientist, who could use doctoral candidates to carry out necessary field investigations (18, 20a, 30, 43, 43a, 134a, 144, 149, 150, 162).

A great deal of useful, well-equipped research space exists at the West African Institute for Trypanosomiasis Research. Future program support should encourage parasite investigation projects in addition to trypanosomiasis studies. Such investigations might be consolidated with the work of the nearby Federal Veterinary Research Laboratories. (109, 162)

Contagious Bovine Pleuropneumonia

Contagious bovine pleuropneumonia (CBPP) is less spectacular but probably equally as serious a disease as rinderpest in West Africa and is far less amenable to control. It is the subject of CCTA Project 16, now in a research phase, with the greatest current activity taking place in East Africa, supported as a joint AID-U.S. Department of Agriculture project (46, 50, 57, 69, 119, 124).

One of the first necessary steps in the approach to this disease in West Africa is the application of newly developed diagnostic techniques. A workable method for large-scale, rapid serological diagnosis, using mobile field equipment, has been devised in East Africa. This system is being used intensively there, but little effort has been made to carry out similar investigations in West Africa (7, 44, 46, 52, 69, 119, 124).
Close observation of developments in CBPP research in laboratories at Vom, Farcha, and Dakar-Hann, as well as in other parts of Africa, should be maintained, for the results of diagnostic and immunological research will definitely influence the practicability of future control programs. In Nigeria, where the government maintains testing systems, vaccination, controlled movement of stock, and slaughter with compensation, the disease is relatively well controlled, and any support for control programs elsewhere should require the establishment of similar policies. Highly qualified personnel have been involved in effective CBPP-control programs in the past. Future maintenance and expansion of CBPP control will depend on how well the programs are organized and supervised, and upon the availability of funds, both for field services and for compensation for slaughter of infected animals. Possible economic uses for carcasses of infected animals should also be investigated. (7, 52, 69, 119, 124, 151)

Furthermore, it is necessary to recognize that in West Africa there are two distinct viewpoints regarding the control of CBPP. One, that of the French, is control by massive vaccination, and the other, subscribed to by the British, is control by testing, elimination of reactors, and restricted movement of animals from infected herds. Protocol for assistance must be based on careful consideration of the particular system involved and each country's willingness to adhere to specific regulations essential for operation of either of these systems. (7, 115, 119, 124)

Currently, and in the foreseeable future, the primary requirements for solution of the CBPP problem deal with research, including basic investigation of the characteristics of the organism. Other research worthy of support deals with developing effective vaccines and more efficient diagnostic tests in the reputable laboratories in West Africa. Such research is essential if future control programs of the magnitude and effectiveness of the current rinderpest campaign are to be realized with respect to contagious bovine pleuropneumonia (44, 52, 69, 119, 124, 151).

Other Diseases and Parasitisms

Although the three diseases discussed above are generally considered to be of major concern and, to some degree, are all subjects of CCTA (now STRC) projects, there are many other diseases that, either singly or collectively, take equal or even greater toll. Some of these also have a deterrent effect on current and future restrictions on international movement of livestock or livestock products. Before any area of West Africa can consider the possibility of efficient livestock production, several of these bacterial, mycotic, viral, and parasitic diseases must be controlled in some measure. (46, 50, 57, 95, 97, 119, 165)

Foot-and-mouth disease (FMD), for instance, is as great or perhaps even greater an impediment than rinderpest to international trade in livestock and livestock products. FMD is not a disease causing spectacular losses in West Africa, and consequently receives little attention. However, its significance is compounded by the existence of at least two European and two South African types in the region (46, 97, 119, 126).
A serious disease, and one possibly increasing in importance, is streptothricosis, a mycotic disease, principally affecting bovines in Africa, but also other animals and man. Although biting insects are suspected in its spread, their exact role is unknown. Periods of high incidence are related to conditions of high rainfall or humidity. A great variety of treatments has been used with little success. This increasingly important disease is worthy of research directed toward finding the mode of transmission and devising effective methods of prevention or treatment (46, 57, 88, 97, 119, 135).

Cysticercosis (larval stage of tapeworm) occurs in as much as 80 percent of the cattle in some areas. It is a definite public health problem and a serious deterrent to export of carcass meat. Its perpetuation is linked to social customs and failure to practice human hygienic principles (41, 46, 95, 97, 119, 135).

Fascioloiasis (liver infestation by flukes) is almost universal among West African cattle, taking a heavy toll in mortality and in weight loss and debility. In some years, the losses from this disease exceed the combined losses from rinderpest, contagious bovine pleuropneumonia, and trypanosomiasis (41, 46, 97, 119).

External parasites, particularly ticks, generally preclude the introduction of exotic breeds. Only the most efficiently operated livestock schemes can implement measures, such as frequent dipping, to reduce tick infestation to tolerable levels. Since Zebu stock are relatively resistant to many of the diseases transmitted by arthropods, they are better suited to conditions prevailing throughout West Africa than other breeds (46, 50, 57, 97, 99, 119, 125, 165).

Many other diseases and adverse conditions impede efficient livestock development. Some of these can be controlled, and some the indigenous animals are able to tolerate (46, 50, 97, 119).

Human and Technological Factors Affecting Production and Marketing

Systems for controlling animal diseases and marketing cattle are inseparable from the cultures of the human groups that handle the animals. The techniques of handling cattle are part of the technology by which some of the peoples of West Africa survive in that environment. These are techniques developed by trial and error through centuries of learning to adapt to that habitat. Outsiders introducing new methods for improving livestock would benefit by finding out what has done on before; for example, the Fulani herdsmen throughout the Sudanic region of West Africa, who have been trading and breeding cattle for centuries, have evolved at least five definite strains of cattle adapted to that region. The place of cattle in the lives of both herding and agricultural people has to be understood as one element in a single integrated pattern of culture, religion, and education, and it is the
whole pattern of human factors that affects modern efforts to control rinderpest and other diseases. Without working through the existing institutions and attempting to see the world through the eyes of the people affected, outside administrators and technicians may waste time, money, and emotion in attempting to assist Africans to develop a more efficient livestock industry. Proper motivation as well as new forms of human organization are needed among the people to get more protein-producing and cash-producing animals from grazing lands to markets in Africa. Officials working on rinderpest control can provide good case-study material backing up the proposition that one must study why people resist or accept change. If outsiders expect to convince the local inhabitants that they might benefit by such modern control measures as new biologics or quarantine, they need to understand how culture change works. Merely recognizing that people are different is not sufficient; imaginative leadership from the outside will most likely come from those who do not let cultural differences provide an excuse for doing nothing or dismissing the situation as hopeless. Human behavior can be understood—and influenced. (21, 28, 100, 110, 137)

While West African cattle may not dominate the social environment as cattle do for such East and South African people as the Akamba, the Bahima, or the Zulu, cattle provide in different degrees for the Fulani and other people of the area the basis of subsistence and an important means of storing wealth and achieving status. A "cultural manual" or "checklist" for technicians working in the area should include in the information pertinent to controlling disease and marketing cattle: (1) the general pattern of social organization among West African herdsmen, as well as regional variations that have been described by a number of authorities; (2) the importance of kinship as the basis for social groupings—especially as it relates to which members of the family manage livestock, how families use land, what they eat, what they know about animal husbandry, and how they transport animals; (3) the social ties between herding peoples that explain how they work together as a group, the movement of their herds, their range management, and their marketing systems; (4) how traditional education systems, based on emulation of kinsmen rather than formal schooling, can provide helpful clues for discovering the channels through which new ideas and techniques flow; and (5) the nature of the relationships between herding people and the sedentary communities (e.g., Hausa, Bambara, Malinke, Mossi, Zerma, and Zoninke) through which the pastoralists move. For example, the planner and technician might take into account the "ecological balance" between the Fulani and settled farmers as evidenced by their exchanges of agricultural products for milk and butter, the farmers' hiring skilled Fulani herdsmen to tend their livestock, and the fertility brought to the farmer's fields by the transient Fulani livestock whose manure remained after they had been allowed to feed on leftovers from the harvest. Understanding such aspects of traditional West African pastoralism and how they can be adapted to modern conditions is crucial to realistic planning of sound improvements in livestock—and ultimately, to the economic health of the region (21, 37, 100, 110, 137).
Because of the subtle interplay between science (biological knowledge developed overseas), technology (methods of manufacturing vaccine locally), and human culture (the total way of life of the people involved), the following "technical" considerations of modern livestock production will be treated here as an extension of "human factors." This approach should help to emphasize the importance of educating and training Africans in livestock management as a basis for controlling animal health. Finding water for animals, maintaining water supply, introducing new grass seed, controlling breeding, and improving the techniques of curing hides and skins ultimately depend upon the motives, organizational skills, and knowledge of Africans. The attention given elsewhere in this report to the importance of the quality of foreign veterinary personnel represents a short-term, although vital, approach to the problem of animal diseases (19, 21, 97, 110, 157, 164).

Both for short-term and long-term means of animal production, it is the Africans who will decide what kind of cattle they will have and how they will get them to market. Such decisions will be based on the political situation (how the herdsmen incorporate new techniques and regulate their economic behavior, as well as how they respond to conflict or cooperation with sedentary people) and, beyond the farmers, the economic and political goals of people running the newly independent states. Besides the African equivalents of "precinct" and national politics, religious factors may play a strong role in patterning people's responses to modern ways. Chiefs or clansmen who speak with sacred authority, such as Moslem prayer leaders, may determine the effectiveness of agricultural extension programs coming from far-away African capitals or universities or a regional office of UNESCO or the FAO. No technical innovation can be divorced from questions of political, religious, or ideological concern to the herdsmen or the people who buy their products (17, 97, 100, 110, 137, 141).

Management

The technology of meat production in West Africa, from the initial growing stage to retail or export outlet, ranks among the most poorly developed in the world. The need for improvement to avoid wastage, to stimulate more efficient production, and to provide animal-protein products within the economic range of the consumer is obvious. If the advantages to be obtained from disease control are to be realized in terms of an improved livestock economy, certain technological changes related to range management, livestock management, and marketing must take place. At this point, there is little evidence that these technological and economic developments are progressing at a satisfactory rate. In each instance, a system for integration between technology and the milieu is critically needed. But it is essential to recognize that changes and advances in productive management will not, under any circumstances in West Africa or elsewhere, occur with spectacular rapidity. Innovations by fiat or massive induction of external management concepts will not be automatically accepted. In many areas of the world, the most significant livestock-productivity development has resulted from improvement in indigenous practices coupled with a subtle infusion of external techniques (15, 19, 45, 91, 97, 110, 119).
Water Conservation. Many attempts have been made to establish wells, dams, and ponds to provide water during the dry season, particularly in the Sahel, in order to reduce the necessity for ceaseless transhumance with attendant losses. But these water development or conservation schemes are currently seldom related to forage development or fodder conservation, with the result that the areas adjacent to the water are often completely denuded. The future development of the livestock industry is dependent on further expansion of water resources, but any support for such projects should be predicated on concomitant projects defining forage development and conservation as well as stocking rates in areas affected. It is absolutely essential that overgrazing caused by water-development schemes be eliminated in future programs. The problem of balance between water development and controlled grazing is recognized, but its solution is very difficult. The problems in water conservation and development often transcend national boundaries. In the development of water for industrial purposes, such problems frequently involve international collaboration and planning over long periods of time, but in the case of water for livestock or human consumption, the same attention is frequently lacking. Water development is undoubtedly one of the most harrowing and intricate problems confronting the arid and semiarid regions of West Africa, and requires the joint, coordinated planning of all assistance agencies and governments in the region. (15, 21, 37, 56, 97, 100, 110, 119, 140, 157)

Pasture Control and Fodder Conservation. The problems related to feed utilization around watering places in arid areas have been mentioned. The whole of the livestock-raising pattern is affected by feed availability. Efforts attempting to overcome feed shortages at various stages of livestock growing and marketing have so far made only a barely discernible impression. The application of demonstrated effective methods of hay making, pasture rotation, bush control, controlled stocking rates, seasonal destocking, provision of feed-holding areas on market routes, and controlled marketing have made little headway. Such programs should be an integral part of any livestock-development program, and support for livestock-development schemes should require that the participating government provide adequate legal support for effective implementation. Sir John Ritchie, former Chief Veterinary Officer of Great Britain, has aptly stated, "The failure to provide satisfactory grazing for the larger number of animals surviving from epidemic diseases as a result of vaccination programmes merely transfers the casualty numbers from the column headed Diseases to the column headed Malnutrition." (15, 21, 45, 97, 109a, 110, 115a, 119).

Breeding Programs. The development of breeding programs in West Africa is characterized by inconsistency and repetition of proven past mistakes. Insufficient attention has been devoted to selection within indigenous breeds. Breeding experiments over the past 30 years, which have shown that introduction of European breeding stock has been a failure, and which have further emphasized that such stock is susceptible to enzootic diseases and other adverse environmental factors, have been largely ignored. Research has indicated emphatically that a sure practical method of improvement involves selection within indigenous breeds,
combined with rational introduction of zebu bloodlines. Projects involving the introduction of dairy stock are glaringly inappropriate. Recently, a trend toward introducing frozen semen, rather than male stock, has developed. This has some obvious advantages, but the financial support for such schemes should come from local entrepreneurs, and outside support should be limited to advisory services in the initial stages of organization and training.

In other parts of Africa, breeding programs related to commercial enterprises have produced dramatic results. Some of these involve selection of indigenous breeds over a 25- to 30-year period; others involve maintenance of purebred foundation herds and crossbreeding to produce market animals. Several demonstrations of outcrossing, using *Bos indicus* (Sahiwal) or *Bos africanus* (Borano) strains, have been carried out in Africa. Some breeds of West Africa show considerable potential for improvement through selection, and appear to be useful in crossbreeding projects. Breeding programs should be designed to take advantage of the wealth of useful information already accumulated, and expectations for effective results should be anticipated as taking not 2 to 4 years, but 20 to 30.

The support for breeding programs dealing with dwarf-type cattle should be abandoned. These animals mature slowly and are obviously inefficient. Their reputed trypanosomiasis tolerance is of questionable value in the long-range cattle-development scheme.

Introduction of European or American dairy and beef breeds should be discouraged, for they offer little potential for hybrid vigor under African conditions, and they are notoriously susceptible to many diseases and parasitisms of Africa. The examples of failure of introduced breeds to survive or to adjust to new environments are too numerous to ignore. The expansion of development programs based on indigenous selection needs to be vastly stimulated.

**Nutrition.** The problem of animal nutrition in West Africa is intimately associated with the effective development and utilization of natural pastures. In a few areas, desirable grass species may be introduced. In addition to pasture development, adequate animal nutrition depends on controlled grazing, which implies rotational utilization of demarcated areas, controlled stocking rates, and conservation of fodder. To supplement available pasturage, more effective utilization of supplemental feed, such as oilseed cakes, slaughterhouse by-products, and possibly fish-residue meal, can contribute much to the delivery of higher-quality animals to slaughter points.

Overcoming the effect of dry periods and the consequent feed shortages is not more insurmountable than overcoming consequences of long winter dormancy in other parts of the world. Development of an efficient livestock industry in West Africa is dependent on successful fodder conservation along with the other programs already cited.
In certain areas, a great deal of attention should be directed toward providing mineral and trace elements for animals in order to increase fertility and reduce serious consequences of mineral and trace-element starvation (21, 45, 46, 54, 93, 97, 108, 110, 115a, 119, 143).

Marketing

Hides and Skins. One of the greatest wastes in livestock products in West Africa is in hides and skins. A great need exists to expand the training programs related to flaying and curing hides and skins. Progress in this area has been achieved in East Africa and at least some of the techniques applied there are equally applicable in West Africa.

The possibility of developing small leather-goods industries designed to produce useful and practical goods for local markets has been overlooked. Such cottage-type industries, which have been established successfully in other parts of Africa and elsewhere, could contribute substantially to the local economy (19, 91, 93, 108, 119).

Meat. The production and marketing of meat are very inefficient processes in West Africa. The marketing of average meat animals takes approximately twice as long as it takes in Europe, and the animals are approximately twice the age and half the carcass weight of those in Australia or the United States. With meat-hungry Africa and a potential resource that can easily satisfy the regional requirement and, in addition, contribute to foreign trade, such inefficiency cannot be tolerated; there are areas of Africa, no more suitable for livestock production, that have altered the situation and have succeeded in approaching the productivity achieved in other parts of the world (15, 19, 80, 89, 91, 97, 119).

Another fact worthy of note in the comparative production of meat is that West Africa’s average annual takeoff of cattle in relation to total cattle production is 7 to 10 per cent. The comparable figure in Europe and the United States is 28 per cent and over (15, 19, 97).

With these basic comparative-productivity estimates established, it is clear that the livestock assistance programs for West Africa must be designed to eliminate causes of loss, contribute to the alleviation of periodic starvation, and increase the efficiency of livestock movement to market areas. The first two problems have been dealt with in previous sections of this report. The third is more complex. It involves the regulated movement of animals either on foot or through commercial transport and the relaxing of the market systems controls in order to develop maximum incentive for livestock production and to eliminate current losses due to shrinkage, disease, and stress factors.
Evidence exists that entrepreneurs are willing and able to market meat nationally and internationally if protective devices favorable to profiteers are eliminated. Marketing systems, with the desirable characteristics of those in Europe, the United States, Australia, and some parts of Africa, should be assisted. After a thorough examination of the available literature on livestock marketing, studies should be initiated dealing with areas where information is lacking, contradictory, or obscure. Many of the studies already completed on livestock marketing define these specific areas. Completion of these studies might well provide incentives for private industry to expand operations, including the development of modern slaughtering, processing, and marketing facilities. (IS, 19, 80, 89, 91, 146, 147, 148)

The area of West Africa between the tsetse-free northern cattle-growing region and the great meat-consumption areas of the coast is infested with the fly. The movement of animals through this area is a costly and hazardous undertaking. The only logical solution to this problem is the establishment of systems that will eliminate or reduce the hazard. One involves the slaughter and shipment of meat from the north to the south or, in the case of Senegal, from the east to the west; another might be the establishment of tsetse-fly-free belts for the trail movement of animals to market areas. Both systems are practical: the first involves the development of slaughterhouses in cattle-growing areas, creation of refrigerated transport, and provision of warehouse facilities at points of consumption; the second involves feasible reclamation of tsetse-fly-infested territory at costs varying from 5 to 28 cents an acre. Either of these systems is a long-range project to which assisting agencies should address themselves. Both systems have been demonstrated effective in other parts of Africa no less plagued by similar conditions. (IS, 18, 19, 29, 42, 43, 46, 80, 89, 97, 119, 150)

The obvious conclusion to solutions of meat-marketing problems of West Africa is that programs require much more detailed long-range planning, more participation by the individual countries, and a much greater recognition of the need for regional and international correlated activity. (IS, 19, 80, 97)

**Manpower and Education**

Although United States Government agencies and veterinary-medicine educational institutions have participated in educational planning abroad for many years and a great deal of money has been committed to support various veterinary educational schemes, no apparent, consistent policy of guidance has been established. In fact, activities in support of veterinary educational programs appear to be conducted without regard to well-established principles and without realistic attention to encouraging the ultimate establishment of competent professional veterinary services (14, 18, 23, 32).

It is the consensus of experts who have studied the problem that an immediate need exists for the establishment of two veterinary schools of creditable professional status in West Africa, one in the English-speaking area and one in the French-speaking area (13, 87a, 109a, 123).
An international veterinary education panel, formed in 1960, has completed three reports which provide useful guidelines for development of educational programs in regions where veterinary manpower is lacking. The recommendations of this panel need to be seriously considered in future planning.

The need for close association between veterinary education and allied sciences, including agricultural, biological, and medical disciplines, has been repeatedly stressed by experts. It is essential that veterinary faculties be established in association with existing universities engaged in teaching and research.

In the development of regional veterinary educational systems in West Africa, plans should specifically include the initial utilization of the most competent African veterinary graduates already in the area—at least at the instructor level. An effort should be made to induce research participation by these individuals in order to ensure a flow of teachers with increased professional competence and status into the faculty. Research should be directed toward major problems of the region (119, 123).

Support for postgraduate fellowships must be provided primarily for students willing to undertake studies within institutions in the region. Postgraduate work abroad should be limited to a few very carefully selected students who have demonstrated interest and competence in some phase of veterinary work within their own countries. Such a system helps to overcome the prevalent desire among students for perpetual education with no intention of active participation in national animal-health organizations (122, 123).

Considerable thought should be given to encouraging and supporting upper-class veterinary students to participate in national animal-health programs during inter-term vacations. Programs such as this would augment student experience, channel interests in future professional activity, and provide funds for school expenses (123).

In view of the progress in a multi-institutional approach, so well demonstrated at Makerere College, it would appear highly desirable to explore the areas of possible collaboration that apparently exist for continuing support for veterinary education in West Africa.

The study group has also received information that a veterinary faculty has been established at the University of Dakar that will admit between 20 and 30 students in October 1965. While this faculty will be essentially a French-supported institution, it has implications of interest to other programs in all the French-speaking West African countries. (14, 32, 87a, 109a, 123)
In view of the critical need for effective veterinary educational planning in Africa, it would be advisable to encourage the convening of a group of experts to define terms for future long-range assistance.

**Current Status and Future Needs**

The strength of veterinary and subprofessional veterinary staffs varies considerably from country to country in West Africa. No country of this region has anywhere near the required number of qualified nationals in veterinary services. Several countries do, however, have considerable foreign veterinary support and reasonably adequate staffing in the subprofessional services (i.e., laboratory technicians, animal-health assistants, and vaccinators). In assessing immediate professional veterinary requirements, it must be recognized that the governments of West Africa cannot immediately absorb significantly more veterinary personnel than were utilized under the optimum colonial systems. Veterinary activities in these countries are almost wholly preventive in nature. The economics of livestock production in these areas will not support extensive clinical-treatment systems in the immediate future (47, 118, 123, 163, 165).

Up to now, veterinarians have been educated abroad. Some countries of West Africa have, or will soon have, substantial numbers of veterinarians trained in Europe and North America, but others have few or none (87a, 123, 143, 163).

Two veterinary colleges, adequately staffed, equipped, and housed—one in English-speaking and one in French-speaking West Africa—could supply the professional veterinary requirements for the foreseeable future. In the English-speaking area, the only university capable of participating in a veterinary educational program until recently has been the University of Ibadan in Nigeria. A nucleus for developing veterinary education has existed at this institution for some ten years, but there has been virtually no unified attempt to consolidate all available resources for veterinary education in any central institution. Local or regional internal political pressures have diluted already limited resources. Thus, in English-speaking West Africa, there are numerous plans for veterinary education, but none has adequate support to utilize the available human resources effectively. Adequate university-level veterinary education cannot be established without adequate staff, proper balance of research and teaching, and sufficient clinical facilities.

Veterinary education in French-speaking West Africa will depend primarily on France and French-speaking countries for support. The only adequate site for professional veterinary education in French-speaking West Africa is at the University of Dakar. France and the countries of French-speaking West Africa have not yet solved the problem of professional veterinary education, but have relied on a system of veterinary education in European schools. This system has not produced satisfactory results. The French Government, in December 1964, authorized the Ecole Nationale Vétérinaire d'Alfort, to assist in establishing a veterinary faculty at the
University of Dakar, Senegal, the only institution in the French-speaking region of West Africa capable of undertaking a professional veterinary education program. The first scheduled classes are to begin in October 1965 (87a, 109a, 123).

Training and education at the subprofessional level is less critical. Countries of both French-speaking and English-speaking West Africa have established schools or training centers for animal-health assistants, laboratory technicians, and vaccinators. Unfortunately, many of these centers have given the impression, through their use of terminology, that graduates have professional veterinary capabilities. Participation in any subprofessional training programs that do not specifically designate trainees as animal-health assistants, laboratory technicians, or with other appropriate titles should be avoided. (13, 26, 53, 109a, 119, 123, 143)

Training Abroad

Although it is currently necessary to educate veterinarians abroad, the policy should be abandoned as soon as professional veterinary educational institutions have been established in Africa. It has repeatedly been observed that African graduates of European or American schools are not adequately trained in veterinary disciplines that are suitable for immediate, direct application to Africa. Moreover, exposure of African students to cultural conditions and animal-health-protection systems of some more advanced countries often leaves them ill-prepared to cope with conditions in rural Africa. Thus, many students seek perpetual advanced education abroad or, alternatively, posts in only the major metropolitan areas of Africa. Many others seek professional or administrative employment in fields not related to veterinary medicine (87a, 109a, 123).

As veterinary services develop in this region, the requirement for veterinary postgraduates and specialized training will increase. To assure continuous progressive development of trained personnel, facilities for advanced training must be planned for and developed within African universities and research institutions. Only a few especially well-qualified individuals should be selected to undertake such training abroad. In cases of training abroad, the studies should be directly related to advanced veterinary problems of significance to the student's future work in his own country (122, 123).

Most of the organizations involved in animal-health assistance programs employ significant numbers of veterinarians for work in the field or in laboratories in developing countries. In order to guide and support such activities, most organizations maintain a veterinary headquarters staff which is expected to be alert and responsive to new or changing conditions.
With respect to personnel requirements for university veterinary-education programs, which are developed primarily under contract arrangements with U.S. universities, contracting institutions will be required to provide staff that is strong enough to meet recognized educational standards; in view of the availability of well-qualified foreign individuals, institutions must be allowed and encouraged to employ such persons. Few, if any, contracting institutions can adequately staff an educational program abroad solely from within its own ranks. In any event, such a system is undesirable for it might well breed provincialism and fail to exploit the constructive experience of individuals from other institutions. (14, 32, 53, 87a, 109a, 123, 152)
APPENDIX A

Itinerary - Personnel Consulted and Institutions Visited

The Study Group left Washington, D.C., on July 26, 1964. The following persons were consulted on the dates and at the locations indicated:

July 27-28

Pirbright, Surrey, England

Animal Virus Research Institute

J. B. Brooksby, Director

P. B. Capstick, Institute Staff

Walter Plowright, Institute Staff

R. F. Sellers, Institute Staff

G. R. Scott, University of Edinburgh, Edinburgh

Ian M. MacFarlane, Assistant Coordinator, CCTA, Fort Lamy, Chad

July 29-30

Brussels, Belgium

European Economic Community (EEC) Office

Harry H. Bell, Liaison Officer to the EEC, U.S. Embassy

Clinton L. Brooks, Assistant Agricultural Attaché, U.S. Embassy

Ralph C. Fish, Chief, European Mission for Research on Animal Diseases, ARS, USDA, Amsterdam

M. Mohrmann, Chief, Central African Agricultural Services, EEC

M. Weimar, Central African Agricultural Services, EEC

Henri Lepissier, Director, CCTA Project 15, Ouagadougou, Upper Volta (Headquarters Phase II)

Walter Plowright, Consultant to NAS Study Group, Animal Virus Research Institute, Pirbright
July 31-August 5

Rome, Italy

Food and Agriculture Organization of the U.N. (FAO)

E. A. Eichhorn, Chief, Animal Health Branch,
Animal Production & Health Division, FAO

W. Ross Cockerill, Assistant to the Director,
Animal Production & Health Division, FAO

J. G. Rumeau, Chief, Veterinary Education and Research Section, Animal Health Branch, FAO

Mark H. French, Chief, Animal Production and Health Division, FAO

A. W. Chalmers, Veterinary Officer, United Nations Special Fund, Study Group on Agricultural Development and Marketing in East Africa

Hans Hofod, Dairy Branch, FAO

Robert Tetro, Agricultural Attaché, U.S. Embassy

August 6-15

Nairobi, Kenya

Hon. William Attwood, U.S. Ambassador to Kenya

William C. Wild, Director, United States Agency for International Development, Kenya

John L. Cooper, Food and Agriculture Officer, USAID

Frank E. Moore, Livestock Advisor, USAID

Stanley Stone, Chief, East African Mission, Animal Diseases and Parasite Research Division, Agriculture Research Service, United States Department of Agriculture

Leroy Coggins, East African Mission, Animal Diseases and Parasite Research Division, Agriculture Research Service, United States Department of Agriculture

W. G. Beaton, Director, Inter-African Bureau for Animal Health (IBAH), Commission for Technical Cooperation in Africa (CCTA)
M.A.S. Lobry, Assistant to the Director, IBAH, CCTA

R. L. Wooldridge, Acting Director, Department of Veterinary Services, Kabete

R. W. Lewis, Assistant Director, Department of Veterinary Services

I. Mann, Veterinary Officer, Department of Veterinary Services, Kabete

Don Destro, District Veterinary Officer, Department of Veterinary Services, Kitale

P. E. Glover, Chief Zoologist, Department of Veterinary Services

Peter Hughes, Senior Veterinary Officer, Animal Industries

Derek North-Lewis, Artificial Insemination Service

Peter Long, Veterinary Officer, Department of Veterinary Services Experiment Station, Naivasha

Michael Blasdale, Supervisor, Dept. of Veterinary Services Experiment Station

William Bruce, Acting Chief, Veterinary Research Officer, Department of Veterinary Research, Kabete

H. Ohder, Department of Veterinary Research

D. W. Brocklesby, Acting Director, East African Veterinary Research Organization (EAVRO), Muguga

R. N. Gourley, Assistant Director, EAVRO

Jane Walker, EAVRO

W. P. Taylor, EAVRO

C. Rampton, EAVRO

Ian McIntyre, Acting Dean, Faculty of Veterinary Science, Kabete, Kenya
August 15-19

Peter C. Nderito, Assistant Dean, Faculty of Veterinary Science, Kabete, Kenya

Duncan Brown, Acting Director, Wellcome Foundation Laboratory, Kabete

John Burger, Wellcome Foundation Laboratory

James Smith, Veterinary Officer, Resettlement Scheme, Nyeri

Harry Carroll, FAO, Kabete

Douglas Hinde, Livestock Rancher, Nanuyki

Sir Donald McGillivary, Project Leader, UNSF Study Group to East Africa

D. Pean, Deputy Secretary, Ministry of Agriculture, Nairobi

Lagos, Nigeria

H. E. A. O. Odelola, Acting Secretary General, CCTA

John Williamson, AID Coordinator, CCTA Projects, USAID

Walton M. Nixon, Acting Food and Agriculture Officer, USAID

Ephriam Hixon, Agricultural Education Advisor, USAID

W. H. North, Assistant Director, Program Office, USAID

James Ford, Chief, Livestock Branch, USAID

Charles Coleman, Veterinary Advisor - Eastern Region, USAID, Ibadan

L.A. Fahlund, Veterinary Advisor, - Western Region, USAID
August 20

**Fort Lamy, Chad**

Hon. Brewster Morris, U.S. Ambassador to Chad, Fort Lamy

Joseph Guardiano, Program Director, USAID

Konrad Bogel, EEC Grant to Farcha Laboratory, Fort Lamy

Georges Tacher, Chief, Livestock Sector #1, Farcha

August 21-24

**Kaduna, Nigeria**

H. E. M. Bukar Shaib, Permanent Secretary, Ministry of Agricultural & Forest Resources, Northern Region, Kaduna

W. A. Rex, Assistant Director, USAID, Kaduna

Everett L. Headrick, Agricultural Program Assistant, USAID

John Schnautz, Veterinary Advisor, USAID

L. Larson, Livestock Advisor, USAID

Edward Kiefer, Agricultural Marketing and Processing Advisor, USAID

D. W. MacGregor, Veterinary Officer, Department of Agriculture & Forest Resources, Northern Region

R. Davis, Veterinary Officer, Veterinary Field Station, Tsetse Center, Mando Road, Kaduna

August 25

**Vom, Nigeria**

A. L. C. Thorne, Acting Director, Federal Veterinary Research Service, Vom, Northern Nigeria

K. Nixon, Assistant Director, Federal Veterinary Research Service

Victor Smith, Federal Veterinary Research Service
Robert Harris, West African Institute for Trypanosomiasis Research (WAITR)

H. T. B. Hall, Acting Director, Livestock Assistant's School, Vom

August 26-27

Kano, Nigeria

H. E. M. Hammam, Assistant Secretary, Ministry of Agricultural & Forest Resources, Northern Region

Harold J. Brooks, Livestock Advisor, USAID

Channing J. Frederickson, Entomology Advisor, USAID

Daniel Stewart, Tsetse Fly Control Officer, USAID

August 28-29

Ibadan, Nigeria

Charles Coleman, Veterinary Advisor, USAID, Eastern Region

Charles Fry, FAO

August 31

Accra, Ghana

H. E. Krobo Edusei, Minister of Agriculture, Accra

William Spooner, Program Officer, USAID

Jack Walker, Livestock Advisor, USAID

Achew Frempong, Chief, Animal Health Officer

K. O. Gyening, Chief Veterinary Officer

Cecil Jackson, Director, Ghana Academy of Sciences

M. Irfan, Principal Research Officer, Ghana Academy of Sciences

K. H. Sappe, Assistant Secretary, Ghana Academy of Sciences

E. M. W. Oppong, Veterinary Officer, Ghana Academy of Sciences
September 2-5

Bamako, Mali

Hon. William J. Handley, U.S. Ambassador to Mali, Bamako

M. Kouyate, Deputy Minister Development, Bamako

I. Konate, Director Livestock Development, Bamako

Marvin Goff, Veterinary Advisor, USAID

Felix Lapinski, Program Officer, USAID

Thomas Bond, Veterinary Advisor, USAID

M. Leipsig, Chief Engineer, Abattoir Construction Project (EEC)

September 7-9

Dakar, Senegal

H. E. Karim Gaye, Minister of Rural Economy, Dakar

H. E. Iboa N'Gom, Deputy Director of Livestock Services, Ministry of Rural Economy, Dakar

Charles Adams, Second Secretary, U.S. Embassy, Dakar

P. C. Morel, Chief of Entomology Service, Hann Laboratory

B. Guilloteau, Hann Laboratory

M. Chambeau, Chief, Microbiology Section, Hann Laboratory

September 10

Paris, France

Henri Lepissier, Director, JP 15, Ouagadougou

Denis Baron, AID Coordination Officer, American University
APPENDIX B-1

ADVISORY COMMITTEE ON AFRICA

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APPENDIX B-2

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Cornell University  
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Dr. T. C. Byerly, Chairman, Division of Biology & Agriculture, NAS-NRC

Dr. C. W. de Kiewiet, Chairman, Advisory Committee on Africa, NAS-NRC

Staff:

Dr. Wilton S. Dillon, Head, African Affairs Section, Office of the Foreign Secretary, NAS
Map 3 - Project 15 - Rinderpest Control - Initiation of Phases

- Phase I October 1962
- Phase II October 1964
- Phase III October 1965
Map 4 - AVERAGE ANNUAL RAINFALL: AFRICA

LIVESTOCK AND MEAT MARKETING IN AFRICA
Report of a survey by H. J. Mittendorf and S. G. Wilson, special FAO consultants and the Centre at Fort Lamy, Chad, 5-22 December 1960 -- Rome -- March 1961
APPENDIX D

Some Educational and Training Institutions in West Africa

Cameroun

Universite Federale - Yaounde
Ecole Nationale d'Agricultura

Central African Republic

Ecole Centrale d'Agricultura, Boukoko
Ecole Territoriale d'Agricultura, Grimari

Gabon

Ecole Territoriale d'Agricultura, Oyem

Ghana

Ghana Academy of Sciences Entomological and Parasitological Research Unit, Achimota

University of Ghana Faculty of Agriculture, Department of Animal Science, Accra

Kwame Nkrumah University of Science and Technology, Faculty of Agriculture, Kumasi

Veterinary Training Institute, Pong Tomale

Guinea

Universite de la Guinea et du Mali, Conakry

Ivory Coast

Institut d'Enseignement et de Recherches Tropicale d'Adiopodoume, Department of Agriculture and Medical Entomology, Abidjan

Universite d'Abidjan, Faculty of Science, Department of Animal Biology, Abidjan

Liberia

University of Liberia, College of Agriculture
Monrovia

Booker Washington Agricultural and Industrial Institute, Kakata

Cuttington College and Divinity School, Department of Agricultural, Suacoco

Mali

Animal Health Assistant School (to be established)
Bamako

Nigeria

University of Ibadan, Faculty of Agriculture, Ibadan
Nigeria (continued)

University of Ife, Department of Agriculture
University of Nigeria, Faculty of Science, Nsukka
Ahmadu Bello University, Faculty of Veterinary Science, Zaria
Federal Veterinary Research Service, Animal Technical School, Vom
School of Agriculture, Akure
School of Agriculture, Moore Plantation, Ibadan
AID Agricultural Technical School, Kaduna

Niger

Animal Health Assistant School (to be established) Niamey

Senegal

Laboratoire Nationale de Recherches Veterinaire Dakar-Hann
Station de Recherches Zootechniques du Djoloff, Dara
Universite de Dakar, Faculty of Veterinary Medicine, Dakar

Sierra Leone

Njala University College, Njala
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