ILRAD

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ILRAD

INTERNATIONAL LABORATORY FOR RESEARCH ON ANIMAL DISEASES

PROGRAM AND BUDGET

1986

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1986 PROGRAM AND BUDGET

This Program and Budget for 1986 was prepared by ILRAD staff and management and was approved by the Board of Directors at their annual meeting in Nairobi on 29 March 1985.

This proposal constitutes a formal request to the Consultative Group on International Agricultural Research for donor support for 1986.

W R Pritchard
Chairman
Board of Directors

1986 PROGRAM AND BUDGET

Contents

		page
1.	Statement of objectives	7
2.	Current stage of development	9
3.	Summary of activities	10
4.	1984 performance	20
5.	1985 prospects	22
6.	1986 budget request	24
7.	Special program and budget considerations	25
8.	Comments on the core program for 1985 and 1986	26
9.	Special projects	31
10.	Capital requirements	33
11.	Assumptions on price changes	33
Appendix:	Tables	34

1. STATEMENT OF OBJECTIVES

The International Laboratory for Research on Animal Diseases (ILRAD) has the mandate to develop safe, effective and economically feasible control measures for livestock diseases which seriously limit world food production. Two parasitic disease complexes of major economic importance in many developing countries were chosen by the Consultative Group on International Agricultural Research (CGIAR) as the original focus of ILRAD's research program. These are trypanosomiasis and theileriosis, particularly East Coast fever.

East Coast fever (ECF) is a cattle disease which causes substantial losses in East and Central Africa. This form of theileriosis is caused by the protozoan parasite *Theileria parva parva*, which is transmitted by the brown ear tick *Rhipicephalus appendiculatus*. Mortality due to ECF is estimated at 500,000 animals per year. Other pathogenic *Theileria* species are a serious constraint on livestock production in extensive areas of North Africa, Asia and the Middle East.

ECF is controlled primarily by dipping or spraying cattle with acaricides to kill the tick vectors. Proper pasture management helps keep tick populations low, and fencing and movement controls keep susceptible animals away from other cattle or wild buffalo which may carry the disease. However, in areas of heavy tick infestation, cattle must be dipped or sprayed as often as twice a week to prevent infection. A drug to cure ECF was introduced on the market in 1983. Yet neither frequent dipping in acaricides nor regular drug treatment is feasible for many African livestock producers, and tick resistance to currently available acaricides is potentially a serious problem.

The prospects for developing an ECF vaccine appear promising, since cattle which recover from natural or experimentally-induced infections show long-lasting immunity to the same or similar *Theileria* strains, even when the initial infection is mild. However, the epidemiology of ECF is complex, especially when buffalo are present as disease carriers, and parasite strains need to be isolated and characterized and cross-immunity patterns determined. The major objective of ILRAD's theileriosis program is to develop better alternatives to experimental immunization procedures which only protect against one or a small number of strains and which require the use of fully virulent parasites.

Different forms of trypanosomiasis occur over large areas of Africa, Latin America and the Middle East, affecting most types of domestic livestock, several wildlife species and man. In Africa, the major pathogenic species of trypanosomes for domestic ruminants are *Trypanosoma congolense*, *T vivax* and *T brucei brucei*. These are transmitted by several species of tsetse fly (*Glossina* spp) or occasionally by other biting flies. Trypanosomiasis occurs over about 10 million km^2 in tropical Africa, or roughly one-third of the continent. Affected areas often have relatively high rainfall and considerable potential for animal and crop production, but due to trypanosomiasis very few ruminants are actually produced, and arable farming is limited by the absence of draught animals. Trypanosomiasis in livestock may also play a role in the epidemiology of the human disease.

At present, measures available to control trypanosomiasis include regular treatment with trypanocidal drugs and reduction of tsetse populations by insecticide spraying. However, both of these approaches are expensive and neither is completely effective in areas of heavy tsetse infestation, high rainfall or dense vegetation. Further drawbacks include increasing drug resistance and the possibility of environmental pollution due to large-scale insecticide spraying. ILRAD's goal is to develop and introduce alternative control methods which are cheaper, more effective and without negative side effects.

Research to date indicates that immunological control of trypanosomiasis will be difficult. The epidemiology of the disease is complex, with animals often exposed to more than one species of trypanosome and to a large number of strains within each species. In addition, the parasites possess a unique ability to change the antigenic composition of their surface coat, so that trypanosomes of one strain may display a large repertoire of different surface antigen types. An infected animal cannot produce antibodies rapidly enough to match them all. This phenomenon - called antigenic variation - is the main reason why domestic livestock do not recover from trypanosomiasis or develop a natural immunity. It is also the main reason why it has not yet been possible to produce a trypanosomiasis vaccine. Research at ILRAD is concerned with several possible avenues of trypanosomiasis control, including studies of the parasites themselves, studies of the responses of different hosts and how useful host responses might be enhanced, and studies of trypanosomiasis epidemiology at several sites in Africa.

In addition to research on ECF and trypanosomiasis, ILRAD conducts an active training program. Training at ILRAD is designed to support the development of scientific and field personnel who can extend research on trypanosomiasis, theileriosis and other pressing veterinary problems - primarily in Africa but also in other parts of the world. Scientists and technicians are trained to carry out the most effective disease control programs possible with the means currently available. At the same time, they are prepared to initiate new field programs when improved control methods are ready for introduction.

2. CURRENT STAGE OF DEVELOPMENT

ILRAD's research program is organized in six project areas, each with a specific disease-control objective. Research results are disseminated through the training and outreach program to national and regional institutes concerned with control of animal diseases in anglophone and francophone Africa and throughout the world.

The research laboratories and supporting facilities at Kabete are largely complete and equipped to support a full complement of scientists. Only minor alterations and some new equipment are required as laboratory functions and needs change.

In addition to facilities for its own staff, ILRAD provides offices for the regional staff of four other CGIAR centres. As this was not considered in the original building plans, additional offices had to be provided by the conversion of existing storage buildings and the lease of one of ILRAD's staff houses. The present arrangement is still inadequate, and the number of regional staff from other CGIAR centres continues to increase. Consideration must be given to the construction of an additional office block to accommodate regional staff of other centres, as well as the increased needs of ILRAD's training and outreach program.

A 13,000-hectare cattle breeding ranch was purchased late in 1981, located on the Kapiti plains about 80 kilometres from Nairobi. The ranch was purchased to assure the supply of cattle for experimental work at ILRAD, and it has been providing calves and steers for ILRAD's research program since February 1982. Certain facilities on the ranch have had to be renovated or remodeled to meet the new production requirements. Most of the urgent work has been completed, but more staff housing and fencing are needed.

In 1983, ILRAD prepared a plan of research activities and priorities for the next decade. This provides the rationale for the research plans outlined in the program and budget documents, and will serve as a yardstick for measuring progress towards ILRAD's research goals. The plan will be revised, if necessary, to accommodate the recommendations of ILRAD's second External Program Review (EPR) which is scheduled to take place early in 1986. At present, no major expansion of ILRAD's scientific staff or research facilities is foreseen or any alteration in current research goals.

3. SUMMARY OF ACTIVITIES

THEILERIOSIS

Research at ILRAD has shown that cattle recovered from ECF infections produce antibodies which are capable of neutralizing the infectivity of *T p parva* sporozoites, the form of the parasite transmitted to cattle by infected ticks. Further studies have shown that the majority of such protective antibodies are of the IgM class of the bovine immunoglobulins. Cattle immunized at ILRAD with dead sporozoites in combination with different adjuvants also produce neutralizing antibodies. When challenged with a large number of infective sporozoites, these cattle survive considerably longer than non-immunized controls.

Progress has been made in 1984 in the biochemical characterization of the sporozoite antigens which are potentially responsible for inducing protective immune responses in cattle. Genetic sequences which code for parts of the relevant antigens have also been identified in the parasite DNA and, in one case, the protein coded for by an isolated gene sequence has been shown to induce the formation of sporozoite-neutralizing antibodies in laboratory animals. Work will continue to characterize the sporozoite antigens which could induce protective immunity in cattle, to isolate the genetic material coding for these antigens and to produce sufficient amounts of the relevant proteins using recombinant DNA technology to carry out vaccine trials in cattle.

ILRAD scientists are also studying the immune responses of cattle to the intracellular schizont form of the parasite. Schizont-infected cells are predominantly thymus-derived cells of the immune system. In clinical cases of ECF, these cells multiply rapidly and the terminal stage of the disease is characterized by massive destruction of these and other cells, which is thought to be by immunological mechanisms In immune animals, destruction is restricted to parasitized cells.

Scientists are working to elucidate the mechanisms responsible for the destruction of parasitized cells and to assess the feasibility of inducing such protective responses by immunizing with isolated parasite components. A major obstacle has been the lack of basic knowledge of the cellular components of the bovine immune system and how they interact to mount protective immune responses. Considerable progress has been made in this area. Reagents are now available which identify subpopulations of the bovine lymphoid system, as well as the bovine histocompatibility antigens which determine 'self' on the surface of cells.

An important achievement in 1984 was the development of techniques to maintain cloned populations of bovine thymus-derived lymphocytes *in vitro*. This technique makes it possible to study immune responses to schizont-infected lymphocytes *in vitro* by providing non-infected cells as a basis of comparison. Particular interest focuses on parasite-induced changes on the surface of infected lymphocytes which immune cells of the same histocompatibility type recognize as 'foreign' and against which they mount a protective immune response.

The same technology will also allow analysis of the functional significance of the various subpopulations of lymphocytes for which there are already serological typing reagents. The ability to analyse the mechanisms by which protective immune responses are induced and controlled in cattle and to transfer parasite genes into cloned cell lines now makes it possible to determine the feasibility of developing an effective vaccine based on the schizont stage of *T p parva*.

At present cattle can be immunized in the field by infection with sporozoites and simultaneous treatment with a long-lasting oxytetracycline antibiotic. This approach offers the most immediate possibility of improved disease control while work continues on the development of a safe and effective vaccine using non-infective parasite material. Standardized protocols for immunization by sporozoite infection and antibiotic treatment are being developed and tested in different field situations and the potential economic benefits of this approach are being assessed.

Immunity induced by infection and treatment is parasite strain-specific, so effective immunization requires the identification of the parasite strains present in a specific field situation. Research continued in 1985 to improve *in vitro* methods for characterizing *T p parva* strains based on monoclonal antibody recognition of intracellular schizont antigens. The present *in vitro* assay gives good correlation with protection induced *in vivo*. Parasite strains from Kenya, Uganda, Rwanda, Zambia, Malawi and Zimbabwe have been characterized and these defined strains have been used in immunization trials in Kenya, Zambia and Malawi. A significant finding in 1984 was that parasite populations isolated from some locations are not genetically homogeneous. This could explain why isolates from certain locations apparently give broad protection against different strains when used to immunize cattle.

T p lawrencei, is a *Theileria* subspecies found in buffalo which causes acute disease when transmitted to cattle. Earlier observations indicated that this subspecies has a much wider repertoire of strains that *T p parva*. Studies in 1984 continued to define and explore this diversity. In some cases, it has been shown that what were previously thought to be isolates of *T p lawrencei* contain both *T p lawrencei* and *T p parva* populations. Work continues to develop methods for characterizing *T p lawrencei* strains and obtain cloned material from both *T p parva* and *T p lawrencei* populations. The derivation of cloned parasite populations and the analysis of specific cell-mediated immune reactions *in vitro* should allow precise definition of the antigenic repertoire of both *Theileria* subspecies.

TRYPANOSOMIASIS

The tsetse-transmitted metacyclic stage of the trypanosome lifecycle is potentially of considerable importance in the induction of protective immunity in the mammalian host. Work continues at ILRAD to develop and standardize *in vitro* culture systems to provide adequate

numbers of this form of the parasite for immunological and biochemical research. Efficient culture systems have been established for *T congolense* and two novel techniques have now been developed to obtain metacyclic forms of *T vivax in vitro*.

An important observation has been that metacyclic forms of *T vivax* obtained either from infected tsetse flies or *in vitro* cultures have a coat of protein on their surface, presumably made up of variable surface antigen similar to that present on metacyclic forms of *T brucei* and *T congolense*. Previous observations had suggested that metacyclic forms of *T vivax* might not have a surface antigen coat, which would imply that the development of a vaccine against metacyclic forms of this parasite would be comparatively simple. Observations of coated metacyclic forms of *T vivax* explain the failure of previous experiments to devise a simple vaccine. The problems of immunizing against metacyclic forms of *T vivax* now appear comparable to those described previously for immunization against metacyclic forms of *T brucei* or *T congolense*.

The capacity for antigenic variation enables the parasite to change the antigens which comprise its surface coat and thus avoid the lethal effects of host protective immune responses. This process is fundamental to parasite survival. In collaboration with the Molteno Institute of Cambridge University (UK) and the Vrije Universiteit Brussels (Belgium), analysis of the genetic mechanisms involved has shown that similar events are associated with surface antigen change in *T brucei* and *T congolense*. However, variable antigen gene rearrangements are apparently less complex in *T congolense* than in *T brucei*, which may indicate that *T congolense* parasites have a smaller repertoire of variable antigens than *T brucei*. This requires further study.

One explanation for the complexity of variable antigen gene rearrangements in *T brucei* is that genetic material may be exchanged between different strains of the parasite during development in the tsetse fly. A collaborative study with the Swiss Tropical Institute has shown that such an exchange can occur. Hybrid metacyclic forms were produced whose variable surface antigens differed from those of the metacyclic forms of the parental strains. If such recombinant events occur with significant frequency in the field, the immunological control of *T brucei* spps will be extremely complex. Studies are now in progress to determine whether such genetic recombination events can also occur in *T congolense* infections in the tsetse fly.

The stages involved in the biochemical synthesis of the variable surface antigens of *T brucei* have been largely elucidated and the parasite organelles have been identified where antigen synthesis and processing take place. The way in which the variable antigens are inserted and removed from the surface of the trypanosome are now being investigated in collaboration with the Molteno Institute. The search continues for parasite-specific processes which could offer a suitable target for immunological or chemical attack.

Parasite antigens which do not change and are species specific have been isolated, and highly specific monoclonal antibodies have been raised against these antigens which have been used to develop

improved diagnostic techniques. This method detects active trypanosome infections at greater levels of sensitivity than is possible with conventional microscopic techniques. Parts of the parasite genomic DNA which are species specific have also been identified and used in new diagnostic assays. Studies are now being undertaken to develop diagnostic tests based on genetic material which do not require the use of radioactive compounds. In 1985 and 1986, efforts will be intensified to develop these techniques for practical use in the diagnosis of trypanosomiasis.

Research is also in progress to elucidate the innate and acquired mechanisms of resistance to trypanosomiasis in domestic ruminants, wild animals and laboratory animals. Evidence continues to accumulate indicating that parasite development in the mammalian host is closely linked with the ability of the host to mount protective immune responses. Several *in vitro* systems have been developed to investigate the host factors used by trypanosomes as signals or substrates in their development process. One possibly important group of host compounds is thought to be carbohydrate or proteoglycan and other potentially important compounds are being analysed.

The analysis of the immune responses of susceptible and resistant laboratory rodents has indicated that susceptibility is associated not with a failure of the immune system to recognize parasite antigens and synthesize antibodies, but rather with some parasite-dependent inhibition of antibody-producing immune cells from actually secreting protective antibodies into the circulation. When such cells are removed from infected animals and maintained *in vitro*, they rapidly recover their function and secrete immunoglobulins. The nature of this secretory block is being investigated and evidence is being sought for a similar phenomenon in resistant and susceptible domestic ruminants and wild animals. The availability of 10 N'Dama calves at ILRAD, obtained as embryos from The Gambia, will facilitate the elucidation of mechanisms of resistance.

The presence of trypanosome infection in a mammalian host sometimes precludes the establishment of a second infection in the same animal and in some cases even suppress the inflammatory lesion which normally develops in the skin at the site of an infected tsetse bite. This phenomenon, termed 'interference', is being investigated to establish which host or parasite factors produced by the initial infection prevent the establishment of a second infection. These studies are being carried out in collaboration with the University of Edinburgh's Centre for Tropical Veterinary Medicine (UK).

The severity of the clinical and pathological manifestations of trypanosomiasis vary in different host/parasite combinations. Studies continue to elucidate which parasite products are responsible for anaemia and other pathological signs of the disease. Two groups of parasite enzymes have been identified which may be involved in the development of anaemia through their effect on the membrane of host red blood cells. A collaborative study with the University of Edinburgh also concentrates on the effects of trypanosomiasis on the reproductive capacity of cows.

A major component of the epidemiology programme continues to be the collaborative study with the International Livestock Centre for

Africa (ILCA) on the productivity of trypanotolerant livestock under different levels of tsetse challenge at various sites in West and Central Africa. ILRAD staff provide training and supervision in the areas of animal health and entomology. ILCA/ILRAD network sites are currently in operation in Gabon, Zaire, Nigeria and Ivory Coast and possibilities exist to expand the operation to Benin and Togo. A major study on the health and productivity of trypanotolerant cattle is starting in The Gambia in collaboration with the International Trypanotolerance Centre and supported by the European Economic Community (EEC). In Kenya, ILRAD is gathering information at two sites in Coast Province on the role of acquired immunity to metacyclic trypanosomes and the influence of drug treatment on disease transmission and the acquisition of immunity.

A collaborative study is in progress with the University of Glasgow (UK) to define, under experimental conditions, the relationship between prophylactic treatment with trypanocidal drugs and the development of acquired immunity to trypanosome infections. Initial results suggest that no immunity is developed to the variable surface antigens of metacyclic trypanosomes during the period in which a trypanocidal drug is actively preventing the establishment of infection.

Work continues on the improvement of techniques for identifying the animal species from which a tsetse fly has taken a blood meal. Analysis of tsetse blood meals has been provided as a service to the tsetse research programme of the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi.

TRAINING

ILRAD's training activities include individualized training programs for scientists and technicians, post-graduate training for students working towards master's and doctoral degrees, and post-doctorate positions for young scientists. A number of training courses and conferences are also held each year. The emphasis is primarily on developing veterinary research and implementation capabilities in African countries where trypanosomiasis and theileriosis are important animal health problems. Altogether, training activities account for over 7% of ILRAD's total budget.

Participants in ILRAD's training program work closely with the scientific staff. In 1984, 25 scientists and technicians came to ILRAD for specialized training for periods from 1 week to 9 months. Their training programs were planned on an individual basis according to the needs of their home institutions. Twenty-three of these scientists and technicians came from African countries. Two who were self-sponsored came from the USA.

Students work as Research Fellows at ILRAD to fulfill requirements for a post-graduate degree. In 1984, 16 Research Fellows from 9 different countries worked with the scientific staff on projects closely linked to ILRAD's research programs. In addition, 6 Visiting Research Fellows worked at ILRAD for periods of 2 to 6 months. Out of 22 post-

graduate students, 16 came from African countries and 6 from Europe. The students from Africa were supported fully or partially by ILRAD, while the European students were supported by funds from their home countries.

Post-Doctoral Fellows are selected on an international basis. They normally spend 2 years at ILRAD, with their work contributing directly to the research program. In 1984, 13 Post-Doctoral Fellows were working at ILRAD.

In addition to training activities for individuals, ILRAD conducted five training courses in 1984. A 4-week training course was held in May and June on the diagnosis of haemoprotozoan diseases with emphasis on trypanosomiasis. The course included a review of basic biochemical and immunological concepts and practical instruction on how to produce antibodies, isolate and purify immunoglobulins, assess specificities and prepare antigens. Seventeen participants took part in the course from 12 African countries.

A second 4-week course, held in June in Bobo-Dioulasso, Burkina Faso, covered the same material in French. This course was cosponsored by ILRAD, the Centre de Recherches sur les Trypanosomoses Animales and the Ecole de Lutte anti-Tsétsé. Eleven French-speaking participants attended from 10 African countries.

Two 6-week courses were held at ILRAD in April/May and October/November 1984 to train field staff working with the ILCA/ILRAD trypanotolerance research network in Kenya, Nigeria, Somalia, Gabon, Togo and Zaire. Six participants took part in the first course, which was conducted in English, and five participated in the second course conducted in French. Both courses concentrated on the diagnosis and control of trypanosomiasis, helminthiasis and tick-borne diseases.

Six participants attended a 3-month course conducted at ILRAD on the preparation and use of reagents for the diagnosis of haemoprotozoan diseases in cattle. All were from African countries.

An international workshop was held in October 1984 to discuss the implementation of ECF immunization programs in East and Central Africa, sponsored jointly by ILRAD and the Food and Agriculture Organization (FAO) of the United Nations. Eighty participants attended, including senior government officers concerned with the control of livestock diseases in Burundi, Kenya, Malawi, Mozambique, Rwanda, Sudan, Tanzania, Uganda, Zaire, Zambia and Zimbabwe. After hearing reports on the incidence and importance of theileriosis in different countries, the participants discussed the results of field trials and presented papers on different approaches to immunization against ECF and related problems and needs. Participants from most of the countries represented agreed to initiate or extend field trials, and results will be compared through an information network which will promote the regular exchange of data, materials and expertise.

Two ILRAD scientists gave a series of lectures on trypanosomiasis and ECF to final-year veterinary students at the Universidade Eduardo Mondlane in Maputo, Mozambique in November 1984 as part of a seminar sponsored by FAO. ILRAD scientists also worked with staff from the Institut de Recherche Agronomique et Zootechnique in Burundi to assess

the training needs of government officers from Burundi, Rwanda and Zaire in the field of veterinary epidemiology.

INFORMATION SERVICES

ILRAD's information services concentrate on publication and distribution of the annual report and the quarterly newsletter, *ILRAD Reports*. Both of these publications are prepared in English and French.

Four issues of *ILRAD Reports* were published in 1984, with major articles on in vitro cultivation of trypanosomes, electron microscopy studies focusing largely on *Theileria*, research on tsetse flies as trypanosomiasis vectors, and an intensive study on haemorrhagic *T vivax*. Shorter articles described other research activities and conferences held at ILRAD.

Members of ILRAD's scientific staff published 33 articles in international journals and 3 chapters in scientific books in 1984. These scholarly publications, plus numerous papers presented at international conferences, comprise the bulk of ILRAD's information output for specialized scientific audiences. Considerable effort has been directed towards ensuring the distribution of these publications. A brochure, *Scientific publications from ILRAD: 1982-83 update*, was produced in 1984, listing articles and chapters published by ILRAD staff members and giving information on how they may be obtained. This brochure has been widely distributed, and reprint requests are now received regularly, particularly from scientists and libraries in Africa.

The annual report and quarterly newsletter are intended for less specialized readers, with emphasis on animal health workers in laboratories and field situations around Africa. In addition, *ILRAD Reports* and occasional short press releases are distributed to journalists in many parts of the world.

The ILRAD library is used by staff members, visiting scientists and participants in the training program. The collection is also made available to staff of other research institutes, government departments and universities. A brochure, *The ILRAD library: user's guide*, was published in 1984, describing the organization of the library and the collection of books and journals available. This brochure has been widely distributed, particularly to appropriate institutions in the Nairobi area.

The ILRAD library participates in an interlibrary loan network, along with the University of Nairobi, the Kenya Government's Veterinary Research Laboratory, the Veterinary Research Department of the Kenya Agricultural Research Institute, the Ministry of Health and ICIPE. Requests for back issues of journals are often filled by members of the network with older libraries, while ILRAD, in turn, can supply current issues of many periodicals which are not available anywhere else in Kenya.

During the year, a major effort was made to improve current awareness services to ILRAD staff. New accessions are listed every week in ILRAD's *Internal Newsletter*, and monthly selective dissemination of information services have been initiated in cooperation with ILCA and FAO. Computer-based literature searches are also carried out using specialized agents in Europe.

RESEARCH SUPPORT

Tsetse laboratory

Seven tsetse breeding colonies were maintained at ILRAD during 1984, representing the three major taxonomic groups *morsitans, palpalis* and *fusca*. The species and subspecies maintained were *Glossina morsitans centralis* originating from mainland Tanzania, *G austeni* from Zanzibar, *G palpalis palpalis* from Nigeria, *G p gambiensis* from Burkina Faso, *G fuscipes fuscipes* from the Central African Republic, *G tachinoides* from Chad and *G brevipalpis* from Kenya. All are important vectors of trypanosomiasis.

Tsetse flies are supplied for a variety of trypanosomiasis research projects at ILRAD. In addition, tsetse puparia and adult flies were supplied in 1984 to colleagues at the Kenya Trypanosomiasis Research Institute, the Kenya Agricultural Research Institute, the University of Nairobi, the National Council for Scientific Research in Zambia, the Institut de Médecine Tropicale in Belgium and the Swiss Tropical Institute.

Tick laboratory

The tick laboratory provides infected and uninfected ticks, tick salivary glands and other organs and tick-derived *T p parva* sporozoites for a wide range of *Theileria* research activities at ILRAD. Breeding colonies of six tick species and several strains are maintained. The most important of these is the theileriosis vector, *Rhipicephalus appendiculatus*, with colonies of 400,000 to 600,000 nymphs. These include populations of *R appendiculatus* (Muguga), a well-established laboratory colony, *R appendiculatus* (Uganda) and several populations derived from ticks isolated in different parts of Kenya.

A colony is maintained of 150,000 to 200,000 *Amblyomma variegatum* nymphs, derived from ticks isolated in various parts of Kenya. This species is the vector for *Theileria mutans, T velifera* and *Cowdria ruminantium*. Smaller colonies are maintained of *Amblyomma gemma, Boophilus decoloratus* - which transmits *Babesia bigemina* and *Anaplasma marginale* -, *Rhipicephalus evertsi evertsi* and *R pulchellus*.

Altogether, more than 3.5 million ticks were used in 1984. In addition to supporting research projects at ILRAD, the tick laboratory provided assistance and supplied tick material to the Kenya Government's Veterinary Research Laboratory, the Kenya Agricultural Research Institute, the Kenya Trypanosomiasis Research Institute, ICIPE, the ILCA/ILRAD trypanotolerance research network and an acaricide resistance project sponsored by FAO.

Farm animal production

ILRAD's research program requires a reliable supply of cattle, sheep and goats. Because *Theileria* parasites do not infect small ruminants or laboratory rodents, nearly all research on ECF is carried out in cattle. In 1984, 70% of the cattle required for experimental work at ILRAD were used for ECF research.

ILRAD's ranch at Kapiti provides most of the cattle required for the research program. In 1984, the ranch supplied 242 Boran calves, 49 Guernsey calves and 45 Boran steers. The breeding herd at the end of the year comprised 1700 Boran cows and heifers, plus 160 Guernsey cows and heifers. The number of heifers of both breeds increased substantially over the year, although livestock production was difficult throughout Kenya in 1984 because of severe drought. The herd at Kapiti was maintained by supplementation with purchased feeds, which was expensive, but nearly all the animals survived.

Scientists used 373 goats and 10 sheep in 1984, almost all for trypanosomiasis research. Most of the small ruminants were purchased from farms in different parts of Kenya.

ILRAD scientists have participated in field studies since 1976 focusing on the resistance to trypanosomiasis exhibited by West African N'Dama cattle. An embryo-transfer project was initiated at the end of 1982, aimed at bringing a small number of these animals to ILRAD for more detailed research. Embryos from N'Dama cows were deep frozen and shipped to Kenya. These were surgically transferred into Boran heifers in June 1983, and 10 N'Dama calves were born on the ILRAD farm in March and April 1984. The 5 N'Dama heifers and 5 bull calves remained with their Boran 'foster mothers' for 5 to 7 days and were then transferred to the calf rearing unit. They have remained healthy and show good growth rates, with liveweights ranging from 58 to 83 kg at 6 months of age.

Laboratory animal production

The laboratory animal unit maintains breeding and production colonies of mice, rats and rabbits, plus small colonies of guinea pigs, gerbils and meadow voles (*Microtus montanus*). The goal is to provide all the laboratory animals required for ILRAD's research programs with a minimum of wastage.

Random-bred rats maintained at ILRAD originate from the Sprague Dawley strain. They are used primarily for the production of trypanosomes. Four inbred strains of mice which vary in their susceptibility to trypanosomiasis are used to study the mechanisms of resistance to the parasites. In 1984, two strains of athymic nude mice were imported as well as inbred beige mice. They were purchased for specific experiments, but if they prove useful breeding colonies will be established.

Rabbits are used to produce antisera and to support ILRAD's tsetse fly and tick colonies. Efforts to achieve self-sufficiency in rabbit production have been frustrated by outbreaks of *Staphylococcus aureus*, and rabbits still have to be purchased from outside sources.

In addition to supplying nearly all the laboratory animals used at ILRAD, the breeding unit provides mice, rats and gerbils to several other organizations in Kenya. In 1984 these included ICIPE, the University of Nairobi's Departments of Zoology, Biochemistry, and Pharmacology and Toxicology, the African Medical Research Foundation, The Kenya Medical Research Institute, the Kenya Trypanosomiasis Research Institute, the Institute of Primate Research, the National Museums of Kenya, the Kenya Society for the Protection and Care of Animals and 53 secondary schools.

Clinical and diagnostic services

The diagnostic laboratory provided 30,082 analyses in 1984, as required by ILRAD's research programs and animal production facilities. These comprised serological, bacteriological, haematological and helminthological analyses - altogether, an 11% increase over the number of samples analysed in 1983. A considerable proportion of this diagnostic work was carried out in support of East Coast fever immunization trials and studies on trypanosomiasis epidemiology.

A new method was developed to harvest and purify *Anaplasma marginale* organisms from the red blood cells of infected cattle. Monoclonal antibodies have been used to prepare a soluble antigen from these organisms which is now used with the ELISA to detect *A marginale* antibodies in bovine sera collected in the field.

In addition to collaboration and services provided to ILRAD staff, the diagnostic laboratory continues to provide reagents and training to other laboratories and projects in developing countries. In 1984, *Theileria*, *Trypanosoma* and *Anaplasma* antigens and antibovine conjugates were provided to the Laboratoire vétérinaire Lubumbashi in Zaire, an FAO/ILRAD collaborative project in Zimbabwe, FAO and German (Federal Republic) projects in Burundi, a USAID (United States Agency for International Development) project at the Kenya Agricultural Research Institute, FAO projects in Zambia and Mozambique and a World Health Organization (WHO) project in Zambia. ILRAD's diagnostic laboratory also analysed 1,283 serological samples for the Ministry of Agriculture and Livestock Development in Kenya and for FAO projects in Kenya and Tanzania.

4. 1984 PERFORMANCE

Table 1. 1984 BUDGET SUMMARY (US $'000)

	1983 Actual	1984 Final Revised	1984 Actual
Core operations	8326	9235	8481
Contingency	31	100	10
Capital	835	570	482
Total	9192	9905	8973
Less: funds brought forward	(1062)		
earned income	(128)	(200)	(255)
Net requirement	8002	9705	8718
Received	7980		9137

For the first time since 1981, ILRAD entered the 1984 financial year with no unexpended core funds to be carried forward. A substantial increase in donor funds was needed to meet financial needs for the year. Revenues increased by US $1.1 million over 1983 levels, but this was still well below anticipated needs. Most of the increase was due to funding provided by the World Bank (International Bank for Reconstruction and Development - IBRD). Because it was anticipated that the full funding request might not be met, expenditures were carefully controlled and were US $1 million less than the final revised budget. As a result, there was a balance of US $419,000 at the end of the year.

Direct research and research support costs accounted for 59% of total expenditures. These included not only the costs of operating the research laboratories, but also the costs of raising and maintaining experimental animals and providing other essential support services. The Training Department accounted for 7.5% of total expenses, which was the same level as in 1983. General administration and general operation costs were 24% of total expenditures.

Inflation in Kenya continued at approximately 15% in 1984, but this was offset by a steady decline in the value of the Kenya shilling against the US dollar. The shilling was not officially devalued during the year, but overall depreciation was about 12%. Slightly over 50% of ILRAD's total revenue was spent in Kenya. The strength of the US dollar against other currencies produced an income loss of US $111,000 compared with pledged donor support during the year.

A breakdown of capital expenditures for construction and equipment is given in Table A-1. A total of US $58,000 was used for capital development at ILRAD's ranch - Kapiti Plains Estate Limited. This expenditure will be converted into additional shares in the ranch, which is a subsidiary corporation.

ILRAD continued to provide office space for regional staff of four other centres in the CGIAR - the Centro Internacional de la Papa (CIP), the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), the International Board for Plant Genetic Resources (IBPGR) and ILCA. The expansion of their activities, as well as ILRAD's, has resulted in considerable pressure on office space.

5. 1985 PROSPECTS

Table 2. 1985 BUDGET SUMMARY (US $'000)

	1984 Actual	1985 Final Revised
Core operations	8481	9350
Contingency	10	10
Capital	482	313
Total	8973	9673
Less: funds brought forward		(419)
earned income	(255)	(150)
Net requirement	8718	9104
Received	9137	

The 1985 final revised budget follows the budget approved by the CGIAR in October 1984 for the bottom of the bracket and with further downward adjustments for lower inflation estimates. Total program costs are expected to be US $9.7 million.

ILRAD entered the year with $419,000 in unused funds from 1984. The laboratory hopes to continue to increase its base of donors in 1985 and should be able to obtain the funds required for operations at the bottom of the bracket.

The effects of inflation in Kenya, where approximately 50% of ILRAD's funds are spent, were reduced in 1984 by the decline in value of the Kenya shilling against the US dollar. However, currency fluctuations are difficult to anticipate and a combination of inflation plus local currency appreciation could cause a considerable increase in costs during the year.

Research and research support costs will increase by 5% in 1985 over 1984 levels and will account for 58% of total expenditure. There are no major changes in individual cost centres. Expenditures for the Parasitology/Trypanosomiasis Laboratory and the Immunobiology Laboratory will increase because of added staff. Certain other units will have lower costs. Overall, one additional senior manyear is planned for 1985.

Expenditures for training and conferences should increase substantially over 1984 levels as more training activities are implemented. General administrative and operating costs will increase by US $160,000. There have been no real increases in administrative and operating costs in the period 1982 to 1985.

Capital expenditures will be divided almost equally between new equipment and small construction and site improvement projects. Because of the nature of ILRAD's research activities, new laboratory equipment must be purchased on a regular basis. A particular concern at present is the expansion ILRAD's data-processing capability. Requirements in this area will probably be met most appropriately by the purchase of microcomputers.

6. 1986 BUDGET REQUEST

Table 3. 1985 CURRENT BUDGET AND REQUEST FOR 1986 (US $'000)

	1985 Final Revised	1986 Proposed
Core operations	9350	9270
Contingency	10	
Capital	313	450
Price change		560
External Program Review (EPR)		115
Total	9673	10395
Less: funds brought forward	(419)	
earned income	(150)	(150)
Net requirement	9104	10245

The 1986 proposed budget recommended by the Technical Advisory Committee (TAC) of the CGIAR exceeds the final revised budget for 1985 by US $570,000 for price increases and US $137,000 for capital expenditures. Core operations are US $90,000 less than projected for 1985. There will be no significant changes in the general structure of the ILRAD budget in 1986, though some minor variations in staff numbers and costs can be anticipated. The greatest single increase will be an additional US $115,000 for training and outreach activities. One senior manyear (visiting scientist position) has been taken out of the 1986 budget in order to meet funding guidelines.

The capital budget of US $450,000 is higher than the amount for capital expenditure in 1985. Most of these funds will be used for new equipment. Section 8 provides details on the research program planned for 1986.

7. SPECIAL PROGRAM AND BUDGET CONSIDERATIONS

OFFICE SPACE

To meet the need for additional office space, in part due to the requirements of regional staff from other CGIAR centres, a block of stores was converted to offices in 1983. These buildings meet the current needs of CIP, CIMMYT and IBPGR. ILCA still leases an ILRAD house and has temporary facilities on site.

Because Nairobi is an appropriate location for regional staff in East Africa, office space requirements for other CGIAR centres are likely to increase. ILRAD's office space needs are also increasing, especially for training and outreach activities. So far, it has been possible to meet all needs by rearranging existing facilities. However, the need for additional space must be reviewed seriously, perhaps as part of the External Program Review.

COMPUTING AND WORD-PROCESSING EQUIPMENT

ILRAD has used a word-processing system and a microcomputer for the past 3 years. The possibility of purchasing computing equipment with a larger capacity is now being considered.

The word-processing system is being used by all departments and work stations are being added each year. When first purchased, the microcomputer was used primarily by the Finance Department but it is now also used extensively by research staff. The initial modest investment in this equipment was made to establish an accurate measure of ILRAD's ultimate data-processing needs.

Experience gained over the past 3 years and information from other CGIAR centres indicate that a major expenditure for new data-processing and word-processing equipment will probably be required in 1985 and 1986. Precise needs are not yet established, but an expenditure of about US $200,000 is anticipated to (1) complete the word-processing system, (2) provide a network of microcomputers for all the laboratories, and (3) replace the main telephone switchboard to facilitate international computer-based communication.

8. COMMENTS ON THE CORE PROGRAM FOR 1985 AND 1986

Table 4. ALLOCATION OF SCIENTIFIC MANYEARS TO PROJECT AREAS IN THEILERIOSIS AND TRYPANOSOMIASIS RESEARCH, 1985 AND 1986

	Manyears		% Program		% Total	
	1985	1986	1985	1986	1985	1986
Theileriosis Program						
1. Epidemiology	3.5	3.4	21	20	9	8
2. Sporozoite immunization	4.1	4.3	24	25	10	11
3. Schizont immunization	9.3	9.3	55	55	23	23
Total	16.9	17.0	100	100	42	42
Trypanosomiasis Program						
4. Epidemiology	5.9	5.1	25	22	15	13
5. Trypanosome antigenicity	9.0	9.8	38	43	22	25
6. Comparative immunology	8.6	8.1	37	35	21	20
Total	23.5	23.0	100	100	58	58

Research at ILRAD is organized in six multidisciplinary project areas, each with a project leader and defined objectives related to the goal of improved theileriosis and trypanosomiasis control. Table 4 gives an estimate of the scientific manyears which will be allocated to each area in 1985 and 1986. With the recruitment of 3 additional scientists in 1985 - 2 in trypanosomiasis and theileriosis immunology and 1 in trypanosomiasis immunogenetics - all 41 senior scientific positions which were previously approved were filled. However, it appears that funding for 1986 will not be sufficient to support full staffing, and a visiting scientist position (1 senior manyear) will be taken from the project area of trypanosomiasis antigenicity. This position has been recommended for funding by TAC if other sources of support can be identified.

THEILERIOSIS

1. Epidemiology and improved control

The objectives of ILRAD's theileriosis epidemiology project are to increase knowledge of the epidemiology of theileriosis in Africa and to introduce and evaluate immunological and chemoprophylactic control methods in endemic areas in collaboration with national and international programs. This is a long-term project.

Strains of *T p parva* and *T p lawrencei* have been isolated from different areas of Kenya and neighbouring countries and are being characterized at ILRAD. Scientists are now assessing their potential value for use in immunization trials in different locations, based on infection with live parasites and treatment. Pilot immunization trials have been carried out successfully in one area of Kenya and are being extended to other affected countries. Scientists are also determining the role of buffalo, as carriers of *T p lawrencei* infections, in the epidemiology of bovine theileriosis.

2. Immunization with non-viable sporozoite material

The objective of ILRAD's *Theileria* sporozoite project is to identify, characterize and produce antigens from sporozoite forms of *T p parva* and *T p lawrencei* which will induce protective immunity. Significant results should be obtained in 4 to 7 years.

Antigenic components of *T p parva* have been detected which give rise to protective antibody responses. These components are being characterized and the specific regions of the molecules responsible for protection will be determined.

The genome of *T p parva* has been isolated in bacterial vectors and some of the genetic sequences coding for sporozoite protective antigens have been identified. Their products will be characterized and tested to determine whether they induce protection in cattle when combined with a suitable adjuvant.

The relevant *T p lawrencei* sporozoite antigens will also be identified and characterized, as soon as problems are overcome associated with obtaining defined populations of this species. The genetic sequences coding for *T p lawrencei* sporozoite antigens will then be isolated and their products characterized and tested for their ability to induce protection in cattle.

3. Immunization with material from schizont-infected cells

ILRAD's *Theileria* schizont project explores the possibility of inducing protective immunity against *T p parva* using antigens

associated with the schizont form of the parasite. The feasibility of this approach should be apparent in 5 to 7 years.

ILRAD scientists are delineating the nature of the bovine lymphoid cells which become infected and transformed by the schizont form of *T p parva*. Scientists are also investigating the changes induced in these cells which allow them to be recognized and destroyed by other cells of the bovine immune system. Antigens identified from these infected cells are being characterized, and their potential is being assessed for use in the induction of immunity.

This research requires definition of the cellular components of the bovine immune system, especially the cell surface antigens of the major histocompatability complex and their role in the acquisition of immunity. The approach involves immunological and molecular biological techniques. Work in this area is being strengthened by the appointment of an additional scientist and research technician to ILRAD's core staff, as well as a visiting scientist partially funded by the French government. Research support for the visiting scientist is provided from ILRAD's core funds.

TRYPANOSOMIASIS

4. Epidemiology

The objectives of the trypanosomiasis epidemiology project are to identify the factors which contribute to tsetse/trypanosomiasis challenge in different climatic regions of Africa, to monitor - and if possible improve - the use of available trypanocidal drugs, and to assess the potential role of trypanotolerant livestock in improving livestock productivity in tsetse-infested areas. This a long-term project.

The results of a pilot study at the Kenya coast are being analysed to assess the role of acquired immunity to local trypanosome populations and to determine the role of chemotherapy in the acquisition of immunity. Collaborative studies will continue with ILCA and national organizations on the nature of trypanotolerance and the productivity of different breeds of livestock under various levels of management and trypanosomiasis risk. ILRAD and ILCA, together with FAO and the British government's Overseas Development Administration (ODA), are participating in a large-scale special project in The Gambia on the use of trypanotolerant N'Dama cattle to increase livestock productivity. Support for ILRAD's participation is provided by the EEC as restricted core funds, including funding for two scientific and one technical position.

5. Trypanosome antigenicity and biochemistry

Trypanosome antigenicity and biochemistry studies at ILRAD are designed to obtain knowledge of the major pathogenic trypanosome species

which can be used for the prevention or improved control of African trypanosomiasis. This is a long-term project.

Studies will continue on the role of the variable surface antigens in the induction of protective immunity. Antigens are being analysed from metacyclic and bloodstream forms of the parasite, focusing on *T congolense* and *T vivax*. The structure of these antigens will be determined, as well as the way they are synthesized and their genetic basis. Work will also continue on the identification and characterization of non-variable antigens which stimulate immune responses in livestock, focusing on their potential use for diagnosis and the induction of protective immunity.

The development of improved methods to propagate trypanosomes *in vitro* will continue. Using *in vitro* culture systems, the effectiveness of available and newly derived trypanocidal compounds is being tested and their mode of action analyzed. Research will also continue on the metabolic pathways required for trypanosome survival in different environments and the transitions which occur in the course of the parasite lifecycle.

6. Comparative immunology and genetic resistance to trypanosomiasis

Research on comparative immunology and genetic resistance concentrates on identifying the immunological and non-immunological mechanisms which contribute to resistance to trypanosomiasis. This is a long-term project.

The elucidation of immunological and non-immunological resistance and pathogenic mechanisms of trypanosomiasis aims at identifying new approaches to alleviate or prevent the disease. Comparative studies are carried out in laboratory animals, domestic livestock and indigenous East African wildlife species. Work on resistant wild animals is being conducted in collaboration with the Kenya government's Veterinary Research Laboratory, supported by the Netherlands. The N'Dama cattle which have been imported into Kenya by embryo transplant are being used for research at Kabete. Additional N'Dama embryos from parents of known resistance status could become available from the EEC supported project in The Gambia.

TRAINING

Twenty-five scientists and technicians came to ILRAD in 1984 for training on an individual basis, and this number will be maintained in 1985 and 1986. Most of the individuals who receive training are partially or wholly funded by ILRAD. A small proportion are sponsored by other sources such as WHO, FAO, the World Bank or the German (Federal Republic) Gesellschaft für Technische Zusammenarbeit.

Four courses and one workshop are being conducted in 1985. Two 8-week ILCA/ILRAD trypanosomiasis network courses are being conducted

in English and one 2-week network course in French. A 3-month course covers the preparation and use of reagents in the diagnosis of bovine haemoprotozoan diseases. A workshop on East Coast fever is being held in September 1985 to follow up the international workshop held in 1984. Discussions will focus on developing standardized data collection and analysis techniques for studying the long-term production performance of cattle immunized against East Coast fever by infection and treatment.

In 1986, three courses and one international conference are planned. The first of the courses in 1986 will be an 8-week ILCA/ILRAD trypanosomiasis network course, the second will be a 4-week course on the diagnosis of haemoprotozoan diseases with special emphasis on East Coast fever and the third will be a 3-month course on the preparation of antigens.

A conference on the Biological and Economic Aspects of Livestock Production under Trypanosomiasis Risk is scheduled for October/November 1986, to be organized jointly by ILRAD and ILCA. At this conference new information will be presented from the ILCA/ILRAD research network on the productivity of domestic livestock living under different levels of trypanosomiasis risk and on the impact of various control measures. Data will be available on the multiplication of trypanotolerant cattle, their exportation and the outcome of their establishment in different locations. Discussions will also cover research at ILRAD and elsewhere on the basis of susceptibility to trypanosomiasis.

9. SPECIAL PROJECTS

WILDLIFE DISEASE RESEARCH TO CONTROL DISEASES OF ECONOMIC IMPORTANCE

A 3-year wildlife disease research project was initiated in 1981, involving one senior scientist. Funding is provided by the government of the Netherlands and research is conducted at the Kenya government's Veterinary Research Laboratory at Kabete. Funds for the project are administered through ILRAD. The first phase of the project ended in 1983 and a new 3-year project has been approved by the same donor.

Table 5. WILDLIFE DISEASE RESEARCH PROJECT BUDGET (US $)

	Actual 1984	Proposed 1985	Proposed 1986
Salaries	87383	88000	86000
Supplies	13769	24000	24000
Travel	6258	6000	6000
Capital	21833	8000	4000
Training	20852	15000	15000
Contingency	29260	22000	30000
Total	179355	163000	165000

N'DAMA PRODUCTION RESEARCH

The EEC has approved funding for a special research project on trypanotolerant N'Dama cattle, to be conducted jointly by ILRAD and ILCA. This project will be the research component of a larger regional project developed by the government of The Gambia and funded by several donors. The goal is to increase the production and export of N'Dama cattle.

This project would allow ILRAD to carry out substantial research on the mechanisms of trypanotolerance. Together with research carried out by ILCA, the findings should make it possible to evaluate the potential productivity of the N'Dama breed in areas of defined tsetse challenge.

Under the project ILRAD will hire two scientists and one senior technician who will be stationed in The Gambia. The project will be carried out over a 3-year period, with an annual budget of approximately US $540,000 for the combined ILRAD/ILCA component.

COLLABORATIVE RESEARCH ARRANGEMENTS

Three of ILRAD's donors are providing support in addition to their contributions to core funding through collaborative research agreements. One veterinarian is provided under a Belgian associate expert program. An ODA-funded project with the Animal Breeding Research Organization has stationed a scientist and research technician at ILRAD to study major histocompatibility groups and disease resistance. In both instances, the donor provides the cost of personal services and ILRAD provides research facilities and supplies in Kenya. The Japanese government supports one scientist in theileriosis parasitology and two in cell culture. In addition to personal services, Japan contributes to the purchase of equipment to support these research activities.

In 1984, the Netherlands Foundation for the Advancement of Tropical Science (WOTRO) initiated a 3-year program to support a Research Fellow at ILRAD. Funding is provided to cover personal services and research supplies. The Research Fellow is registered for a Ph.D. degree at the University of Utrecht.

10. CAPITAL REQUIREMENTS

1985

Capital will be required in 1985 primarily to purchase equipment for the laboratories and support units (Table A-1). Originally, plans for 1985 had also included construction of a final set of staff houses at the Kapiti ranch. Unless unanticipated needs arise, this construction should complete essential development for full operation of the ranch. However, TAC has recommended that the construction planned for 1985 should be delayed unless funds above the proposed level become available.

1986

Primary requirements in 1986 will be for the purchase of laboratory and data processing equipment. Construction will be limited to small modifications and site improvement.

11. ASSUMPTIONS ON PRICE CHANGES

The Kenya shilling was not devalued in 1984, although it did decline in value against the US dollar by approximately 12%. The consumer price index for Kenya continued to increase at an estimated annual rate of 15%. Since price increases in North America and Europe are expected to be below the level anticipated for Kenya, an overall provision of 6% for price increases has been made for 1986.

APPENDIX: TABLES

Table A-1. SUMMARY OF CAPITAL BUDGET, 1983-1986 (US $'000)

	1983 Actual	1984 Actual	1985 Final Revised	1986 Proposed
CONSTRUCTION				
Staff Housing	249			
Addition to Tick Unit	17			
Development of Kapiti Plains Ranch	77	58		50
Sheep & Goat Holding Unit	20			
Small Projects & Site Improvement	59	158	168	100
TOTAL	422	216	168	150
EQUIPMENT				
Laboratory	170	88	90	150
Farm		1	10	50
Office	36	48	25	20
Vehicles	37			
Food & Housing	38	1	5	5
Engineering	32	1	10	10
Training Laboratory		36	5	5
TOTAL	313	175	145	240
ADDITIONAL WORKING CAPITAL		91		60
TRANSFER TO REVOLVING FUND	100			
TOTAL CAPITAL	835	482	313	450

Table A-2. DETAILS OF CAPITAL BUDGET: CONSTRUCTION, 1983-1986 (US $'000)

	1983 Actual	1984 Actual	1985 Final Revised	1986 Proposed
SMALL PROJECTS & SITE IMPROVEMENT				
Fire Control	6		20	
Farm Roads	15	16	15	
Radioisotope Laboratory Improvements	4			
Site Improvements		27	25	
Incinerator	6			
Oxidation Pond Expansion		20	4	
Water Supply System		69		
Liquid Nitrogen Supply Tank			5	
Small Modifications & Unidentified	28	26	99	100
TOTAL	59	158	168	100

Table A-3. DETAILS OF CAPITAL BUDGET: EQUIPMENT, 1983-1986 (US $'000)

	1983 Actual	1984 Actual	1985 Final Revised	1986 Proposed
LABORATORY EQUIPMENT				
Laminar Flow Hoods	4		2	
Fluorimeter Attachment	4			
Frozen Thin Sectioning System	7			
Micro ELISA Reader	12			
Fluorescence Activated Cell Sorter Equipment	41	12	3	
Microcomputer		10	10	
Centrifuge Drive Unit	15			
Microforge	18			
Stereomicroscopes	6			
Incubator	5			
Centrifuge RC-3B (Sorvall)		20		
Eppindorf Centrifuge		2		
Incubator (low temperature)		7		
Paper Tape Punch		3		
ELISA Plate Washer		4		
Electrophoresis Equipment			15	
Freezer (-80°C)			9	
Other	58	30	51	150
TOTAL	170	88	90	150
FARM EQUIPMENT - Small Equipment		1	10	50
OFFICE EQUIPMENT				
Word Processing Equipment	10	41	20	10
Unidentified	26	7	5	10
TOTAL	36	48	25	20
VEHICLES - Work & Staff Vehicles	37			
FOOD & HOUSING	38	1	5	5
ENGINEERING - Maintenance Equipment	32	1	10	10
TRAINING LABORATORY EQUIPMENT				
Microscopes		2		
Photographic		9		
LKB Fraction Collectors & Accessories		5		
Balances		1		
Gelman Electrophoresis Equipment		9		
Micro ELISA Reader		4		
Other		6	5	5
TOTAL		36	5	5
TOTAL ALL EQUIPMENT	313	175	145	240

Table A-4. SUMMARY OF COSTS BY PROGRAM AND ACTIVITY, 1983-1986 (US $'000)

	1983 M-Y	1983 Actual Cost	1984 M-Y	1984 Actual Cost	1985 M-Y	1985 Final Cost	1986 M-Y	1986 Proposed Cost
RESEARCH								
Parasitology-Trypanosomiasis	4.8	293	5.0	315	5.0	421	5.0	345
Biochemistry	7.7	666	5.8	727	6.0	685	6.5	551
Cell Biology	3.0	340	4.3	541	5.0	497	5.0	498
Immunobiology	5.1	490	5.8	356	7.3	483	8.0	500
Parasitology-ECF	5.8	497	6.5	527	6.1	561	6.0	564
Pathology	5.5	541	7.2	598	6.7	644	6.5	579
Tsetse Laboratory	1.0	317	1.0	279	1.0	308	1.0	316
Tick Laboratory	1.0	115	1.0	106	1.0	137	1.0	148
Electron Microscopy	1.3	178	1.3	150	1.2	150	1.0	153
TOTAL	35.2	3437	37.9	3599	39.3	3886	40.0	3654
RESEARCH SUPPORT								
Research Director	1.0	281	1.3	562	1.0	482	1.0	409
Kabete Farm	1.0	685	1.0	623	1.0	640	1.0	650
Small Animal Unit		133		133		156		155
Veterinary Services	1.0	67	1.0	86	1.0	87	1.0	90
Central Core		347		303		345		350
TOTAL	3.0	1513	3.3	1707	3.0	1710	3.0	1654
TOTAL RESEARCH	38.2	4950	41.2	5306	42.3	5596	43.0	5308
TRAINING & CONFERENCES	1.0	695	1.0	685	1.0	974	1.0	1089
LIBRARY & INFORMATION	1.0	337	1.0	313	1.0	437	1.0	452
ADMINISTRATION								
Board of Directors		70		91		92		92
Director General's Office	2.0	357	2.0	348	2.0	371	2.0	400
Finance	1.0	358	1.0	342	1.0	382	1.0	410
Purchasing		274		275		281		282
Personnel		72		85		97		99
TOTAL	3.0	1131	3.0	1141	3.0	1223	3.0	1283
GENERAL OPERATIONS								
Engineering	1.0	726	1.0	572	1.0	611	1.0	638
Transport		208		252		222		237
Services		104		146		194		162
Food & Housing	1.0	127	1.0	14	1.0	40	1.0	47
Stores		48		52		53		54
TOTAL	2.0	1213	2.0	1036	2.0	1120	2.0	1138
OTHER								
Contingency/EPR		31		10		10		115
Price Change								560
TOTAL		31		10		10		675
TOTAL CORE	45.2	8357	48.2	8491	49.3	9360	50.0	9945
SPECIAL PROJECTS		203		236		163		160

Table A-5. SUMMARY OF COSTS BY OBJECT OF EXPENDITURE, 1983-1986 (US $'000)

	1983 Actual	1984 Actual	1985 Final	1986 Proposed
Personal Costs	5259	5075	5839	5861
Supplies	1744	1829	2119	2048
Services	725	861	568	560
Equipment Replacement	229	394	336	231
Travel	369	322	488	570
Contingency/EPR	31	10	10	675
TOTAL	8357	8491	9360	9945

Table A-6. SUMMARY OF APPLICATIONS AND SOURCES OF FUNDS: APPLICATIONS (US $'000)

	1983 Actual	1984 Actual	1985 Final	1986 Proposed	1987 Proposed
APPLICATION OF FUNDS					
Core Operations	8357	8491	9360	9945	12772
Capital	735	391	313	390	350
Special Projects	203	236	163	165	
Unexpended Balances					
Unrestricted Core		419			
Working Funds	687	778	778	838	1064
Revolving Fund	100	100	100	100	100
TOTAL APPLICATIONS	10082	10415	10714	11438	14286
MEMO: Total Core Operating Funds Required	8357	8491	9360	9945	12772
Less Unexpended Balance from Previous Year	(881)		(419)		
Less Earned Income Applied	(85)	(144)	(150)	(150)	(150)
NET CORE OPERATING FUNDS REQUIRED	7391	8347	8791	9795	12622
Total Capital Funds Required	1544	1269	1191	1328	1514
Less Unexpended Balance from Previous Year	(181)				
Less Previous Working Funds	(709)	(687)	(778)	(778)	(838)
Less Revolving Fund		(100)	(100)	(100)	(100)
NET CAPITAL FUNDS REQUIRED	654	482	313	450	576
TOTAL FUNDS REQUIRED FROM CGIAR	8045	8829	9104	10245	13198

Table A-7. SUMMARY OF APPLICATIONS AND SOURCES OF FUNDS: SOURCES (US '$000)

	1983 Actual	1984 Actual	1985 Final	1986 Proposed	1987 Proposed
CORE OPERATING FUNDS					
UNRESTRICTED					
USAID	2500	2500	2490		
World Bank	800	1570	700		
Germany (Federal Republic)	603	556	528		
United Kingdom (ODA)	548	468	458		
Canada (CIDA)	615	699	680		
Switzerland	383	437	414		
Norway	287	255	234		
Belgium		229	135		
Netherlands	250	264	249		
Australia	286	208	281		
Sweden	186	197	237		
Italy	136	112	164		
Saudi Arabia	300	300	300		
France	52	59	70		
Denmark			47		
Unidentified			666	9479	12369
UNEXPENDED BALANCES					
From Previous Year	881		419		
Earned Income Applied in Year	85	144	150	150	150
TOTAL UNRESTRICTED	7912	7998	8222	9629	12519
RESTRICTED					
UNDP	576	639	691	766	829
Belgium	151	105	110		
Japan		150	150		
Italy	350	500	500		
TOTAL RESTRICTED	1077	1394	1451	766	829
TOTAL UNRESTRICTED/RESTRICTED	8989	9392	9673	10395	13348
Transfer to Capital Funds	(654)	(482)	(313)	(450)	(576)
TOTAL OPERATING FUNDS	8335	8910	9360	9945	12772
CAPITAL					
Transferred from Core	654	482	313	450	576
Unexpended Balance from Previous Year	181				
Balance of Working Funds from Previous Year	709	687	778	778	838
Balance of Revolving Fund from Previous Year		100	100	100	100
TOTAL CAPITAL FUNDS	1544	1269	1191	1328	1514
SPECIAL PROJECTS - Netherlands	203	236	163	165	
TOTAL FUNDS	10082	10415	10714	11438	14286

Table A-8. SUMMARY FINANCIAL DATA, 1983-1987 (US $'000)

	1983 Actual	1984 Actual	1985 Final	1986 Proposed	1987 Proposed
CURRENT ASSETS					
Cash	1936	628	1300	1345	1450
Receivables	435	1596	458	500	500
Inventories	246	218	200	250	250
Prepaid Expenses	115	248	220	250	250
Other Current Assets (Kapiti)	135	133	100	100	100
TOTAL CURRENT ASSETS	2867	2823	2278	2445	2550
FIXED ASSETS					
Operating Equipment	784	818	834	884	924
Research Equipment	4642	4875	5100	5300	5500
Vehicles	251	302	310	320	340
Furnishing/Office Equipment	453	507	523	545	585
Buildings & Land	9444	9882	10050	10200	10290
Investment in Kapiti Ranch	1728	1706	1786	1836	1836
Other Fixed Assets	517	244	250	250	250
TOTAL FIXED ASSETS	17819	18414	18853	19335	19725
TOTAL ASSETS	20686	21237	21131	21780	22275
LIABILITIES					
Accounts Payable	986	828	750	800	800
Other Liabilities	652	698	650	707	586
TOTAL LIABILITIES	1638	1526	1400	1507	1386
GRANTS RECEIVED IN ADVANCE	442				
CAPITAL GRANTS					
Fully Expended	17819	18414	18853	19335	19725
Unexpended	687	778	778	838	1064
Revolving Fund	100	100	100	100	100
TOTAL CAPITAL GRANTS	18606	19292	19731	20273	20889
UNEXPENDED CORE OPERATING GRANTS		419			
TOTAL LIABILITIES & GRANTS	20686	21237	21131	21780	22275

Table A-9. POSITIONS AND MANYEARS, 1983-1986

	SCIENTIFIC & SENIOR ADMINISTRATIVE STAFF								SUPERVISORY STAFF								SUPPORT STAFF							
	Positions				Manyears				Positions				Manyears				Positions				Manyears			
	83	84	85	86	83	84	85	86	83	84	85	86	83	84	85	86	83	84	85	86	83	84	85	86
Research	41	41	41	41	35.2	37.9	39.3	40.0	20	20	20	19	19.1	19.4	18.5	19.0	75	77	78	78	70	72	73	74
Research Support	3	3	3	3	3.0	3.2	3.0	3.0	4	4	5	5	4.0	3.5	4.5	5.0	85	82	82	82	80	80	81	81
Training & Conferences	1	1	1	1	1.0	1.0	1.0	1.0	1	1	1	1	0.8	0.7	1.0	1.0								
Library & Information	1	1	1	1	1.0	1.0	1.0	1.0	1	1	1	1	0.7	0.7	1.0	1.0	7	7	10	10	7	5	6	7
Administration	3	3	3	3	3.0	3.0	3.0	3.0	10	10	10	10	8.7	10.0	10.0	10.0	22	23	22	22	20	23	22	22
General Operations	2	2	2	2	2.0	2.0	2.0	2.0	3	3	3	3	3.0	3.0	3.0	3.0	129	136	139	139	123	129	130	130
TOTAL	51	51	51	51	45.2	48.1	49.3	50.0	39	39	40	39	36.3	37.3	38.0	39.0	318	325	331	331	300	309	312	314
OF THESE: NON-ILRAD FUNDED						5.3	4.8	3.5																

SUMMARY:

Year	Positions	Manyears	% Positions Filled
1983	408	381	93
1984	415	394	95
1985	422	399	95
1986	421	403	96