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OPTIONAL FORM NO. 10
5010-108

UNITED STATES GOVERNMENT

Memorandum

TO : See Distribution

DATE: August 16, 1982

FROM : Douglas W. Butchart
S&T/AGR/AP, Room 4200, SA-18
Tel: 235-9877

SUBJECT: Project Paper (PP) Committee Review - Host Resistance - Integrated Tick Control 936-4083
(COPY ATTACHED)

The following meeting has been scheduled for the Project Committee Review. Please mark it on your calender.

September 22, 1982 - Wednesday - 2:00 P.M.
RPC (SA-18) Conference Room #520

S&T/AGR/AP, J. Yohe
AFR/DP, L. Abel
ASIA/TR, E. Williams
LAC/DR, P. Warren
NE/TECH, D. Sanger
PPC/PDPR, J. Acherton
BIFAD/S, W. Johnson
R. Roach, B. Roach

File

PP approved
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will take [illegible] to
[illegible] procedure.
JDA

Best Available Document

RECORD OF S&T PROJECT REVIEW COMMITTEE MEETING

COMMITTEE MEETING DATE:

September 22, 1982 - 2:00 P.M.
RPC (SA-18) Conference Room #520

1. PROJECT OFFICE: S&T/AGR/AP PROJECT NUMBER: 936-4083

PROJECT TITLE: Host Resistance - Integrated Tick Control

PROPOSED CONTRACTOR: The International Centre of Insect Physiology and Ecology (ICIPE)
P.O. Box 30772
Nairobi, Kenya

PROPOSED PROJECT PERIOD: July 1, 1983 through June 30, 1988

TOTAL FIVE YEAR LIFE OF PROJECT BUDGET: $1.45 million

FY 1983 PROPOSED BUDGET: $250 thousand

2. THE MEMBERS OF THIS COMMITTEE, AND THEIR FINDINGS ARE SPECIFIED BELOW:

OFFICE SYMBOL	TYPE/NAME/SIGNATURE	DATE	ENDORSED	NOT ENDORSED
AFR/DR	L. Abel			
ASIA/TR	E. Williams			
LAC/DR	P. Warren			
NE/TECH	D. Songer			
PPC/PDPR	J. Atherton			
BIFAD/S	W. Johnson			
S&T/PO	B. Roach			

3. It is the decision of this Committee that this project be:

_____ENDORSED _____NOT ENDORSED

SIGNATURE_____ Date:_____

John M. Yohe
Chairperson
S&T/AGR/AP

4. Any dissenting opinions are attached

TICK RESISTANT CATTLE IN THE ECOLOGICAL MANAGEMENT OF TICKS
PROJECT PAPER

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ABBREVIATIONS

ARS, S&E, USDA	- Agricultural Research Service, Science and Education, United States Department of Agriculture
ECF	- East Coast Fever
ERS, USDA	- Economic Research Service, United States Department of Agriculture
FAO	- Food and Agriculture Organization
ICIPE	- International Center of Insect Physiology and Ecology
ILRAD	- International Laboratory for Research on Animal Diseases
KARI	- Kenya Agricultural Research Institute, Veterinary Research Department
REDSO/EA	- Regional Economic Development Services Office/ East Africa
S&T	- Bureau of Science and Technology
UNDP	- United Nations Development Program

Project Design Credits

The Project Paper was prepared by:

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Washington, D.C.

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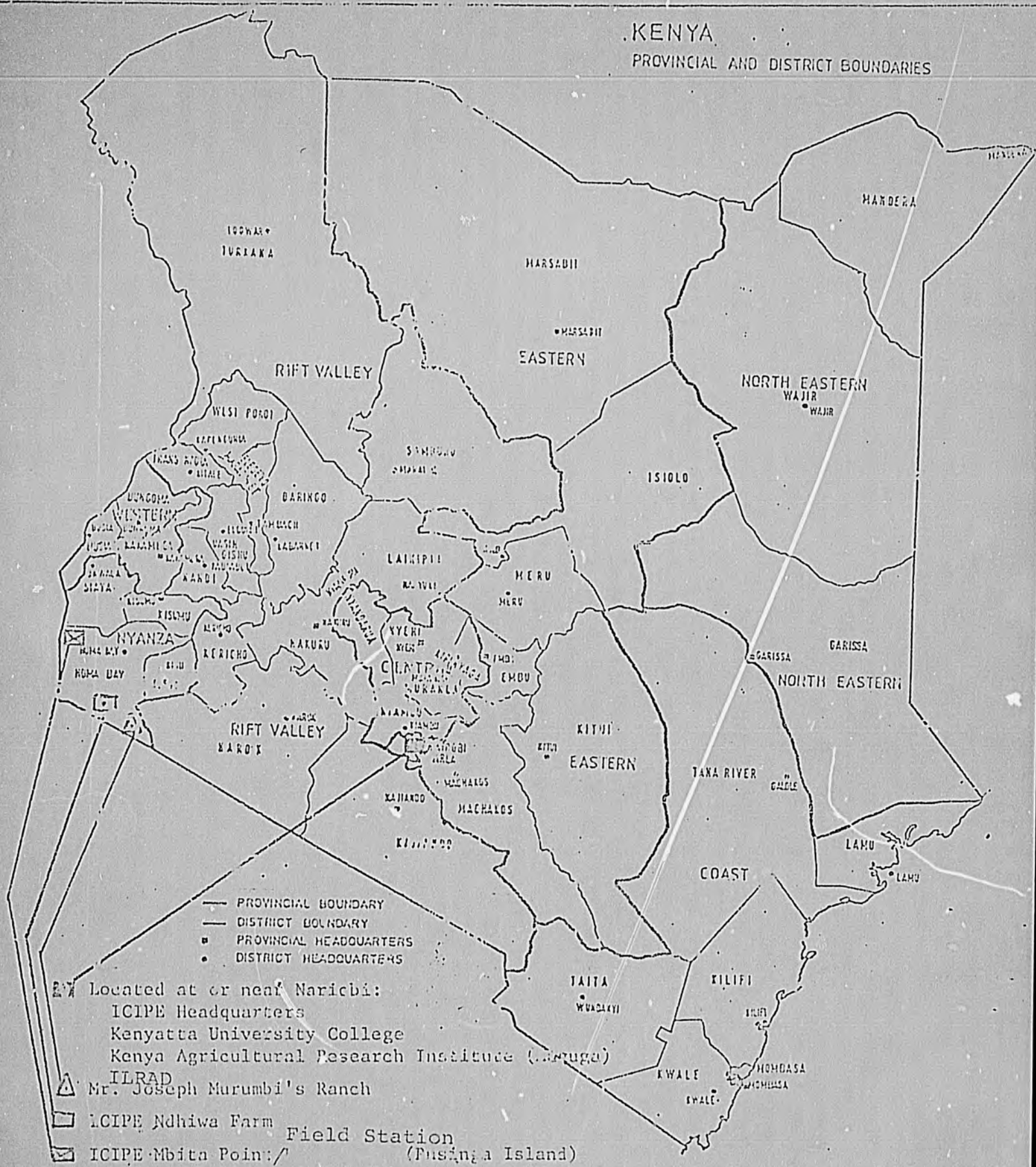
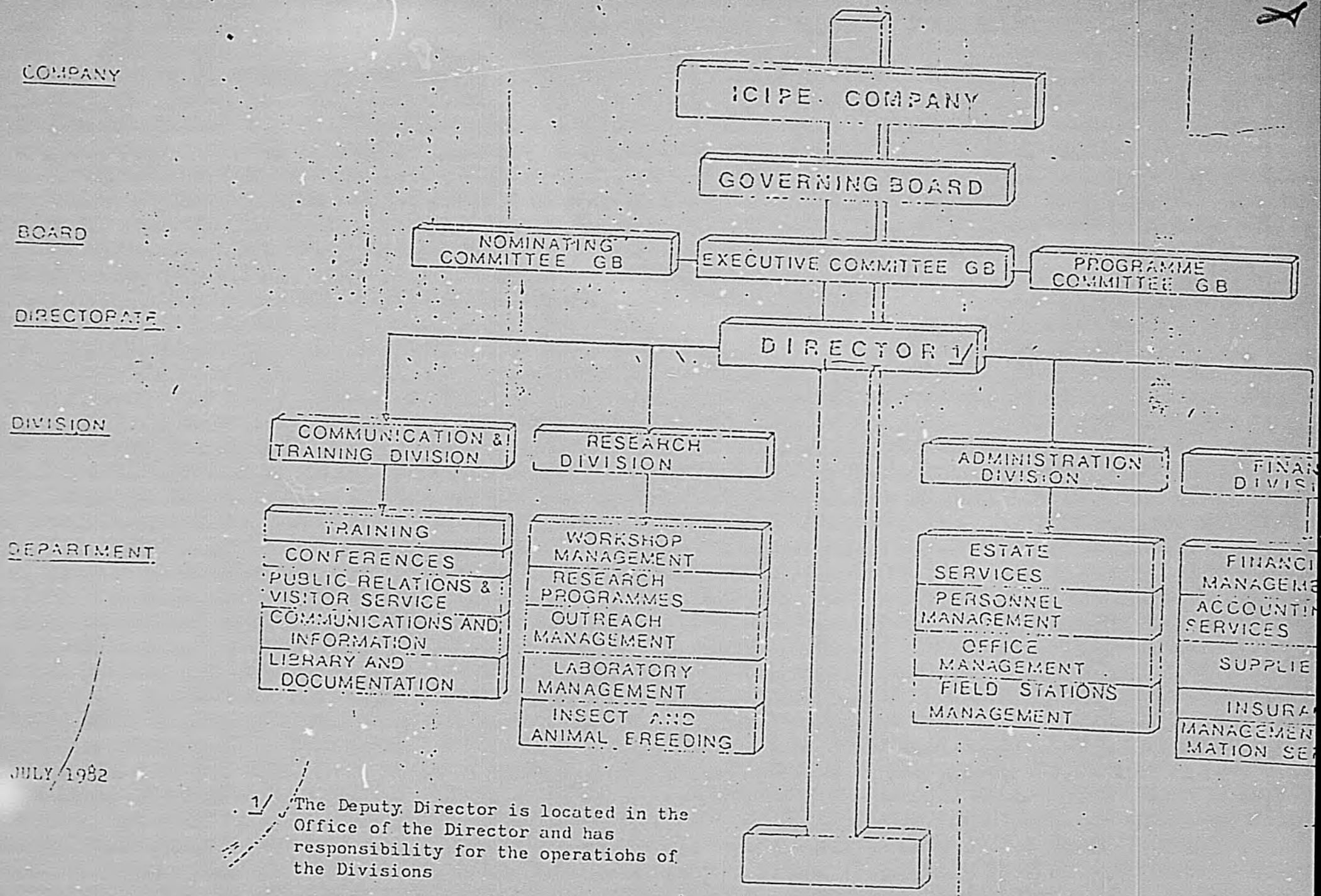
Washington, D.C.


KENYA
PROVINCIAL AND DISTRICT BOUNDARIES
TURKANA
MARSABIT
EASTERN
RIFT VALLEY
WEST POKOT
BARINGO
WESTERN
KAKAMEGA
KISUMU
NYANZA
KISIMU
KERICHO
NAKURU
LAIKIPIA
MERU
CENTRAL
EMBU
KITUI
EASTERN
NAIROBI
KAJIADO
MACHAKOS
RIFT VALLEY
NAROK
NORTH EASTERN
WAJIR
ISIOLO
MANDERA
GARISSA
NORTH EASTERN
TANA RIVER
GARISSA
LAMU
COAST
TAITA
WUNDANYI
KILIFI
KWALE
MOMBASA
PROVINCIAL BOUNDARY
DISTRICT BOUNDARY
PROVINCIAL HEADQUARTERS
DISTRICT HEADQUARTERS
Located at or near Nairobi:
ICIPE Headquarters
Kenyatta University College
Kenya Agricultural Research Institute (Muguga)
ILRAD
Mr. Joseph Murumbi's Ranch
ICIPE Ndhiwa Farm
ICIPE Mbita Point Field Station (Rusinga Island)

APPROVED ICIPE ORGANISATION CHART



JULY 1982

1/ The Deputy Director is located in the Office of the Director and has responsibility for the operations of the Divisions

235-8878

Appendix 5A to HB 3, Part I
(TM 3:19)

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT PAPER FACESHEET

1. TRANSACTION CODE: A (A = ADD, C = CHANGE, D = DELETE)

PP

2. DOCUMENT CODE: 3

3. COUNTRY/ENTITY: AID/W

4. DOCUMENT REVISION NUMBER: -

5. PROJECT NUMBER (7 digits): 936-4083

6. BUREAU/OFFICE: A. SYMBOL: S&T; B. CODE: 36

7. PROJECT TITLE (Maximum 40 characters): HOST RESISTANCE-INTEGRATED TICK CONTROL

8. ESTIMATED FY OF PROJECT COMPLETION: FY 88

9. ESTIMATED DATE OF OBLIGATION: A. INITIAL FY 83; B. QUARTER 1 (Enter 1, 2, 3, or 4); C. FINAL FY 87

10. COSTS ($ IN THOUSANDS OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY B. FX	FIRST FY C. L/C	FIRST FY D. TOTAL	LIFE OF PROJECT E. FX	LIFE OF PROJECT F. L/C	LIFE OF PROJECT G. TOTAL
AID APPROPRIATED TOTAL	250	-	250	1,450	-	1,450
(GRANT)	(250)	-	(250)	(1,450)	( )	(1,450)
(LOAN)	( )	( )	( )	( )	( )	( )
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST COUNTRY						
OTHER DONOR(S)	100	-	100			500
TOTALS	350	-	350	1,450		1,950

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	PRIMARY TECH. CODE D. LOAN	E. 1ST FY 83 F. GRANT	E. 1ST FY 83 G. LOAN	H. 2ND FY 84 I. GRANT	H. 2ND FY 84 J. LOAN	K. 3RD FY 85 L. GRANT	K. 3RD FY 85 M. LOAN
(1) FW	111	070		250	-	300	-	300	-
(2)	771	960							
(3)									
(4)									
TOTALS				250	-	300	-	300	-

A. APPROPRIATION	N. 4TH FY 86 O. GRANT	N. 4TH FY 86 P. LOAN	Q. 5TH FY 87 R. GRANT	Q. 5TH FY 87 S. LOAN	LIFE OF PROJECT T. GRANT	LIFE OF PROJECT U. LOAN
(1)	300	-	300	-	1,450	-
(2)						
(3)						
(4)						
TOTALS	300	-	300	-	1,450	-

12. IN-DEPTH EVALUATION SCHEDULED: MM 03 YY 84

13. DATA CHANGE INDICATOR. WERE CHANGES MADE IN THE PID FACESHEET DATA, BLOCKS 12, 13, 14, OR 15 OF THE PRP FACESHEET DATA, BLOCK 12? IF YES, ATTACH CHANGED PID FACESHEET.

1 (1 = NO, 2 = YES)

14. ORIGINATING OFFICE CLEARANCE

SIGNATURE

TITLE

DATE SIGNED: MM DD YY

15. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

AID 1330-4 (3-76)

9

I. SUMMARY AND RECOMMENDATIONS

A. Recommendations

1. Financial Support Requested from AID.

a. Total Request $1,450,000 ($250,000 in year one, $300,000/year remaining 4 years).

b. Period covered: 1983-1987.

2. The techniques for tick control that will be investigated in the proposed research project have potential for application in widespread portions of East Africa where East Coast Fever (ECF) and the vector of this disease, Rhipicephalus appendiculatus, occur. Scientists both inside and outside of Africa are investigating tick control methods to eliminate current excessive dependence on acaricides. It is important for the scientists from the International Center for Insect Physiology and Ecology (ICIPE) to have frequent opportunities to exchange ideas and information with their peers. Interactions with other scientists can result in improvements in the ICIPE scientists approach and conversely, ideas or research outputs from ICIPE can lead to more rapid progress by others. Accordingly it is strongly recommended that funds budgeted in this proposal for travel to scientific meetings, conferences, workshops, and visits to other laboratories be protected and utilized for this intended purpose.

B. Summary Description

1. Background: In Africa, the tick-borne diseases of cattle are Anaplasmosis, Babesiosis, Cowdriosis, and Theileriosis (East Coast Fever). Vaccines or drugs are already available for the control of Anaplasmosis, Babesiosis and Cowdriosis, but not for East Coast Fever (ECF) caused by Theileria parva. ECF occurs through East and Central Africa, involving Angola, Burundi, Kenya, Malawi, Mozambique, Rwanda, Uganda, Tanzania, Zaire, Zambia, and Zimbabwe. In these countries, ECF is by far the most important of the tick-borne diseases, with morbidity and mortality in susceptible cattle approaching 100%. In indigenous cattle, mortality is generally confined to calves, but cattle which survive and acquire an immunity to the disease are frequently stunted and subsequent productivity is greatly reduced. Because one infected tick feeding on an animal for less than 2 days can transmit a fatal infection, the only method presently available for the control of the disease is close interval (3-4 days) application of acaricides in dips or sprays. This procedure has obvious disadvantages. However, since it is likely that drugs and a method of vaccination will soon become available for the control of ECF, methods other than the close interval application of acaricides should be considered for the control

of ticks. However, even with control measures available for these diseases ticks per se cause very substantial losses in cattle productivity. Therefore this project is designed to evaluate losses in cattle due to ticks and to develop cost effective, environmentally sound control methods.

2. Goal: The goal of the project is to improve cattle production through the utilization of naturally acquired resistance to ticks and thus reduce pesticide (acaricide) use.

3. Purpose: The purpose of this research is to develop tick control methods that rely on acquired resistance of cattle to ticks instead of close-interval applications of acaricides. The approach requires the protection of cattle against ECF by naturally acquired immunity, by vaccination or by the use of curative drugs. Under some circumstances the strategic application of acaricides may be needed.

4. Outputs:

a. Outputs: To survey the ticks and tick-transmitted diseases affecting indigenous Zebu cattle maintained on communal pastures according to indigenous cattle management practices and then to implement and evaluate tick and disease control procedures to protect the cattle.

b. Output: To determine if tick-resistant Boran steers vaccinated against ECF will cause a decline in the tick population and subsequently maintain it at a low level in a pasture containing no other tick hosts and if weight gains of these animals will be comparable to Boran steers dipped weekly in acaricides to effect tick control.

c. Output: To establish a breeding herd of improved Boran cattle in an ECF enzootic area, to control ticks by using acquired tick-resistance and strategic acaricide applications, to control ECF by vaccination and the use of curative drugs, and to compare the productivity and levels of tick infestation on the Boran cattle with animals in a Maasai herd of indigenous Zebu cattle maintained in a communal grazing area adjacent to the experimental pastures.

d. Ouput: To conduct laboratory experiments to obtain additional information on the ability of ticks to stimulate acquired resistance in cattle and to determine the effects on ticks of feeding on resistant cattle.

e. Output: To extend preliminary research on the transmission of *Theileria parva* to and from tick-resistant cattle.

C. Problem Statement

1. Ticks and ECF, and other tick-transmitted diseases

have a substantial impact on cattle production in Africa. With the development of a curative drug and effective vaccination method for the treatment and prevention of ECF it is possible to control the major tick-borne diseases in East and Central Africa. In view of these circumstances it is important for current methods of tick control with their excessive reliance on acaricides, to be re-evaluated. In Australia, Boophilus microplus, a one-host tick is being successfully controlled on ranches where selected tick-resistant breeds are stocked. Different tick-species, breeds of cattle, livestock production practices, cultures, climate, physiography, and a variety of other factors make the tick problems in Africa distinctively different from those in Australia. However, the Australian successes with tick-resistant cattle justify efforts to extend their research methodology along with the testing of new ideas to the solution of tick problems in Africa.

2. The proposed project on the role of acquired tick-resistance in the management of tick is just one of two complimentary research programs involving the use of immunological methods for controlling ticks. The second part of the program, which at present is being funded by the Government of Switzerland, has the goal of developing a vaccine for the artificial immunization of cattle against ticks. This research effort appears to be very active and innovative. Immunologists and other scientists at both ILRAD and KARI are directly involved in various aspects of this effort.

II. PROJECT BACKGROUND AND DESCRIPTION

A. General Background and Project Rationale

Tick-borne diseases and debility caused by tick infestations are major inhibiting factors in livestock production throughout the world but particularly in tropical regions and especially in Africa. Tick-borne diseases are prevalent all over the African continent, including an estimated 10 million square kilometers (Young, 1981, Adv. Cont. Theileriosis, Martinus Nijhoff, p.38-55) across Central Africa where livestock production is impossible or severely limited because of the presence of trypanosomiasis. Throughout this area and the the rest of the continent, diseases transmitted by ticks to domestic animals include Anaplasmosis, Babesiosis, Cowdriosis, and Theileriosis. The most notorious of these diseases, and the most difficult to contain is East Coast Fever (ECF). ECF is caused by Theileria parva and is transmitted by Rhipicephalus appendiculatus (Irvin and Cunningham, 1980, Trop. Dis. Cattle, Martinus Nijhoff, p.393-410). It occurs throughout East and Central Africa, involving Angola, Burundi, Kenya, Malawi, Mozambique, Rwanda, Uganda, Tanzania, Zaire, Zambia, and Zimbabwe.

In susceptible cattle exposed to ECF, and this includes both exotic breeds and improved Zebu or Zebu from non-enzootic areas, morbidity and mortality approach 100%. In the case of

the indigenous cattle in enzootic areas, mortality is low and generally confined to calves. Calves that survive exposure become immune, and remain completely resistant to subsequent challenge. However, different circumstances, such as a prolonged drought that severely lowers population densities of R. appendiculatus, may result in the failure of a calf crop to be appropriately challenged and therefore to not become immune. At a later time exposure to T. parva of such non-immune indigenous cattle may cause enormous losses (Radley et al. 1975a, Vet. Parasitol. 1: 35-41)

Cattle mortality is a serious factor in the losses attributable to ECF, but it is probable that the greatest losses in indigenous cattle in enzootic areas are caused by the stunted growth of surviving animals as a result of continuous challenge during calfhood. These effects are manifested in decreased production of calves, milk, and beef. For example, in the Mbita Point area in southwestern Kenya, where ICIPE has a field station, and where ECF is enzootic, adult Zebu cows commonly produce no more than 1 liter of milk a day, beef steers take 6-8 years to reach a live-weight of 350 kilograms, and heifers do not mature to the calf-bearing stage until they are about 4 years of age. Obviously, other factors are involved in the low productivity of such cattle, but undoubtedly tick infestation and ECF play an important role in this problem.

Methods of vaccination and/or curative drugs have been available for some time for the control of the other tick-borne diseases. Significantly, a method of vaccination against ECF has recently been developed (Radley, 1981, Adv. Cont. Theileriosis, Martinus Nijhoff, p.227-237; Radley et al., 1975a; Radley et al., 1975b, Vet. Parasitol 1: 43-50; Radley, et al., 1975c, Vet. Parasitol. 1: 51-60) which has been successfully tested in small (Cunningham et al., 1973, Trop. Anim. Hlth. Prod. 6:39-43) and large scale (Uilenberg et al., 1977, Tropemed. Parasit. 28: 499-506) field trials. In addition, an efficacious curative drug (Dolan, 1981 Adv. Cont. Theileriosis, Martinus Nijhoff, p.186-208 .) is expected to be on the market in the very near future.

The new technology for ECF management will appreciably alter the necessity of depending excessively on the application of acaricides to cattle. The use of acaricides for controlling ticks and tick-borne diseases of livestock has many disadvantages including cost, danger of toxicosis in livestock and humans handling and applying the acaricides, unacceptable pesticide residues in meat and milk, and dangers of environmental contamination. Two other important limitations of excessive dependence on acaricides are:

1. Acaricide resistant tick populations are widespread. This necessitates the development of new products. Companies must account for the risk that acaricide resistance will affect sales before a reasonable profit occurs. This has made companies cautious about the development

of new acaricides.

2. The unremitting and close interval application of acaricides to cattle at 3-4 day intervals necessitated in East and Central Africa for the control of ECF, produces an inherently unstable situation where cattle are completely susceptible to tick-borne diseases, and naive to tick infestation. If for any reason acaricide control breaks down, catastrophies can occur, and large numbers of cattle may die of disease and debility caused by massive tick infestations. Such a situation recently arose in Zimbabwe where acaricide control failed during the liberation wars, and more than a million cattle were lost. (Norval, 1978, Rhod. Vet. J. 9: 9; Lawrence et al., 1980, Vet. Record 107: 82).

There has always been a need to develop integrated systems of tick control to provide methods that minimize or eliminate excessive dependence on acaricides. Possible alternative approaches are limited. Past experience and present knowledge do not indicate that biological control using tick parasitoids, pathogens, or predators is likely to offer a solution. Similarly, the prospects of using pheromones, kariomones, or arthropod growth regulators as tools in new tick control technology are minimal. These methods need further investigation before their potential can be assessed properly. Genetic methods for controlling tick populations are a possibility. Researchers in the United States have successfully produced a 'sterile hybrid' cattle fever tick with possible application for the control of either Boophilus microplus or Boophilus annulatus. A variety of other genetic approaches may be possible with other species of ticks. Acquired resistance from cattle to particular tick species can interfere with engorgement and appreciably limit the degree to which livestock are parasitized. This knowledge is presently being exploited and, as the following brief literature review indicates it is a field which is attracting interest at an accelerating rate. The research being proposed by the ICIPE Livestock Ticks Research Program includes elements relating to livestock management practices and tick ecology, in addition to their interest in the application of knowledge of tick resistance in cattle to the problems of controlling ticks affecting livestock.

B. Description of Proposed Research

The following outlines the purpose, outputs and procedures for individual research areas within the overall project.

1. Goal: The goal of this project is to improve cattle production through the utilization of naturally acquired resistance to ticks and thus reduce pesticide (acaricide) use.

2. Purpose: The purpose of this research is to develop tick control methods that rely on acquired resistance of cattle to ticks instead of close-interval applications of

acarcides. The approach requires the protection of cattle against ECF by naturally acquired immunity, by vaccination or by the use of curative drugs. Under some circumstances the strategic application of acaricides may be needed.

3. Output and Procedures:

a. Output: To survey the ticks and tick-transmitted diseases affecting indigenous Zebu cattle maintained on communal pastures according to local cattle management practices and then to implement and evaluate tick and disease control procedures to protect the cattle.

Procedure: This study will be done on Rusinga Island which is located in Lake Victoria adjacent to Mbita Point. The island is approximately 10 km long and 1 to 3 km wide. Farmers on the island graze their indigenous Zebu cattle on communal pastures. Enzootic ECF occurs there and cattle in the area are commonly known to be infested with several tick species including R. appendiculatus and A. variegatum. The quality of the cattle is very poor and is typical of situations where, because of ECF only the indigenous Zebu can survive to provide meat and milk for their owners. The study on Rusinga Island will proceed as follows:

(1) Cattle producers with small herds will been identified as potential cooperators. Approximately two years will be spent (a) assessing the husbandry practices used on the island; (b) surveying the diseases of the cattle; (c) studying the ticks on the cattle to determine the numbers and kinds of ticks on the animals, the seasonal cycles of tick activity, and the comparative numbers of ticks on individual animals of different ages; (d) collecting data on cattle productivity; and (e) obtaining data on climate and pasture vegetation.

(2) After baseline data have been obtained, cattle will be vaccinated against ECF and other diseases. Tick-resistance will be induced by the controlled application of ticks to the susceptible cattle, primarily calves. Cattle will continue to be examined on a regular basis to determine the numbers of ticks on them. Within a herd not all the cattle will be equally susceptible to ticks and some animals will consistently be more heavily parasitized than others. Such animals will be identified during the first phase of this study and, if possible, the farmers will be persuaded to cull the most tick-susceptible animals from their herds. Cattle will be observed for improved weight gains and milk production. Recommendations will be made to cattle owners and assistance provided to aid them in the use of the methods developed.

b. Output: To determine if tick-resistant Boran steers vaccinated against ECF will cause a decline of the tick population in a pasture containing no other tick hosts and if the weight gains of these animals are comparable to those of

other Boran steers dipped weekly in acaricides to effect tick control.

Procedure:

(1) This study will be done near Lolgorien on the Joseph Murumbi ranch in an area where ECF is enzootic. Experimental animals will be improved Boran steers obtained from an ECF-free area in northern Kenya. All the steers will be susceptible to both ECF and ticks.

(2) The cattle will be vaccinated against ECF, divided into two groups, and placed into two securely fenced tick-infested pastures after tick-resistance has been induced in one group. The tick-susceptible group will be dipped weekly to keep them free of ticks. The tick-resistant group will not be dipped.

(3) By the use of blanket drags an index of the tick population density will be obtained for each pasture before cattle are introduced. Thereafter, free-living ticks will be sampled at regular intervals to evaluate tick population trends. After the steers are introduced they will be examined at regular intervals to measure tick infestation levels.

(4) Rainfall amounts, daily temperatures, and data on the conditions of pasture vegetation will be collected at regular intervals.

(5) Individual animal weights will be recorded and mean weight gains between groups will be compared.

(6) The duration of the study will be 2 years.

c. Output: To establish in an enzootic ECF area a breeding herd of improved Boran cattle susceptible to ECF. Ticks will be controlled by using acquired tick-resistance and strategic acaricide applications, while ECF will be controlled by vaccination. Productivity and levels of tick infestation of the Boran cattle will be compared with animals in a Maasai herd of indigenous Zebu cattle maintained in a communal grazing area adjacent to the experimental pastures.

Procedure:

(1) This study will be done on ICIPE's Ndhiwa Farm which is located in in the southwest corner of Kenya within a few miles of the Joseph Murumbi ranch. The farm is located in an area where ECF is enzootic and only indigenous cattle are reared on communal pastures by Maasai herdsmen.

(2) Pregnant improved Boran heifers will be placed in a fenced pasture after they are vaccinated against ECF and exposed to small numbers of ticks to make them

tick-resistant.

(3) During the course of the study, which is planned for 5 years, tick infestations should remain at low levels if tick-susceptible animals, primarily individuals in the annual calf crop, are kept out of regular grazing areas until they become tick-resistant. Calves will be kept in tick-free areas until about one month of age. They then will be exposed to a small number of ticks to elicit resistance and then treated with acaricide before the ticks engorge and detach. It is possible that during a prolonged wet period increased tick survival rates would result in unacceptably large numbers of ticks occurring on the cattle. During such periods strategic acaricide applications will be made.

(4) During the course of the study tick densities on individual animals will be regularly noted. Cattle consistently infested with greater than average numbers of ticks will be culled from the herd.

(5) On a seasonal basis densities of free-living ticks will be measured by dragging. Climatic data and records on condition of the pastures will also be kept.

(6) For the improved Boran herd detailed records indicating herd productivity will be kept and will include the following data:

(a) Calving success,
(b) Weight of calves at birth,
(c) Growth rates of calves,
(d) Age at first estrus,
(e) Weights of all animals in the herd.

(7) Cooperation of a local Maasai herdsman will be obtained. A herd of indigenous Zebu cattle maintained under traditional Maasai husbandry techniques will be monitored to obtain comparative data on cattle growth, development, and reproduction. Additionally, data will be collected at regular intervals on levels of tick infestations on the Maasai cattle and on the quality of forage available to them.

(8) The duration of this study will be 4 to 5 years.

d. Output: To conduct further laboratory experiments to obtain additional information on the ability of ticks to stimulate acquired resistance in cattle and to determine the effects on ticks of feeding on resistant cattle.

Procedures:

(1) Laboratory space provided at KARI has been used to test the ability of *R. appendiculatus* to stimulate tick resistance in experimental cattle and to determine the effect

on ticks of feeding on resistant cattle. These experiments need to be extended. Nymphs fed on tick-resistant cattle molt into adults that are significantly smaller than normal. Quantities of nutritional reserves in the small adults will be compared with those in normal ticks. The comparative abilities of stunted and normal ticks to survive periods of environmental stress, such as prolonged exposure to relative humidities below the critical level, will be tested.

(2) Study the ability of cattle to develop tick-resistance to A. variegatum and B. decoloratus by repeating the experiments performed with R. appendiculatus.

(3) Use groups of cattle resistant to either R. appendiculatus, A. variegatum, or B. decoloratus to determine if animals resistant to one tick species are cross-resistant to the other two species.

e. Output: To extend preliminary observations on the resistance to infection by T. parva of tick-resistant cattle.

Procedures:

(1) Obtain two comparable groups (10 animals/group) of T. parva susceptible cattle. One group will be tick-resistant and the other tick-susceptible.

(2) Challenge animals in both groups of cattle by feeding identical numbers of T. parva infected R. appendiculatus on them. Follow the course of illness in animals that develop ECF and compare the susceptibility of tick-resistant and tick-susceptible animals to T. parva.

(3) During the period of peak parasitemia, place uninfected R. appendiculatus nymphs on the T. parva infected cattle. After the nymphs have molted to adults the salivary glands of the partially fed adults will be inspected to measure the level of their infection by counting parasitized type III acini in the tick salivary glands.

C. State of Knowledge

The earliest reported observations of acquired resistance of cattle to tick infestations were by Johnston and Bancroft (1918, R. Soc. Queensland Proc. 30: 219-317). Trager had (1939a, J. Parasitol. 25: 57-81; 1939b, J. Parasitol 25: 137-139) discovered that guinea pigs acquired resistance to Dermacentor variabilis larvae after one infestation. He also reported that a degree of tick resistance apparently could be passively transferred by innoculating serum from tick-resistant to tick-susceptible guinea pigs. As evidenced by the increasingly large body of literature on the topic of acquired resistance of hosts to ticks, current interest in this subject is consequential. Two recent reviews by Willadsen (1980, Adv. Parasitol. 18: 293-313) and Wikel (1982, Ann. Rev. Entomol.

27: 21-48) are excellent summaries of the state of knowledge of immune responses to ticks.

In general, the effects of resistance may be manifested in two ways. In the first case ticks, particularly larvae, on immune animals are unable to attach and feed, and a large percentage may be rejected in the first 24 hours after infesting a host. Among ticks parasitic on cattle this phenomenon has been demonstrated for Boophilus microplus larvae, and to a lesser extent for nymphs and adults on Bos taurus (European cattle) (Roberts, 1968, J. Parasitol. 54: 667-673) and also on Bos indicus (Zebu cattle) (Wagland, 1978, Austral. J. Agric. Res. 29: 395-400). Amblyomma americanum on Bos indicus, Bos taurus, and cross-breed cattle (Strother et al. 1974, J. Med. Entomol. 11: 599-563) stimulated acquired immunity as shown by a reduction in the number of ticks engorging and a decrease in engorged tick weights. Similar evidence of resistance has been obtained by feeding ticks on immune rabbits (Bowessidjaou et al., 1977, Experientia 33: 528-530) and guniea pigs (Allen, 1973, Int. J. Parasitol. 3: 195-200). Acquired resistance following tick infestation has been reported widely. A few researchers have artificially induced tick immunity with inocula containing salivary gland extract (Kohler et al., 1967, Berl. Munch. Tieraerztl Wochenschr 80: 396-400; Brossard, 1976, Acta Tropica 33: 15-36; Wikel, 1981, Am. S. Trop. Med. Hyg. 30: 284-288). Midgut, reproductive, and other internal organs have been successfully employed in the preparation of antigen extract to immunize hosts against ticks (Allen and Humphreys, 1979, Nature 280: 491-493; Ackerman et al., 1980, J. Med. Ent. 17: 393-399). In at least one instance homogenates of whole ticks have been used to artificially elicit immunity of rabbits to ticks (McGowan et al, 1980, J. Parasitol. 66: 42-48). The studies cited and others indicate that a vaccine to artificially protect against tick infestation is possible. However, as Wikel (1980) emphasizes, protective antigens will have to be characterized and obtainable in sufficient quantities at reasonable costs.

Much information is accumulating from efforts to characterize the mechnisms of immunity to ticks. Some investigations documented the involvement of cell-mediated immunity in experiments with guinea pigs as hosts (Allen, 1973, Int. J. Parasitol 3: 195-200; Wikel and Allen, 1976, Immunology 30: 311-316; Askenase, 1977, Am. J. Trop. Med. Hyg. 26: 96-103). Other studies have implicated humoral factors (including antibody, certain complement components, and mediators such as histamines) in the immune process when rabbits or cattle were the experimental hosts (Reik, 1958, Aust. J. Agric. Res. 9: 830-841; Roberts and Kerr, 1976, J. Parasitol. 62: 485-489; Fujinsaki, 1978, Nat. Int., Anim. Health Quart. Tokyo 18: 27-30). Researchers generally agree that a complex of immunologically mediated events causes alteration of the bite site in a manner that makes it unfavorable for the normal acquisition of the blood meal (Trager, 1939a; Reik, 1962, Aust. J. Agric. Res. 13: 532-550; Tatchell, 1969, Parasitol. 59:

93-104).

A small, but significant number of reports contain data which indicate that host immunity to a vector can negatively affect the success of transmission of vector-borne pathogens to the host. Francis and Little (1964, Aust. Vet. J. 40: 247-253) reported that Boophilus microplus resistant Droughtmaster cattle were significantly less likely to develop Babesiosis than animals susceptible to tick infestation. Bell et al. (1979, Am. J. Trop. Med Hyg. 28: 876-880) found that rabbits resistant to tick infestation were significantly protected against the transmission of Francisella tularensis. Wikel (1982) observed interferon at tick attachment sites on tick resistant animals and he suggested that the presence of the interferon might indicate a hostile environment for tick transmitted viruses.

McGowan at el. (1979, J. Parasitol. 65: 692-699) illustrated that acquired immunity of the cottontail rabbit to Haemaphysalis leporispalustris, the rabbit tick, may effectively serve as a mechnism to limit the density of populations of this tick. Australian acarologists faced with the crisis of controlling acaricide resistant Boophilus microplus populations also have been evaluating the role played by acquired resistance of cattle to B. microphus in the regulation of this tick's population size. Several scientists reported major differences in levels of resistance to B. microplus between Zebu and European breeds (Reik, 1967, Aust. J. Agric. Res. 13: 532-550; Francis and Little, 1964; Seifert, 1971, Aust. J. Res. 22: 159-168, Wagland, 1975, Aust. J. Res. 26: 1073-1080). Between breeds and also within breeds, differing capacities to acquire tick resistance are inherited (Hewetson and Nolan, 1968, Aust. J. Agric. Res. 19 :323-333; Wharton et al., 1970, Aust. J. Agric Res. 21: 163-181; Heweston, 1968, Aust. J. Agric. Res. 19: 497-505). Although initially opposed to the concept because of preferences for traditional breeds, economic considerations finally are causing many Australian stockman to adopt some of the tick-resistant breeds in place of tick-susceptible European cattle. As a result, profits for stockmen using the new breeds are greater and the need for acaricides has diminished appreciably (Heweston, 1981, Proc. Int. Conf. Tick Biol. and Control, Grahamstown, S. Afr. p. 91-93).

D. Recent Research Accomplishments at the ICIPE

As a result of the above considerations ICIPE has embarked on a program to investigate the feasibility of using biological methods for tick control concentrating initially on R. appendiculatus because of its importance in transmitting ECF and for its ability to cause debility in infested cattle.

The overall objective of these studies is to increase animal production in the tropics by developing an integrated method to control ticks and tick-borne diseases, which will involve the

use of tick-resistant host animals to control tick populations, and vaccines and curative drugs to control the diseases.

1. Naturally acquired resistance to *R. appendiculatus* in cattle (Type 1 resistance) and its effect on tick population dynamics.

When cattle are infested with *R. appendiculatus* they quickly become resistant. This resistance develops in cattle grazing tick infested pastures or following the single application of 500 female ticks confined in ear bags. The resistance produced is long lasting, for at least two years. It is manifested most markedly against larval ticks, less against nymphs, and least against adults. When normal ticks are applied to resistant cattle, reduced numbers feed to engorgement, and the weight of the engorged ticks is also reduced. Larvae or nymphs which do feed to engorgement molt into nymphs and adults which are greatly reduced in size and have a reduced survival potential when exposed to environmental stresses of unfavorable temperature and relative humidity. When larvae, nymphs, and adult ticks are fed sequentially on the same resistant animal, the adverse effects are enhanced and very few individuals survive to be engorged females. These adults are also greatly reduced in size and produce egg batches of low viability.

Two tests have been developed to identify resistance in cattle following infestation with ticks:

a. The 100 nymphs test: When 100 nymphs are fed on naive cattle, approximately 90% of them will engorge, with the engorged weight ranging from 8-9 mg. On the other hand when 100 nymphs are fed on a resistant animal 0-50% will engorge and the engorged weight will be less than 4 mg.

b. Intradermal Hypersensitivity Test: An extract with two protein fractions has been produced from larval *R. appendiculatus*. When one of these extracts is inoculated into tick-naive cattle, no reaction is observed. On intradermal inoculation into resistant cattle an immediate type hypersensitivity reaction occurs within 30 minutes, resulting in a marked swelling at the site of inoculation. When the skin test is carried out at regular intervals in naive cattle exposed in tick infested paddocks positive reactions are obtained a short time before the development of Type 1 resistance can be confirmed by the 100 nymphs test. So that, while the immediate hypersensitivity response may not be directly related to the development of Type 1 resistance, it is nevertheless a useful test in identifying animals previously exposed to tick infestations.

2. Development of *R. appendiculatus* populations at different host-stocking densities

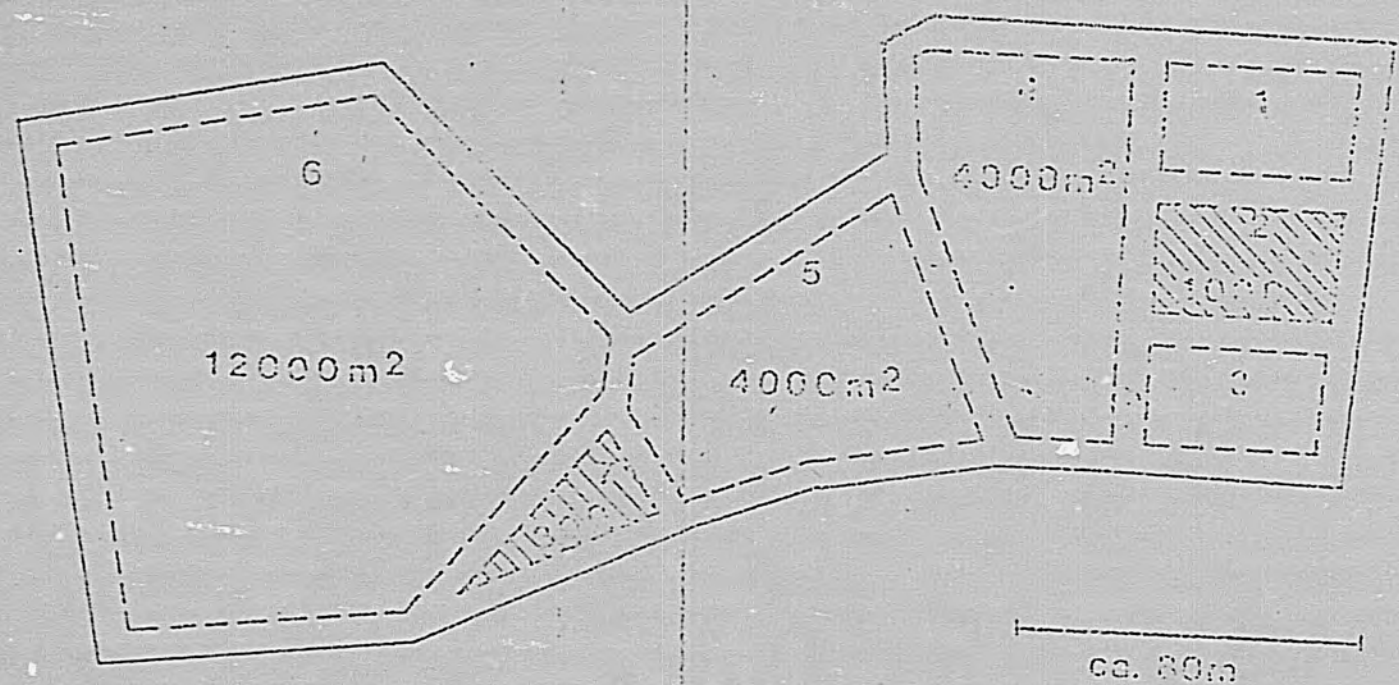
This investigation was to show the interaction

relative to tick population dynamics between high stocking density, which cause rapid pick-up of ticks waiting on the ground for a host, and the concomitant reduction in favorable tick habitat due to grazing and trampling that would also increase with host density. The 7 experimental plots varied in size from 300 to 1,200 M^2 and, except for two unstocked control plots, each plot was stocked with a single oxen (Figure 1). The plots were all infested with unfed larvae and nymphs at the same mean density in June 1976, when the 5 host oxen (B. taurus type adult steers) were then introduced. Intensive observations were made until April 1979 on the numbers of ticks on the hosts and on the vegetation, and on the state of the vegetation itself. The tick populations all followed essentially the same pattern (Figures 2-6), reaching very high numbers of adults on the hosts in March-June 1977. Then they declined steadily to virtual extinction in 4 of the plots, and very low numbers in the fifth. R.appendiculatus normally has an annual activity cycle with maximum numbers of adults on livestock in April during the long rains. However, results indicated no resurgence of activity in any month of 1978 or 1979. In the light of other experience it was hypothesized that during the first year, the hosts had developed resistance to tick infestation which had in some way disrupted the tick life cycle. Observations were continued during 1978-1979 to see if host resistance would eventually wane after the tick challenge had been reduced and thus allow some recovery in tick numbers to take place. This did not happen.

The 5 oxen were removed from the paddocks in April 1979. They were transferred to the labortory where small numbers of tick larvae, nymphs and adults were fed on them to detect tick-resistance.

The control consisted of two native calves that had never been exposed to acaricides. Calves were used because native adult steers are expensive and their exposure to acaricides for extended periods, could have affected the tick feeding performance. It should also be explained that the ticks were fed on the ears of cattle. The ticks were confined inside of cotton bags which were attached to the base of the animals ears with zinc oxide plaster. As noted in Table 1 small numbers of ticks were applied to the resistant cattle because previous experience had shown that large numbers of ticks applied to the ears of resistant cattle produced a severe local reaction involving considerable swelling of the ears, exacerbated by the confining ear bags. Larger numbers of ticks were applied to the naive cattle because a severe local reaction was not anticipated, and the ticks produced were to be used in other experiments.

For each group of ticks fed on each of the 5 steers (Table 1) there was a marked reduction in both the percentage engorging and the mean engorged weight, thus confirming some degree of host resistance. Apparently, during the period on the pasture,



LAYOUT OF TICK-HOST EXPERIMENT
One ox per plot, except 2 and 7
Figure 1.

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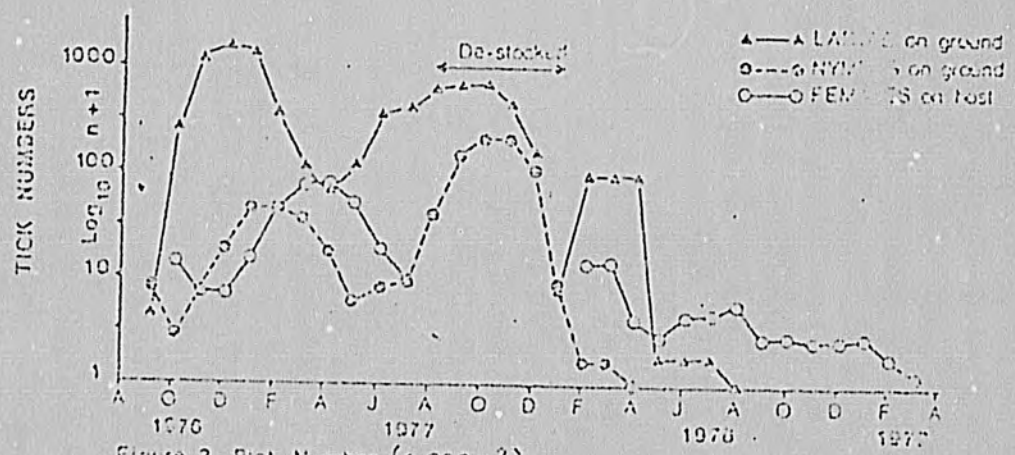

Figure 2. Plot Number (1,000 m²)

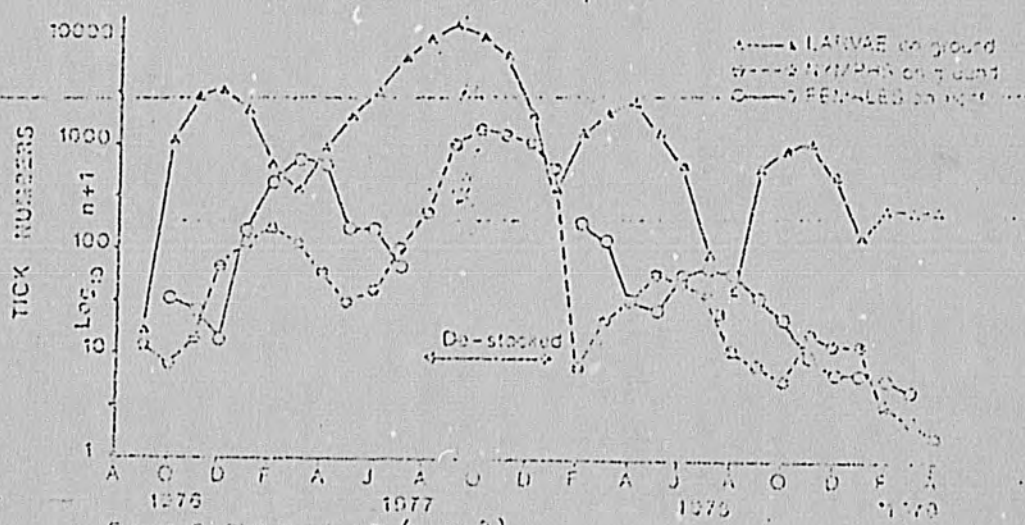

Figure 3. Plot Number 3 (1,000 m²)

Figures 2 & 3. Tick populations in paddocks, in 5 experimental paddocks

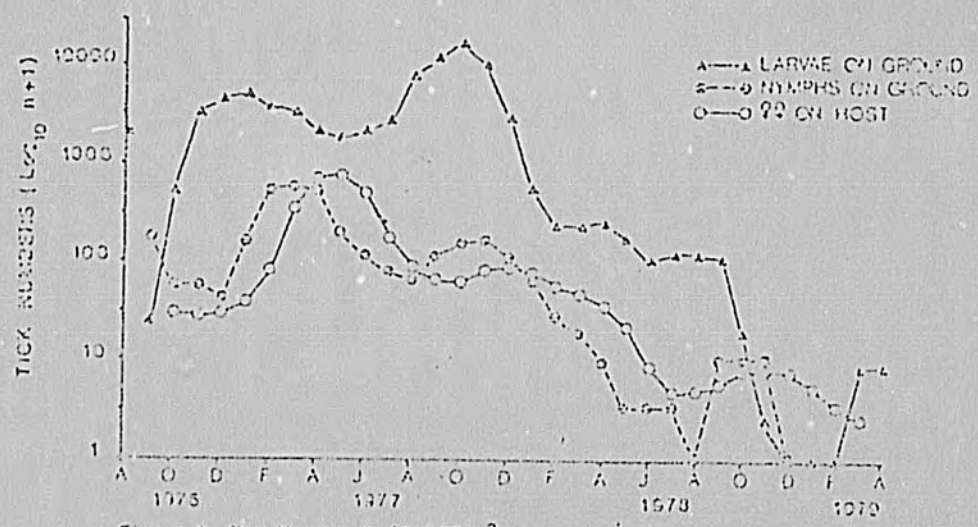

Figure 4. Plot Number 4 (4,000 m²)

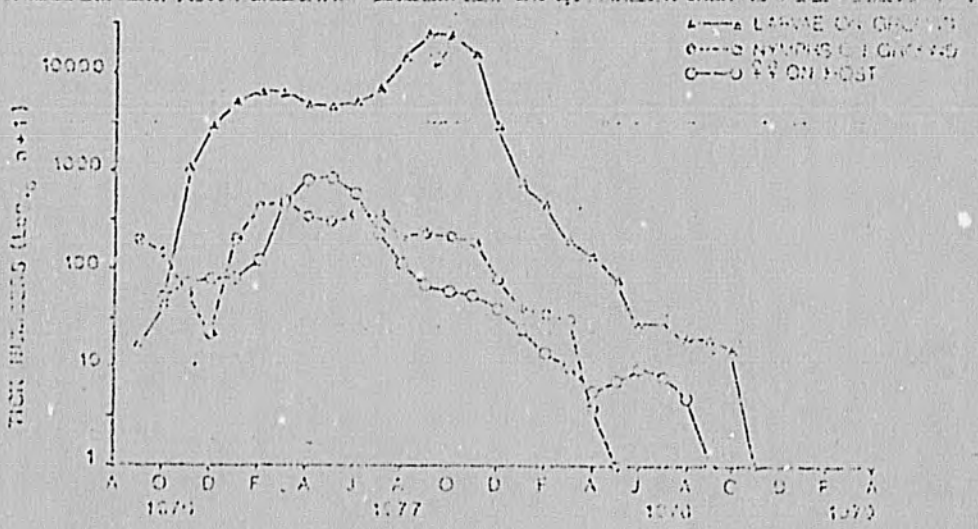

Figure 5. Plot Number 5 (1,000 m²)

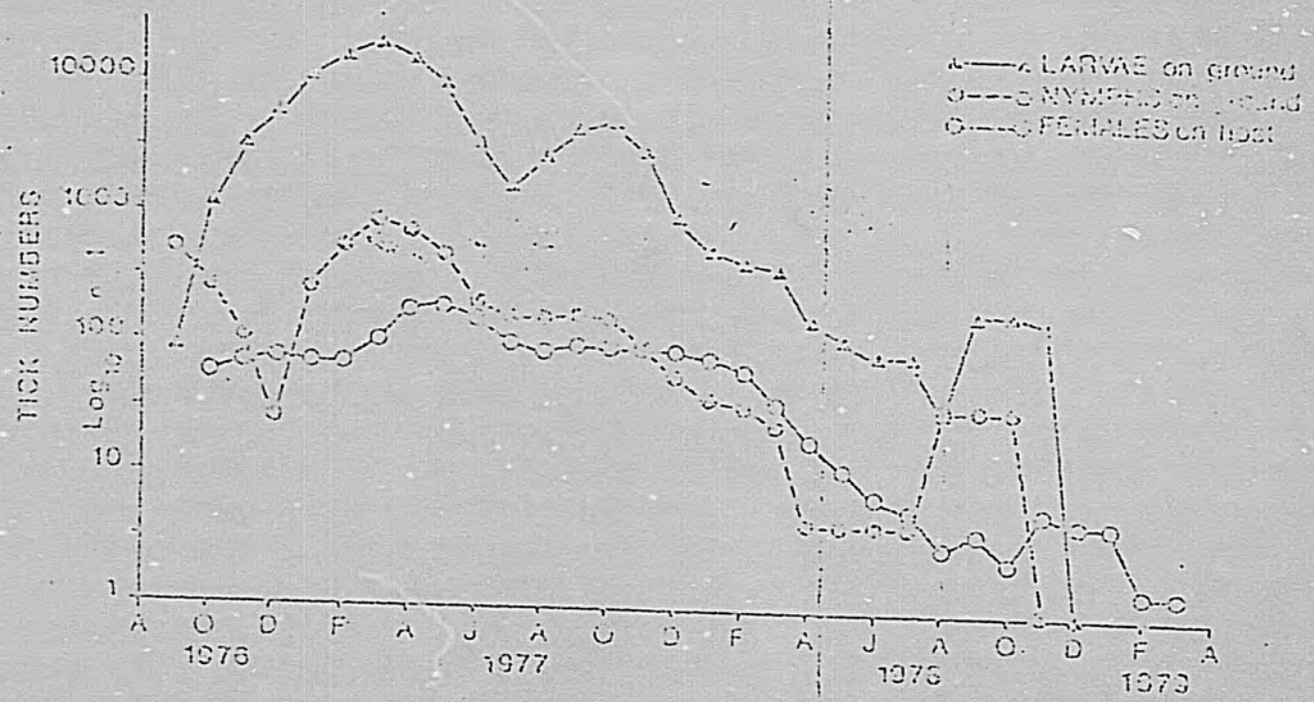

Figure 6. Plot Number 6 (13,000 m²)

acquired Type 1 resistance by the oxen to tick infestation reduced the tick populations to very low numbers, or even extinction. The original objectives of the experiment were not achieved because the unexpected impact of the acquired tick-resistance by the oxen obscured the effect on tick populations of different stocking rates and pasture conditions.

TABLE 1 Mean feeding performance of ticks fed on five oxen after 34 months exposure to experimental tick populations, compared with two naive 6-9 month old Friesian bull calves.

Hosts	Mean engorged Weight (mg)	Percentage engorged	No. of ticks tested/host
LARVAE			
5 oxen		1	100
2 calves	0.4	74	2,000
NYMPHS			
5 oxen	3.7	15	100
2 calves	8.9	81	100
FEMALES			
5 oxen	253.1	10	10
2 calves	364.7	91	500

3. Effect of Host Resistance on R. appendiculatus Population Development

Proceeding from the results of the previous experiment, a further experiment was started in October 1979. The first part was completed in December 1980. The experimental designs (Figure 7) included 3 plots of equal size and infested with identical numbers of ticks. Tick-susceptible animals were placed on plot 1 and left there for the duration of the experiment. Tick-susceptible animals were placed on plot 2 and replaced at intervals by other tick-susceptible cattle. Resistant animals were kept on plot 3 throughout the experiment:

The hypotheses were:

a. There would be little or no production of nymphs or adults in plot 3, but the numbers of nymphs and adults in plots 1 and 2 would increase.

b. Breeding success of any tick adults produced in plot 3 would be lower than in plots 1 and 2.

c. Susceptible cattle in plot 1 would develop resistance to ticks as a result of exposure to tick feeding, and reduction in tick populations would appear.

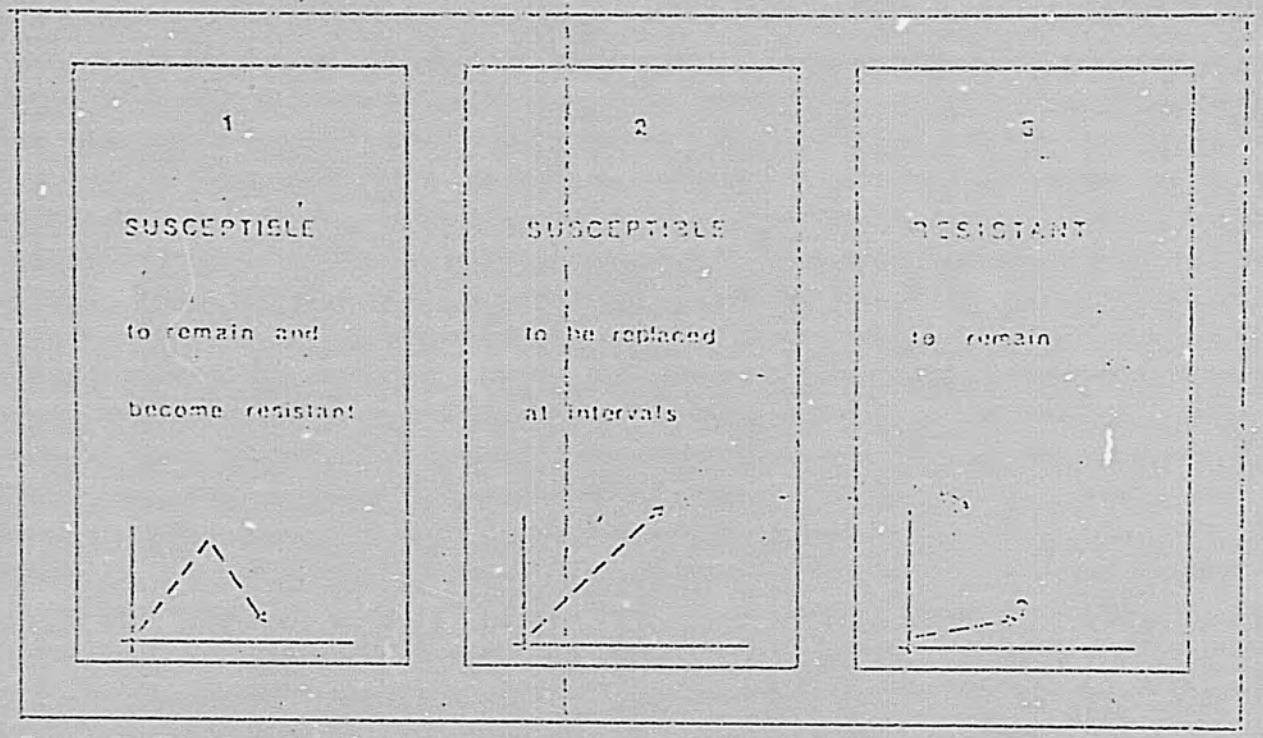

Figure 7. Experimental design for effect of host resistance to R. appendiculatus

Each plot approx. 0.6 hectares

UNFED LARVAE introduced 18.10.79 21/ m^2

2 CATTLE per plot introduced 29.10.79 =DAY 0

SAMPLING : blanket (grass) ; octopus (skin ; counts and collections

d. Replacing the hosts in plot 2 with other tick-susceptible cattle (this was done 3 times) would minimize effects on the tick population of feeding on tick-resistant cattle and would result in a sustained increase in tick numbers.

Before the experiment started, we demonstrated in the laboratory that nymphs which engorged on resistant hosts (and were therefore under-weight) molted into undersized adults. It was also found that the size of the scutum is directly related to the size of the unfed tick and therefore could be used to determine the original size of partially fed ticks obtained from oxen. Change in size of the rigid scutum in nymphs, and adult males and females fed in the field on tick-resistant cattle also was investigated. Experimental cattle were removed from the plots in September 1980; and, in late November, one pair of susceptible bait cattle was exposed for 9 days in each plot to assess tick numbers. Counts of the numbers of ticks attached to each of the bait animals provided an index of the size of the residual tick population in each of the 3 plots (Table 2).

TABLE 2 Number of ticks in plots after one year counted on two host cattle per plot after 9 days exposure, and also by ground sampling.

		Host	Paddock 1	Paddock 2	Paddock 3
WHOLE BODY COUNTS					
	Adults	A	636	3659	13
		B	423	2377	19
SKIN SCRAPES PER CM2					
	Nymphs	A	0.1	0.1	0.1
		B	0.1	0.3	0.1
	Larvae	A	7.3	61.6	0.1
		B	6.9	31.9	0.1
GROUND SAMPLING PER 100 M2					
	Nymphs		0.4	7.8	0.4
	Larvae		47.9	597.9	7.1

In estimating the number of ticks feeding on the cattle, the adult ticks were counted directly, while the nymphs and larvae which attach and feed on the lower parts of the body were estimated by counting the ticks obtained from a measured area of the brisket, using a scalpel to scrape off the superficial layer of skin. The skin scrapes were examined microscopically and numbers were expressed per square centimeter of skin.

To determine the concentration of ticks on the vegetation, a one meter square piece of rough towelling cloth was dragged for 100 metres across the vegetation in a plot. Only larvae and nymphs which are actively questing and thus available to be picked up by grazing cattle are collected by this method.

Adult ticks do not attach to the cloth.

All of the hypotheses were confirmed, and reductions were demonstrated in scutal size where host resistance effects were to be expected (Table 3), namely in paddocks 1 and 3 while no reduction in scutal size was seen in paddock 2.

TABLE 3 Changes in scutal size (in mm) in experimental tick populations after one year: first-generation nymphs, December 1979-January 1980; first-generation adults, January-July 1980 (Mean ± S.D.)

	Scutal size in mm		
	Paddock 1	Paddock 2	Paddock 3
NYMPHS			
1st generation	0.49 ± 0.02(204)	0.48 ± 0.03(215)	0.45 ± 0.03(25)
December 1980	0.46 ± 0.02(13)	0.48 ± 0.02(32)	0.44 (1)
MALE			
1st generation	1.31 ± 0.08(99)	1.28 ± 0.10(158)	1.14 ± 0.13(18)
December 1980	1.26 ± 0.07(175)	1.29 ± 0.07(93)	1.22 ± 0.11(31)
FEMALE			
1st generation	2.83 ± 0.33(185)	2.75 ± 0.30(375)	2.29 ± 0.15(30)
December 1980	2.57 ± 0.24(148)	2.94 ± 0.29(55)	2.38 ± 0.40(14)

(Number in sample in brackets)

The scutal size is directly related to the size of the tick before feeding, which in turn is affected by the resistance state of the host on which the previous instar has fed. All of the adult ticks were of necessity obtained from cattle because adult R. appendiculatus cannot be collected by dragging, therefore, they had fed for an indefinite period before collection. Thus, scutal size was the only method available to determine the size of the unfed adult ticks and did reflect statistically significant decreases in size among the ticks that fed on resistant cattle.

4. Induced Type 2 resistance in host animals following inoculation of target antigens from ticks (It should be noted that this part of the project is not to be funded by AID, but is briefly described here to provide background information concerning the overall tick research effort at ICIPE.)

Using the complement fixation test, bovine immunoglobulins have been demonstrated in the haemolymph of R. appendiculatus adults

previously fed on cattle. When Ornithodoros porcinus ticks are fed on rabbit blood containing high titer agglutinins against T. brucei, agglutinins could be demonstrated in the tick haemolymph.

Homogenates of R. appendiculatus eggs, unfed larvae, unfed nymphs and unfed adult ticks were emulsified with Freunds complete adjuvant and inoculated into rabbits. High titer antigens were detected against the relevant antigens using agar gel double diffusion and indirect haemagglutination tests. When larvae, nymphs and adult ticks were fed on these rabbits, the ticks fed normally and no adverse effects were noted.

Fully engorged R. appendiculatus females were used to produce a homogenate which was then inoculated into rabbits with adjuvant. The rabbits were boosted 3 weeks later with the same preparation and high titer antibodies were produced. When adult ticks were applied to these immunized rabbits, the ticks were unable to feed properly and the majority of the ticks died before eggs were produced. Very small numbers of larvae hatched from the egg batches produced by the surviving ticks.

Serum from rabbits which had demonstrated the most marked adverse effects against feeding ticks was then used in an agar gel double diffusion test and the precipitated antibody antigen complexes were collected. These complexes were emulsified in Freund's complete adjuvant and inoculated intradermally into rabbits. The rabbits were boosted twice with the same preparation. When adult ticks fed on these rabbits, the female ticks engorged normally and laid eggs, but the hatchability of the eggs was reduced by 80-90%.

5. Transmission of T. parva to and from Cattle Resistant to R. appendiculatus

A group of six indigenous Zebu cattle (1-2 years old) were purchased at Sindo Market, which is close to the ICIPE Field Station at Mbita, and where ECF is enzootic. The cattle were brought to the Veterinary Research Department at Muguga. Blood smear examination confirmed that all of the cattle were infected with theilerial piroplasms, species unknown.

To investigate their resistance status to R. appendiculatus, a 100 nymphal test, and an intradermal hypersensitivity test were applied to each animal. Approximately 60% of nymphs engorged, and the engorged weight was approximately 75% of control nymphs. The intradermal test gave a positive reaction in all cattle. These results confirmed that the cattle had naturally acquired resistance to R. appendiculatus.

In an attempt to identify the theilerial parasite seen on blood smear examination, transmission was attempted by applying 2,000 R. appendiculatus nymphs to the ears of each animal. The host

reaction to the large number of ticks applied was severe and less than 200 ticks fed to engorgement on each animal. The average engorged weight was approximately 4 mg. On dissection, 2% of the ticks were found to be infected with a theilerial parasite which on transmission to cattle proved to be T. parva. Field collections of adult ticks from Mbita and Sindo were found to have an infection rate of less than 2% with T. parva. Thus, tick-resistant cattle appear to limit the T. parva infection rate in ticks.

To investigate this matter further, the following pilot experiment was carried out. Four ECF susceptible Bos taurus type cattle were used, two of them tick-naive, and two resistant to R. appendiculatus following infestation. One hundred R. appendiculatus nymphs which had engorged as larvae on an animal infected with ECF, and having an infection rate of 12% were applied to each of the four cattle in ear bags. Sixty-five and sixty of the nymphs, respectively, fed to engorgement on the tick-naive cattle, both of which became infected and died of ECF. Thirty-four of the nymphs fed on one of the resistant cattle, which after an extended prepatent period became infected with ECF and died. Twenty-eight fed to engorgement on the remaning resistant animal, which did not became infected with ECF.

In an attempt to transmit the disease four-thousand uninfected R. appendiculatus nymphs were applied to each of the cattle which eventually died from ECF, at a time calculated to allow engorgement to coincide with a high piroplasm parasistaemia in the infected cattle, thus assuring maximum infection rate in the ticks. On the two naive cattle, 95% of the nymphs engorged and the average weight was 9.2 and 8.2 mg. On the infected resistant animal 50% of the nymphs engorged and the average weight was 6.7 mg. Of the nymphs which engorged on the tick naive cattle 60% were infected with T. parva with an average of 17 acinar cells infected per tick (each infected acinar cell contains approximately 30,000 sporozoites, the infective stage for cattle). Of the ticks which engorged on the infected resistant steer, 14% were infected with T. parva with an average of 1.3 acinar cells infected per tick.

It is possible therefore that cattle resistant to R. appendiculatus will greatly reduce the rate of transmission of T. parva, thus enhancing the efficacy of vaccination against the disease by reducing challenge, and contributing to the development of an integrated method of controlling ECF, and ticks with minimal reliance on acaricides.

III. PROJECT ANALYSIS SUMMARIES

A. Technical Analysis:

1. Tick control on cattle in Africa and in most other places in the world depends upon the repeated application of acaricides by spraying or dipping. The effective treatment interval may vary from twice a week to once every 21 days and the period of treatment may be all year long in some parts of the tropics to no more than several months during the summer or the rainy season in other areas. In addition to the cost of acaricides and their application, there are environmental hazards associated with their use, and also not insignificant risks to human and animal health due to possible intoxication. Natural selection pressure for acaricide resistance is high in many areas and new cases of acaricide resistance in ticks are being reported at an alarming rate. In fact, 18 countries in the world are known to contain acaricide resistant ticks. Tick-resistance to all the major groups of acaricides is known. The pesticide industry is concerned that before they are able to obtain a profit from the sale of a particular acaricide, ticks may exhibit resistanct to it.

At present there are few alternatives to acaricides for tick control. Under some circumstances pasture-spelling is effective against host-specific ticks, but the method is difficult to implement and under some conditions ticks such as R. appendiculatus could survive in a vacated pasture as long as two years. Biological control with parasitoid wasps has been unsuccessful and this approach to tick control appears to have very little potential. An experimental genetic control procedure has been developed for use against B. microplus and B. annulatus, but the development of additional genetic control methods in the near future is unlikely.

Tick-resistant cattle are being successfully used in Australia against a one-host tick species and the technique has potential value in Africa particularly against tick species with limited host ranges. Along with the selection and utilization of cattle with the ability to acquire resistance to ticks, related developments in the eventual development of anti-tick vaccines have future promise.

Can the people in Africa who manage small herds of cattle apply the technology that the ICIPE research project is likely to develop? The answer is affirmative. Many of the Africans such as the Maasai herdsmen are very knowledgable about the care of their cattle. The management techniques to be developed will not require any special technical skills and during the course of the research practical recommendations will be developed. Of course, the key to the successful application of new tick control procedures is first for cattle producers to vaccinate their cattle against ECF.

2. Research Facilities: ICIPE owns or has access to a variety of laboratory facilities, experimental pastures, and pastures with animal herds owned by cooperators. Adequate facilities and places for conducting the proposed research are available and include (See map of Kenya with approximate locations marked).

a. The central ICIPE administrative offices, conference room, and laboratories are located on the campus of the University of Nairobi.

b. The ICIPE Mbita Point Feald Station has offices, research laboratories, housing accommodations and buildings for housing cattle and other experimental hosts. Rusinga Island is 2-3 km from this facility.

c. ICIPE's Ndhiwa Farm is located in southwestern Kenya and will provide 500 acres of pasture for the Livestock Ticks Research Program. This facility was just acquired and must be developed.

d. Experimental pastures, cattle stalls in animal holding buildings, and laboratory space with facilities for experimental animals are provided for ICIPE at Muguga in the Veterinary Research Department of KARI.

e. The Ranch of Mr. Joseph Murumbi is near Lolgorien in southwestern Kenya near the Ndhiwa Farm. Experimental pastures and improved Boran steers are available for use in the proposed project.

f. If needed, laboratory facilities are available in the Department of Zoology, Kenyatta University College located in the Nairobi area.

3. The Livestock Ticks Reseach Program at ICIPE has working relationships with a variety of other scientists. Included are scientists assigned to ICIPE support programs as well as a number of individuals from other reseach groups in the Nairobi area. There appears to be a considerable amount of constructive interaction between these various scientists. Three of these people will play a direct role in the proposed research. Dr. David Whitehead (ICIPE biochemist) will provide technical support to the effort to measure nutrient reserves of ticks. Drs. Alan Young (KARI epidemiologist) and Tom Dolan (KARI veterinarian) will cooperate with portions of the research involving ECF chemotherapy or vaccination. ICIPE will continue to cooperate with ILRAD in investigating the development of Type 2 resistance to ticks in cattle. A complete list of the scientists of the Livestock Ticks Research Program and the various scientists with whom they interact is presented in Annex 5.

ICIPE is one of 11 organizations in Kenya whose mission involves research on animal diseases, disease vector and their effect on livestock productivity. Recently, the "Nairobi Cluster" was created as a formal organization for enhancing communication and cooperative between member institutes. The purpose of the group, as they have stated it is as follows:

"The Nairobi Cluster is a scientific group that has been established amongst research institutes and departments in Kenya, to create a forum and framework for the exchange of scientific ideas and information, and to promote collaboration between scientists working on animal diseases and their vectors.

The Nairobi Cluster also aims to disseminate the results of scientific research to government, veterinarians, farmers, donors, industry and all others who might benefit from the work being conducted". The existence of this research group will provide additional avenues of cooperation and collaboration for ICIPE scientists and could increase the probability of developing improved methods for tick control. The member institutions of the Nairobi Cluster are listed in Annex 7.

B. Socio-Economic Soundness Evaluation

1. Introduction:

Ticks and tick-borne diseases have been a limiting factor to livestock production in many areas of the world and are of particular significance in Africa. The magnitude of tick losses can be illustrated by examining those which occur annually in the western hemisphere (U.S. dollars): Argentina - 88 million, Colombia - 66 million, Mexico - 287 million, USA - 100 million, and Venezuela - 16 million (Masiga, 1981, Proc. Conf. Ani. Dis. Res. Livestock Prod. Afr., 175-176). It is estimated that in Kenya 50,000 to 70,000 improved cattle die each year from ECF.

In addition, to the livestock losses the cost of controlling ticks is significant. In Kenya, for example, there are about 4,500 dip facilities (Masiga, 1981). These cost about 6,000 (U.S. dollars) per unit to construct. The annual cost of acaricides for dipping cattle in Kenya, are estimated to range from 8 to 9 million (U.S. dollars). Maintenance and the supply of water must be added to the above costs.

Reducing tick and tick-borne disease losses is an important consideration in African agricultural production. Cattle numbers in Africa have increased from 150 million head in 1969-71 to 170 million head in 1980 (FAO, Vol. 34.1980). Carcass weight has remained constant at 138 kg/animal in 1969-71 and 139 kg/animal in 1980. Therefore, productivity per animal on the average has not changed. Total beef and veal

slaughter in Africa increased from 2,339 thousand metric tons in 1969-71 to 2,909 thousand metric tons in 1980. During the same period population rose from 354 million to 470 million. As a result beef availabilty declined from 6.6 kg per capita to 6.2 kg per capita. The foregoing analysis excludes beef that was consumed on the farms.

The above data indicate the need to improve livestock production in Africa. Therefore, research to reduce livestock losses due to ticks and tick-borne diseases is important not only to individual farmers but to the economy of Africa as a whole.

2. Evaluating research

There are many difficulties involved in evaluating research on an "a priori" basis. These problems are well documented and will not be discussed (World Bank Working Paper No. 360, 1979). It is generally agreed that investment in agricultural research has a high payoff. Studies indicate that the internal rate of return to public expenditures in agricultural research in the United States is 30-50 percent, India 60 percent, and Columbia 70 percent.

ECF transmitted by ticks is considered to be the most important cattle disease in East and Central Africa and has been a limiting factor in improving cattle productivity. ICIPE cooperated in a UNDP-FAO Regional Project to address the ECF issue. As a result of this research a curative drug and a practical method of vaccination will be available in 1983. In addition, under a previous AID research grant ICIPE investigated the stimulation of acquired resistance in cattle to ticks. This research has been successful and is reported in Section II.C.

ICIPE has laid a good research foundation in determining tick resistance in cattle. ICIPE, through the ECF project has also demonstrated a capability for cooperating with others in addressing a complex research problem. The proposed project would extend the basic research generated by ICIPE to the development of tick management systems. Investigations will involve indigenous cattle as well as improved breeds with the objective of improved productivity and to gain information so that farmers can upgrade their herd with high producing breeds. The return from this research should be significantly higher than those cited previously due to the current low productivity of the indigenous cattle.

3. Role of the project

With the availability of a curative drug and vaccination scheme for controlling ECF, ICIPE is shifting the focus of its research to investigate and identify tick management strategies for cattle production. The research output of the project will be used by the National programs in East and Central Africa to develop management systems that can be used by farmers to improve the productivity of their existing herds and improve their herds through breeding programs.

4. Potential benefits and savings:

As noted previously in this report dipping with acaricides is the current method of controlling ticks on cattle in Africa. This is a costly method, stressful on the animal, damaging to the environment, and dangerous to human health. The output of the research outlined above will be used by the National programs to develop management systems that can be adopted by farmers. There should be minimal sociological impediment to this adoption because farmer have accepted the use of acaricides and drugs and are known to attend agricultural fairs and exhibitions to gain knowledge on new farming practices.

The potential benefits of this research are an increase in the productivity of the indigenous cattle and the creation of management systems that will enable farmers in enzootic ECF areas to adopt improved breeds that can acquire tick-resistance. The increased availability of meat and livestock products will enable the subsistence farmer to improve the nutritional level and well being of his family as well as society as a whole.

The reduced use of acaricides will be associated with both benefits and savings. By using strategic dipping, less scarce public and private funds will need to spent on acaricide. For example, in Kenya if acaricide dippings could be reduced by 50 percent the Government would save an estimated 4.5 million (U.S. dollars) annually on the purchase of materials. This also would have an impact on foreign exchange because acaricide materials must be imported. In addition, there would be savings by reducing the need for constructing new dipping facilities, mainteinance of existing facilities, and the supplying of water.

An intangible benefit from this research project is a reduction in environmental contamination from the acaricide use and a reduction of the dangers to human health.

5. Summary:

The research proposed in this project is an extension of the basic research program currently funded by AID. The knowledge gained in the experimental research on acquired tick-resistance in cattle is now ready for larger scale field testing. The large scale field tests are a necessary intermediate step for identifying strategies that can be used by National Research to develop management systems for integrated tick control. ICIPE is the logical organization to carry out this research because they have been involved in the basic research. Funding by AID of this project extension would enable ICIPE to test management strategies and rapidly extend the research output to the National programs. Continuity in research is an important consideration in developing new systems.

C. Environmental Concerns

An initial environmental examination (IEE) recommending a categorical exclusion is provided in Annex 4.

IV. ADMINISTRATIVE ARRANGEMENTS AND IMPLEMENTATION PLANS

A. Administrative Arrangements: The organization that will administer the project will be ICIPE. ICIPE has a competent administrative staff capable of providing the necessary managerial and financial services. The scientific team assigned to the project has the necessary background and skill to achieve research objectives. The project has an experienced project leader who has established cooperative linkage with National and International programs including ILRAD, KARI, and Kenyatta University College. Although the linkages are informal, the research commonality (i.e. control of ticks and tick-borne diseases) among the cooperating institutions make continued and strengthened cooperation probable.

Annual work plans will be developed by the project leader that will specifically outline overall project objectives and strategies as well as specific objectives of individual experiments. Periodic review of the work plans will provide an excellent method to insure that project and administrative goals are met in a timely manner.

B. Implementation Plan

1. Implementing Agents: The project will involve the input of two implementing agencies; ICIPE and AID.

a. ICIPE: ICIPE is the key implementing agency in the project. ICIPE will be the management entity and provide most inputs including scientists and technical support

staff as well as physical facilities and equipment. Accordingly ICIPE will be responsible for the arrangement and the implementation of research activities. The institution's Director has the overall managerial and financial responsibility for the project's implementation.

The project leader is responsible for research direction and the day-to-day implementation of project activities. Working with individual scientists and technicians the project leader will develop an overall project implementation strategy. Individual scientists in turn are assigned specific areas of responsibility for which they will develop work plans. The work plans, discussed in section IV.A will provide detailed implementation plans for individual experiments.

b. AID: The primary AID role will be project monitoring. The mechanism for technical monitoring of the project will be thru in-depth external reviews. The proposed Calendar of Events lists three such reviews during the life of the project. Review teams will be composed of 2-3 technical experts and one AID representative and will be funded from the AID/S&T/AGR Livestock Management PASA or other similar sources. The reviews will produce a comprehensive technical assessment of the project and recommend changes if appropriate. REDSO/EA will provide periodic non-technical management reviews relating to work plan implementation. Scientific consultation will be provided to the project upon request from AID/W via the Livestock Production Systems Cluster.

2. Proposed Calendar of Events

Date	Action	Primary Responsibility
	Project Development Schedule	
July 1982	Submission of PP to AID/W	REDSO/EA
Oct 1982	Submit PP/Proposal for RAC Review	AID/W
Nov 1982	AID/W Review and Project Authorization	AID/W
Dec 1982	PAF Authorizing 5 year Project Life	AID/W
Dec 1982	PIO/T Authorizing 1st Year Funding	AID/W
Jan 1983	Grant Agreement Signed	AID/W REDSO/EA ICIPE

Months after Proj.Begins	Project Implementation Schedule	
1(Jan 1983)	Project Begins	ICIPE
6	Management Review	REDSO/EA
11	PIO/T Authorizing 2nd Year Funding	AID/W
13 (Jan. 1984)	Work Plans for 2nd Year, Annual Report Completed	ICIPE
14	1st In-depth External Review	AID/W REDSO/EA ICIPE
23	PIO/T Authorizing 3rd Year Funding	AID/W
23	Work Plans for 3rd Year	ICIPE
24	Annual Report Completed	ICIPE
25 (Jan 1985)	Management Review	REDSO/EA ICIPE
30	2nd In-depth External Review	AID/W REDSO/EA ICIPE
34	PIO/T Authorizing 4th Year Funding	AID/W
35	Work Plan for 4th Year	ICIPE
36	Annual Report Completed	ICIPE
37 (Jan 1986)	Management Review	REDSO/EA ICIPE
46	PIO/T Authorizing 5th Year Funding	AID/W
47	Work Plan for 5th Year	ICIPE
48	Annual Report Completed	ICIPE
49 (Jan 1887)	Management Review	REDSO/EA
58	Recommendations for Project Extension	ICIPE
60	3rd In-depth External Review	AID/W REDSO/EA ICIPE
61 (Jan 1988)	Management Review	REDSO/EA
	Completion of Project	ICIPE

C. Evaluation Plan and Monitoring Arrangements

1. The proposed project is an extension of research begun with the support of previous AID grants. Much of the current research of the ICIPE Livestock Ticks Research Program forms the foundation for the proposed project and is either in its final stages of completion or is being incorporated into manuscripts. Progress on the early phases of the proposed project should be rapid because of the state of current work and the lead time before the proposed project is funded. Therefore, an in-depth external review 12 to 14 months into the project would provide ICIPE an opportunity to exhibit their accomplishments and to interact with the review team relative to both their research findings and plans. At an early stage in the program AID should have assurance of appropriate progress and orientation of the project.

2. The following recommended schedule for evaluation and monitoring is integrated into the overall implementation plan:

Months after Project Begins	Type of Review
6	Management Review
14	First In-depth External Review
25	Management Review30Second In-depth
30	External Review
37	Management Review
49	Management Review
60	Final In-depth Review

3. Each member of an in-depth external review team should have a copy of the project proposal and the pertinent series of annual reports, work plans, and review documents at least a month before they arrive in Nairobi.

4. The ICIPE should be provided clear instructions relative to the information required in annual reports and work plans, and the format for preparing these.

D. Financial Plan and Arrangements

1. Procurement of miscellaneous commodities with funds provided hereunder shall be accomplished in accordance with existing procedure and good commercial practices. Procurement of units exceeding $12,000 or the local currency equivalent will not be eligible for financing hereunder unless agreed to by AID in writing prior to procurement.

2. Funds for this project should be transferred from AID/W to the Regional Finance Management Center (RFMC) Nairobi. This will facilitate timely payment by AID. of expenses incurred by the project.

3. A summary cost estimate and financial plan for the project is projected in Table 4 which includes other donors contributions from ICIPE unrestricted core budget to the project. Table 4 is supplemented by Annex 2, a 5 year detailed budget of projected expenditures.

Table 4: Summary of Cost Estimate and Financial Plan for the ICIPE Tick Project

Donor Organizations:	AID	UNDP	SWISS	EEC	TOTAL
	(Thousands of Dollars U.S.)				
Year					
1983	250.0	95.2	139.2	223.0	707.4
1984	300.0	103.0	139.2	220.0	762.2
1985	300.0	104.0	*	210.0	*
1986	300.0	106.0	*	170.0	*
1987	300.0	*	*	*	*

*New agreements to be negotiated.

ANNEX 1

AID 1020-28 (1-72)

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 83 to FY 87
Total U.S. Funding $1,450,000
Date Prepared: June 29, 1982

Project Title & Number: TICK RESISTANT CATTLE IN THE ECOLOGICAL MANAGEMENT OF TICKS

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: To improve cattle production through the utilization of naturally acquired resistance to ticks and thus reduce pesticides use.	Measures of Goal Achievement: Measurable increase in the marketing of beef and dairy products as well as a measurable decrease in purchase and use of acaricides.	Statistics from national departments of agriculture documenting levels of beef and dairy production as well as sales of acaricides.	Assumptions for achieving goal targets: In conjunction with a practical means of vaccinating cattle against East Coast Fever (ECF) and the availability of an ECF curative drug the use of naturally acquired tick resistance and selected tick resistant breeds of cattle can improve cattle health and productivity.
Project Purpose: To evaluate the role of naturally acquired tick resistance in cattle and to develop improved management practices in the limitation of tick parasitism of cattle.	Conditions that will indicate purpose has been achieved: End of project status. Adoption of tick reduction technique by cattle producers with concomitant increase in productivity of cattle. Publication of research results	Extension publications and extension personnel feed-back. Published verification of research results by peers.	Assumptions for achieving purpose: ICIPE will continue to give responsibility for program direction to well qualified project leader, and provide well trained competent scientific staff and support personnel as well as complete the construction of laboratory and other physical facilities in a timely manner.
Outputs: Improved techniques for integrated tick control. Assessment of tick damage to cattle. Evaluate the extent to which tick resistance cattle reduce the population of ticks in the field. Transfer technology to National and International institutions. Initiate postdoctoral training.	Magnitude of Outputs: 2-4 Standardized techniques for improved tick control. Standardized procedure for evaluation of resistance of cattle to ticks. Field evaluation involving 4 cattle management schemes involving tick control. Extend standardized techniques to significant number of cattle producers. Linkages established among 4 country and 3 international institutions.	Publication of research results in National and International referred journals and recommendation of control techniques in extension bulletins. In-depth external evaluation of the program. Evaluation protocol established to improve linkages. Improved technology being utilized by National and International institutions.	Assumptions for achieving outputs: Tick resistant breeds of cattle are being used successfully in Australia to increase productivity/ profits and reduce labor and acaricide inputs.
Inputs: ICIPE: Scientific and technical staffing. Laboratory and pasture facilities. Equipment and furnishings. Cattle AID: Funding support Scientific and Budgetary Review.	Implementation Target (Type and Quantity) ICIPE: 3 Scientists, 5 technicians, 8 animal caretakers, 3 laboratory facilities, 4 experimental pastures equipment and furnishings in accordance with laboratory and pasture needs. AID: $1,450,000 for 5 years, consultation as needed, 3 in-depth external review funded from S&T Livestock Production Systems cluster.	ICIPE: Review of staff, budget and program records. AID: Review of project, financial and team review records.	Assumptions for providing inputs: ICIPE has given high priority to the subject matter area of the project. Well trained enthusiastic scientists are working on the project and adequate facilities are being developed to conduct the outlined research.

ANNEX 2

PROPOSED BUDGET: TICK RESISTANT CATTLE IN THE ECOLOGICAL MANAGEMENT OF TICKS
(IN U.S.$ X 1,000)

	SCALE	FY 1983[2/]	FY 1984	FY 1985	FY 1986	FY 1987	TOTAL
1. PERSONNEL COSTS							
a. International Professional Staff[1/]							
Senior Research Scientist (Tick Ecologist)	ER4	25,2(1.0)[3/]	34.4(1.0)	35.3(1.0)	36.2(1.0)	37.1(1.0)	168.2
		25.2(1.0)	34.4(1.0)	35.3(1.0)	36.2(1.0)	37.1(1.0)	168.2
b. Postdoctoral Research Fellows		18.0(1.0)	24.6(1.0)	25.3(1.0)	26.0(1.0)	26.7(1.0)	120.6
		18.0(1.0)	24.6(1.0)	25.3(1.0)	26.0(1.0)	26.7(1.0)	120.6
c. Other Research Staff							
Scientific Officer	T1	11.3(1.0)	15.4(1.0)	15.8(1.0)	16.2(1.0)	16.6(1.0)	72.3
Associate Scientific Officer	T2	7.8(1.0)	10.7(1.0)	10.9(1.0)	11.2(1.0)	11.5(1.0)	52.1
		19.0(1.0)	26.1(1.0)	26.7(1.0)	27.4(1.0)	28.1(1.0)	124.4
d. Technical Staff							
Technician	T4	5.1.(1.0)	7.0(1.0)	7.2(1.0)	7.4(1.0)	7.6(1.0)	34.3
Junior Technician	T5	12.6(3.0)	17.2(3.0)	17.7(3.0)	18.1(3.0)	18.5(3.0)	84.1
Technical Assistant	T6	3.2(1.0)	4.4(1.0)	4.5(1.0)	4.6(1.0)	4.7(1.0)	21.4
Stockmen	T6	25.8(8.0)	35.3(8.0)	36,1(8.0)	37,0(8.0)	38.0(8.0)	172.2
		46.7(13.0)	63.9(13)	65.5(13.0)	67.1(13.0)	68.8(13.0)	312.0
e. Other Staff Costs							
Provident Fund		11.0	15.0	15.4	15.7	16.1	73.2
TOTAL PERSONNEL COSTS		119.9(16.0)	164.0(16.0)	168.2(16.2)	172.3(16.0)	176.8(16.0)	801.2
2. CONSULTATIONS FOR PROFESSIONALS[4/]		12.0	13.0	15.0	16.0	20.0	76.0

	1983	1984	1985	1986	1987	TOTAL
3. MATERIALS, SERVICES, AND EXPENDABLES						
Supplies and expendables (syringes, needles, glassware animal care products; chemicals, reagents, slides, glue, etc.)	3.5	10.0	10.0	10.0	10.0	43.5
Field Expenses	2.5	7.0	7.0	7.0	7.0	30.5
Vehicle Running Expenses	4.5	12.0	12.0	12.0	12.0	52.5
Insurances	0.4	1.0	1.0	1.0	1.0	4.4
Drugs and Vaccines	2.0	6.3	6.3	6.3	6.3	27.2
Equipment Maintenance	0.5	1.2	1.2	1.2	1.2	5.3
Reports Costs	1.6	5.0	5.0	5.0	5.0	21.6
Animal Food (For Cattle and Rabbits)	2.0	7.0	5.0	3.0	3.0	20.0
Cattle	2.5	15.0	10.0	5.0	5.0	37.5
Photographic Services	1.0	1.5	1.5	1.5	1.5	7.0
Statistical and Biochemical Services	6.1	8.3	15.5	22.7	22.9	75.5
	26.6	74.3	74.5	74.7	74.9	325.0
4. EQUIPMENT						
1 Cryopreservation Equipment	10.0	-	-	-	-	10.0
1 Deep Freezer	1.8	-	-	-	-	1.8
1 Refrigerator	0.7	-	-	-	-	0.7
1 Centrifuge	9.0	-	-	-	-	9.0
1 Suzuki 4 wheel drive vehicle[5/]	9.0	-	-	-	-	9.0
1 Micro-hematocrit centrifuge	5.0	-	-	-	-	5.0
1 Motorcycle[5/]	2.0	-	-	-	-	2.0
1 Livestock scale	1.6	-	-	-	-	1.6
	39.1	-	-	-	-	39.1
5. FIELD STATION COSTS						
Development and Maintenance of Ndhiwa Farm[6/]	46.4	31.6	24.8	18.9	9.5	131.2
Other Institutional costs[7/]	6.0	6.5	6.9	7.5	8.2	35.1
	52.4	38.1	31.7	26.4	17.7	166.3
6. PROVISION FOR INFLATION:	0	10.6	10.6	10.6	10.6	42.4
TOTAL PROJECT COST	250.0	300.0	300.0	300.0	300.0	1450.0

1/ Salaries of the Project Leader and a senior scientific officer assigned to this project are paid by another donor.

2/ The projected funding date is January FY 1983 and the budgeted amount is for 3/4 of the fiscal year.

3/ Person years.

4/ This category is intended to identify funds to support professional travel to meetings, conferences, workshops, or to consult with other scientists.

5/ These vehicles are necessary because much of Rusinga Island is not accessible via regular vehicles. Most of the trails are too narrow for full-sized vehicles.

6/ Development and Maintenance of Ndhiwa Farm includes costs of items such as water, roads, fencing and buildings on the farm.

7/ Other Institutional costs includes costs like postage, telex, telegrams, water, electricity, etc.

ANNEX 3

MANUSCRIPTS IN PREPARATION

A.O. Mongi and M.P. Cunningham. Comparative analysis of feeding performance of female ticks of R. appendiculatus fed on rabbits, naive and resistant to larval ticks.

A.O. Mongi and M.P. Cunningham. Skin reactivity to tick bites and skin reactions to salivary gland and larval homogenates in tick resistant animals.

A.O. Mongi and M.P. Cunningham. The feeding performance and reproductive fecundity of adult ticks of R. appendiculatus fed on rabbits immunized with unfed female tick homogenates.

A.O. Mongi and M.P. Cunningham. The feeding performance and fecundity of adult ticks of R. appendiculatus fed on rabbits immunized with fully fed female tick homogenates.

A.O. Mongi, S.Z. Shapiro and M.P. Cunningham. Immunization against ticks with specifically isolated precipitin lines of tick antigen extracts.

A.O. Mongi, S.Z. Shapiro and M.P. Cunningham. Characterization of specific target antigen(s) possibly responsible for provoking a protective immune response against feeding ticks of R. appendiculatus.

A.O. Mongi, S.Z. Shapiro and M.P. Cunningham. Affinity chormatography on Protein A-Sepharose: Matrixbound Protein A from Staphylococcus aureus for the isolation and determination of specific tick immunogen(s) possibly responsible for provoking a protective immune response against feeding ticks.

A.O. Mongi, S.Z. Shapiro and M.P. Cunningham. Preliminary investigation and characterization of tick tissues possibly involved in the production of specific target antigen(s) from: salivary gland, gut, reproductive system and the haemolymph of partially fed females of R. appendiculatus.

D.K. Punyua. Developmental periods of Rhipicephalus appendiculatus. Newmann, (Acarina: Ixodidae) under field conditions.

D.K. Punyua. Climbing activity of partially fed adults of Rhipicephalus appendiculatus in the field.

D.K. Punyua, R. M. Newson. The Brown Ear tick Rhipicephalus appendiculatus Newmann (Acarina: Ixodidae) and associated tick species on wild and domestic host at Muguga, Kenya.

D.K. Punyua, R.M. Newson and M. J. Mutinga. Diurnal and seasonal activity of unfed adults of Rhipicephalus appendiculatus (Acarina: Ixodidae) in relation to some intrinsic and extrinsic factors. I. Factors regulating activity..

D.K. Punyua, R. M. Newson and M. J. Mutinga. Diurnal and seasonal activity of unfed adults of Rhipicephalus appendiculatus (Acarina: Ixodidae) in relation to some intrinsic and extrinsic factors. II. Factors affecting vertical distribution of ticks in the habitat.

D.K. Punyua, R. M. Newson and M. J. Mutinga. Diurnal and seasonal activity of unfed adults of Rhipicephalus appendiculatus (Acarina: Ixodidae) in relation to some intrinsic and extrinsic factors. III. Daily changesd in water content.

J.W. Chiera, R.M. Newson and M. P. Cunningham. The effect of size on feeding and breeding performance of Rhipicephalus appendiculatus Newmann.

M.G. Binta, M.P. Cunningham and F.R. Rurangirwa. Bovine homocytrophic antibody in the sera of cattle resistant to infestation with Rhipicephalus appendiculatus Newmann.

M.G. Binta, M. P. Cunningham and F.R. Rurangirwa. Passice sensitization of rat mast cells with bovine seram from tick resistant cattle.

M.G. Binta, M.P. Cunningham and E.Z. Mushi. Effect of some drugs on the skin response in tick resistant cattle to an allergenic tick larval extract.

J.W. Chiera. Aggregation and climbing behaviour of Rhipiecephalus appendiculatus Newmann on grass stems.

J.W. Chiera, R.M. Newson and M. P. Cunningham. The effect os sequential feeding on naive and resistant hosts on Rhipicephalus appendiculatus Newmann.

R.M. Newson, J.W. Chiera, M.P. Cunningham, T.T. Dolan, D.E. Radley and A.S. Young. Field survival of Rhipicephalus appendiculatus

R. Dolan, R.M. Newson, A.J. Wilson, H.J. Schwarty and C.R. Field. Camel production in Kenya and its constraints II tick infestation.

R.M. Newson, J.W. Chiera and M.P. Cunnigham. The use of tick resistant cattle to control field populations of R. appendiculatus.

ANNEX 4

INITIAL ENVIRONMENTAL EXAMINATION

OR

CATEGORICAL EXCLUSION

Project Country: Regional (Based in Kenya)

Project Title and Number: Tick Resistant Cattle in the Ecological Management of Ticks. (Number to be assigned)

Funding: FY (s) 1983-1987 $ 1,450,000

IEEC/CE Prepared By: John J. Gaudet

Environmental Action Recommended:

Positive Determination _____

Negative Determination _____

OR

Categorical Exclusion ___X X X___

This activity meets the criteria for Categorical Exclusion in accordance with Sections 216.2(c)(1)iii and 216.2(c)(2)ii and is excluded from further review because:

(See attached justification)

Action Request By: Date: _____

Concurrence: _____
(Bureau Environmental Officer)

APPROVED _____

DISAPPROVED _____

DATE _____

Clearance: GC/AFR _____ Date _____

A. Project Activities

The project is designed to achieve control over ticks and tick-borne disease of cattle by breeding for resistance. It is primarily a research project which will be carried out under controlled experimental conditions. The major activities will be to:

1. Survey tick population and tick-transmitted diseases;
2. Evaluate local cattle management practices and study various tick and disease control strategies;
3. Determine the effect of vaccinated, tick-resistant animals on subsequent tick population;
4. Establish a breeding herd in an East Coast Fever area by using an integrated control technique (acquired tick resistance, vaccination, curative drugs, and strategic acaricide application);
5. Conduct laboratory studies on tick simulation of acquired resistance;
6. Extend preliminary research on transmission of East Coast Fever to and from tick-resistant cattle.

B. Impacts

Strategic acaricide applications will occasionally be used to develop tick-free animals. These applications will be done under controlled experimental conditions and will have only slight, localized effects.

The majority of impacts from this project will be positive, for example:

1. Selection and preservation of disease resistant cattle germplasm;
2. Reduction in overall use of acaricides to control tick infestations by developing tick resistance, better management strategies, or more effective integrated control of ticks and tick-borne diseases.
3. General increase in protein production and well-being of people in LDCs.

C. Actions Requested

A categorical exclusion is requested for this project under Sections 216.2(c)(1)(iii) and (216.2(c)(2)(ii).

ANNEX 5

Scientific Staff of the ICIPE Livestock Ticks Research Program and Collaborating Scientists

1. Project Scientists - Tick Resistant Cattle in the Ecological Management of Ticks.1/

Dr. M.P. Cunningham	Principal Research Scientist and Program Leader, Livestock Ticks Research Program (ICIPE). Member Royal College of Veterinary Surgeons (U.K.), 1952.
Dr. R.M. Newson	Senior Research Scientist. B.A. (Contab.), 1957; D. Phil. (Oxford); Member, Institute of Biology.
Mr. D.K. Punyua	Scientific Officer. B.Sc. (Armarir Zooveterinary College, USSR), 1970; M.Sc. (Nairobi), 1979.
Mr. J.W. Chiera	Associate Scientific Officer/Research Assistant. B. Ed. (Kenyatta University College), 1976.
Dr. Julio de Castro2/	F.A.O. 'Andre Mayer' Fellow. D.V.M., Universidad de la Republica Oriental del Uruguay (Montevideo), 1975; M.Sc. University of North Wales (Bangor), 1980.
Dr. Ciharu Suto3/	Visiting Scientist Tokyo University of Education (Bachelor's Degree), 1965; M.S. and D. Med. Sci. (Nagoya), 1979.

1/ One Senior Research Scientist (Veterinary Surgeon-familiar with ecto-parasites and anthropod-borne diseases of livestock) will be added to this staff.

2/ He is funded by F.A.O. and for two years will infest cattle with ticks to determine economic thresholds and the effects of tick infestation levels on acquired resistance to ticks. Dr. de Castro is attached to ICIPE and is using research facilities at KARI.

3/ Dr. Suto is funded by the Government of Japan and is attached to ICIPE for a year as a visiting scientist. Dr. Suto has developed methods for investigating Type 1 tick-resistance in mice and is studying the resistance and cross-resistance of mice to several tick species including *R. appendiculatus* and *A. variegatum*.

2. Project Scientists - Type 2 Resistance Research Program.

Dr. C.K. A. Mango	Scientific Officer. B.A. (Inter-American University), 1964; M.Sc. (Columbia), 1966; Ph.D. (Nairobi), 1980.
Ms. G.M. Binta	Associate Scientific Officer. B.V.M. (Nairobi), 1976; M.Sc. (Nairobi), 1978.
Mr. Abdul Mongi	Associate Scientific Officer. B.Sc. (Dar es Salaam), 1976; M.Sc. (Nairobi), 1979; Ph.D. candidate, University of Nairobi, (Nairobi)

3. Other ICIPE Scientists - Assisting with Type 2 Resistance Research Program and other Research.

Dr. D.L. Whitehead	Senior Research Scientist, Chemistry and Biochemistry Research Unit. B.Sc. (Natal), 1957; M.Sc. (Natal), 1958; D. Phil. (Oxford), 1961; M.A. (Oxford), 1965.

4. Cooperating Scientists.

A. ILRAD

1. Dr. Tony Irvin (Veterinarian, Ph.D.), ECF Vaccine Development.
2. Dr. Max Murray (Veterinarian, Ph.D.), Pathology of ECF and cellular response of host animals to tick.
3. Dr. Stuart Shapiro (M.D., Ph.D), Immunology of Type 2 resistance.

B. KARI

1. Dr. Alan Young (Ph.D.), Epidemiology of ECF
2. Dr. Tom Dolan (Veterinarian, Ph.D.), Chemotheraphy of ECF.
3. Dr. Chris Gruecock (Veterinarian, Ph.D.), Effects of tick infestations on immunocompetence of cattle.

C. Department of Zoology, Kenyatta University College

Dr. Jane Allenby (Ph.D.), Tick-resistance in goats and sheep.

ANNEX 6 - Curriculum Vitae of Project Scientists

Name: Mathew Paton Cunningham

Nationality: British

[redacted]

Marital Status: Married, 3 sons

Education:

1931 - 1938 Doune Primary School

1938 - 1944 Girvan High School

1944 - 1947 H.M. Forces

1947 - 1952 University of Glasgow Veterinary School

Qualified as member of the Royal College of Veterinary Surgeons.

Employment:

1952 - 1957 Lecturer in Department of Veterinary Medicine, University of Glasgow Vet. School, Glasgow, Scotland, U.K.

Research: Control and epidemiology of bovine paratuberculosis, and canine leptospirosis. Vaccination of cattle against Dictyocaulus vivipara.

1957 - 1967. Principal Research Scientist at East African Trypanosomiasis Research Organisation, Tororo, Uganda.

Research:- Immunology & epidemiology of Bovine & Human Trypanosomiasis.

1967 - 1977. Project Manager, FAO-UNDP, (RAF/77/067) Project at East African Veterinary Research Organisation, Muguga, Kenya.

Research: Vaccination of cattle against Theileria parva (East Coast Fever)

1977 - 1982. Programme Leader, Livestock Works Programme, ILRAD.

Research:- Induced resistance in cattle to tick infestation

PUBLICATIONS RELEVANT TO TICK PROGRAMME

Theileria parva: Comparative infectivity of a ground tick stabilate and a classical 10 tick challenge. Cunningham, M.P., Brown, C.G.D., Burridge, M.J., Irvin, A.D., Purnell, R.E., Radley, D.E. (1973). Res. Vet. Sci. 15, 263-265

Theileriosis: The exposure of immunized cattle in a Theileria lawrencei enzootic area. Cunningham, M.P., Brown, C.G.D., Burridge, M.J., Joyner, L.P. and Purnell, R.E. (1973). Trop. Anim. Hlth. Prod. 6, 39-43.

East Coast fever: The infectivity for cattle of infective particles of Theileria parva harvested in various substrates. Cunningham, M.P., Brown, C.G.D., Burridge, M.J., Joyner, L.P. and Purnell, R.E. (1973). Int. Jnl. Parasit. 3, 335-338.

East Coast fever of cattle: Co-irradiation of infective particles of Theileria parva. Cunningham, M.P., C.G.D., Burridge, M.J., Musoke, A.J., Purnell, R.E. and Dargie, J.D. (1973). Jnl. Protoz. 20(2), 298-300.

East Coast fever: Titration in cattle of suspensions of Theileria parva derived from ticks. Cunningham, M.P., Brown, C.G.D., Burridge, M.J., Musoke, A.J. Purnell, R.E., Radley, D.E. and Sampebwa, C. (1974). Br. Vet. J. 130, 336.

Cryopreservation of infective particles of Theileria parva. Cunningham, M.P., Brown, C.G.D., Burridge, M.J. and Purnell, R.E. (1973). Int. Jnl. Parasit. 3, 583-587.

Some effects of irradiation on the infective stage of Theileria parva harvested from infected ticks. Cunningham, M.P., Brown, C.G.D., Purnell, R.E., Musoke, A.J., Burridge, M.J. (1973). Isotopes and radiation in parasitology III, 145-154. Int. Atomic En. Ag., Vienna.

Infection of cattle with East Coast Fever by inoculation of the infective state of Theileria parva harvested from the tick vector Rhipicephalus appendiculatus. Cunningham, M.P., Joyner, L.P., Brown, C.G.D., Purnell, R.E. and Bailey, K.P. (1973). Bull Epizoot. Dis. Afr. 21(3), 235-238

Theileria parva: Significance of leukocytes for infecting cattle. Brown, C.G.D., Cunningham, M.P., Joyner, L.P., Purnell, R.E., Branagan, D., Corry, G.L. and Bailey, K.P. (1978). Exp. Parasit. 45, 55-64.

The use of tetracyclines in the chemotherapy of experimental East Coast Fever (Theileria parva infection of cattle). Brown, C.G.D., Radley, D.E., Burridge, M.J., Cunningham, M.P. (1977). Tropenmend. Parasit. 28, 513-520.

Immunization against ECF (Theileria parva infection of cattle) by infection and treatment: chemoprophylaxis with N-pyrolidinomethyl tetracycline. Brown, C.G.D., Radley, D.E., Cunningham, M.P., Kirimi, L.M., Morzaria, S.P., Musoke, A.J. (1977). Tropenmed. Parasit. 28, 342-348.

Duration of immunity to East Coast fever (Theileria parva infection of cattle). Burridge, M.J., Morzaria, S.P., Cunningham, M.P. and Brown, C.G.D. (1972). Parasit. 64, 511-515

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A pathogenic theilerial syndrome of cattle in the Narok district of Kenya. Irvin, A.D., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Musoke, A.J., Pierce, M.A., Purnell, R.E. and Radley, D.E. (1972). Trop. Anim. Hlth. Prod. 220-229.

Growth of Theileria parva infected bovine lymphoid cells in irradiated mice. Irvin, A.D., Brown, C.G.D., Cunningham, M.P., Crawford, J.G. and Ledger, M.A. (1972). Nat. Phy. Sci. Vol. 230, No. 13 106-107

Attempts to infect mice with East Coast fever. Irvin, A.D., Purnell, R.E., Brown, C.G.D., Cunningham, M.P. (1975). Vet. Rec. 7/6/1975.

The application of an indirect method of infecting ticks with piroplasms for use in the isolation of field infections. Irvin, A.D., Purnell, R.E., Brown, C.G.D., Cunningham, M.P., Ledger, M.A. and Payne, R.C. (1974). Br. Vet. Jnl. 130, 280.

The duration of emission of infective particles of Theileria parva by infected ticks fed artificially. Joyner, L.P., Cunningham, M.P., Purnell, R.E. and Brown, C.G.D. (1972). Res. Vet. Sci. 13, 402-403.

East Coast fever: co-irradiation of Theileria parva in its tick vector, Rhipicephalus appendiculatus. Purnell, R.E., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Emu, H., Irvin, A.D., Ledger, M.A. Njuguna, L.M., Payne, R.C. and Radley, D.E. (1974). Int. Jnl. for Parasit. Vol. 4, 507-511.

East Coast fever: Correlation between the morphology and infectivity of Theileria parva developing in its tick vector. Purnell, R.E., Brown, C.G.D., Cunningham, M.P., Burridge, M.J. (1976). Parasit. 66, 539-544.

The establishment of an experimental field population of Theileria parva infected ticks. Purnell, R.E., Cunningham, M.P., Musisi, F.L., Payne, R.C. (1975). Trop. Anim. Hlth. Prod. 7, 133-137.

A note on the susceptability of sheep and goats to East Coast fever. Purnell, R.E., Radley, D.E., Cunningham, M.P. (1974). Vet. Rec. 30/3/74 p. 278.

East Coast fever: 1. Chemoprophylactic immunization of cattle against Theileria parva (Muguga) and five theileria strains. Radley, D.E., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Kirimi, I.M., Purnell, R.E. and Young, A.S. (1975). Vet. Parasit. 1, 35-41.

East Coast fever: Quantitative studies of Theileria parva in cattle. Radley, D.E., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Pierce, M.A., Purnell, R.E. (1974). Exp. Parasit. 36, 278-287.

East Coast fever: 3. Chemoprophylactic immunization of cattle using oxytetracycline and a combination of theileria strains. Radley, D.E., Brown, C.G.D., Cunningham, M.P., Kimber, C.D., Musisi, F.L., Payne, R.C., Purnell, R.E., Stagg, S.M. and Young, A.S. (1975). Vet. Parasit. 1, 51-60.

East Coast fever: Challenge of immunized cattle by prolonged exposure to infected ticks. Radley, D.E., Brown, C.G.D., Cunningham, M.P., Kimber, C.D., Musisi, F.L., Purnell, R.E. and Staff, S.M. (1975). Vet. Rec. 14/7/75, 525-527.

Effects of prolonged exposure of T. parva immunized cattle in an experimentally infected paddock. Radley, D.E., Newson, R.M., Cunningham, M.P., and Punyua, D.K. (1976). Int. Conf. Tick-borne Dis. Vec. Edin.

East Coast fever: 2. Cross immunity trials with a Kenya strain of Theileria lawerencei. Radley, D.E. Young, A.S., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Musisi, F.L. and Purnell, R.E. (1975). Vet. Parasit. 1, 43-50.

Preliminary observations on a theilerial species pathogenic to cattle isolated from buffalo (Syncerus caffer) in Tanzania. Young, A.S., Brannagan, D., Brown, C.G.D., Burridge, M.J., Cunningham, M.P. and Purnell, R.E. (1973) Br. Vet. J. 129, 382.

Observations on the cross immunity between Theileria lawrencei (Serengeti) and Theileria parva (Muguga) in cattle. Young, A.S., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Kirimi, I.M. and Irvin, A.D. (1973). Int. Jnl. Parasit. 3, 723-728.

Establishment of an experimental field population of Theileria lawrencei infected ticks maintained by African buffalo (Syncerus caffer). Young, A.S., Brown, C.G.D., Burridge, M.J., Cunningham, M.P., Payne, R.C. and Purnell R.E. (1977). Jnl. Parasit. 62 No. 5, 903-907.

Evaluation of methods of immunizing cattle against Theileria lawrencei. Young, A.S., Brown, C.G.D., Cunningham, M.P. and Radley, D.E. (1976). Int. Conf. Tick-borne Dis. Vec. Edin.

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"Immunization of cattle against Theileria parva" Cunningham, M.P. (1977). Theileriasis IDRC - 096e International Development Research Centre, Ottawa.

"Research on tick-borne diseases and tick control". Cunningham, M.P. (1978). Terminal Report FAO, ROME.

Exposure of immunized cattle to prolonged natural challenge of Theileria Lawrencei derived from african buffalo (Syncerus Caffer). Young, A.S., Radley, D.E., Cunningham, M.P., Musisi, F.L., Payne, R.C., Purnell, R.E. (1977). Veterinary Parasitology 3, 283-290.

Further studies on the immunization of cattle against Theileria Lawrencei by infection and chemoprophylaxis. Radley, D.E., Young, A.S., Grootenhius, J.G., Cunningham, M.P., Dolan, T.T., Morzaria, S.P. (1979). Veterinary Parasitology 5, 250-256.

The effect of immunization with B.C.G. on Theileria parva infection in cattle. Dolan, T.T., Brown, C.G.D., Cunningham, M.P. (1980). Research in Veterinary Science, 28, 132-133.

East Coast fever: Further studies on the protection of cattle immunized against a combination of theileria strains. Dolan, T.T., Radley, D.E., Brown, C.G.D., Cunningham, M.P. Morzaria, S.P. and Young, A.S. (1980). Veterinary Parasitology 6, 325-332.

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Vaccination of cattle against East Coast fever. Cunningham, M.P. (1978). In Tick-borne diseases and their vectors J.K. Wilde E/D. Lewis Reprints - Publisher.

Evaluation of methods of immunizing cattle against Theileria lawrencei. Young, A.S., Brown, C.G.D. Cunningham, M.P. and Radley, D.E. (1978). In Tick-borne diseases and their vectors. J.K. Wilde ED. Lewis Reprints - Publisher.

Effects of prolonged exposure of T. parva immunized cattle in an experimentally infected paddock. Radley, D.E., Newson, R.M., Cunningham, M.P. and Punyua, D.K. (1978). In Tick-borne diseases and their vectors. J.K. Wilde ED. Lewis Reprints - Publisher.

Advances in the Control of Theileriosis. Irvin, A.D., Cunningham, M.P. and Young, A.S. (Editors) (1981). Martinus Nijhoff, Publishers, The Hague.

Biological control of ticks. in Advances in the Control of Theileriosis. Cunningham, M.P. (1981). Martinus Nijhoff, Publishers, The Hague

Immunology - Future Prospects in Advances in the control of Theileriosis. Cunningham, M.P. ILEMOBADE/ (1981). Martinus Nijhoff Publishers. The Hague.

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CURRICULUM VITAE

DR. ROBIN MITFORD NEWSON

1. Personal History

[redacted]

Married	1959; two daughters born 1963 and 1965.

2. Education

School	Durham School, Durham, England, 1947-52, (King's Scholar).
First Degree (1957)	M.A. (Cantab.), Class II, division I, St. John's College, Cambridge, England, 1954-57. Natural Science Tripos: Part I-Zoology, Botany, and Organic Chemistry with Biochemistry; Part II - Zoology.
Higher Degree (1960)	D. Phil. (Oxon.), Balliol College, Oxford, England, 1957-60. Thesis "The ecology of vole and mouse populations in different habitats." D.S.I.R. Studentship at the Bureau of Animal Population, Dept. of Zoological Field Studies; supervised by Dr. H.N. Southern.
1960-62	Post-doctoral Fellowship at the Dept. of Zoology, University of Guelph, Ontario, Canada. Worked with Dr. A. de Vos and my wife (Dr. Janet Newson) on a population study of the snowshoe hare, *Lepus americanus*.

3. Employment

1962-68	Civil Service Senior Research Fellowship with Ministry of Agriculture Infestation Control Laboratory, carrying out an independent study of the population dynamics of coypu (*Myocastor coypus*) in southern England.
1968-197-	Tick Ecologist with the Food and Agriculture Organization of the U.N. Employed in the Animal Health and Production Division in the professional category (Grade 3). Worked in Mwanza, Tanzania, 1968-71, and at Veterinary Research Laboratory, Kabete, Kenya, 1971-1974.
From Sept. 1974	Senior Research Scientist (Tick Ecology), at ICIPE, Nairobi, Kenya.

4. Other experience

1952-54	National Service in the British Navy, commissioned in the Seamen Branch.

1959 Four weeks field work in Norway on lemming populations (Lemmus lemmus) with my wife and Dr. H. Gall, with a Royal Society grant.

1960 Return to Norway for 4 weeks with my wife to follow up previous observations (D.S.I.R. support).

1966 Four weeks tour in U.S.A. and Canada to see research on the coypu and to discuss control methods.

5. Selected Publications

Newson, R. (1963). Differences in numbers, reproduction and survival between two neighboring populations of bank voles (Clethrionomys glareolus). Ecology, 44, 110-120.

Newson, R.M. and de Vos, A. (1964). Population structure and body weights of snowshoe hares on Manitoulin Island, Ontario. Canadian Journal of Zoology, 42, 975-986.

Newson, R.M. (1966). Reproduction in the feral coypu (Myocastor coypus). Symposia of the Zoological Society of London, 15, 323-334.

Newson, R.M. and Holmes, R.C. (1968). Some ectoparasites of the coypu in eastern England. Journal of Animal Ecology, 37, 471-481.

Newson, R.M. (1969). Population dynamics of the coypu, Myocastor coypus (Molina), in eastern England. (Summary only). In Energy Flow through Small Mammal Populations, ed. Petrusewicz, K. and Ryszkowski, L. pp. 203-204. Warsaw, Polish Scientific Publishers.

Newson, R.M., Mella, P.N.P. & Franklin, T.E. (1973). Observations on the numbers of the tick Rhipicephalus appendiculatus on the ears of Zebu cattle in relation to hierarchical status in the herd. Tropical Animal Health and Production, 5, 261-263.

Young, A.S. and Newson, R.M. (1973). An improved method of handling ticks collected from the field. Research in Veterinary Science, 15, 133-135.

Burridge, M.J., Brown C.G.D., Crawford, J.G., Kirimi, I. Morzaria, S.P., Payne, R.C. & Newson, R.M. (1974). Preliminary studies on an atypical strain of bovine Theileria isolated in Kenya. Research in Veterinary Science, 17, 139-144.

Newson, R.M. (197~~7~~8). Rhipicephalus appendiculatus, the brown ear tick, its ecology and possible biological control. Proc. 1st. East African Conference in Entomology and Pest Control. Nairobi, 1976, (in press).

→ Newson R.M. & Obenchain F.D. (1977). [Details overleaf] 50

Newson, R.M. (197~~X~~). The life cycle of Rhipicephalus appendiculatus on the Kenyan Coast. Proc. of Conference on Tick-borne Diseases and their Vectors. Edinburgh, 1976, (in press). pp. 46-50.

Newson, R.M. and Punyua, D.K. (197~~X~~8). The life cycle of Rhipicephalus appendiculatus and associated species in an ecologically marginal situation in central Kenya. ~~Ibid~~ Ibid, pp. 51-55.

Radley, D.E., Newson, R.M., Cunningham, M.P. & Punyua, D.K. (197~~X~~8). Effects of prolonged exposure of T. parva immunized cattle in an experimentally infected paddock. Ibid, pp. 297-301.

Add. (2) (3) (4) (5) [See below]

6. FAO/UNDP Technical Reports (1975)

Joint ~~basic~~ authorship of two (nos. 1 and 3) and sole basic authorship of one (no. 4) of the Technical Reports listed below, arising from work on the FAO project in Kenya (AG: DP/KEN/70/522, Research on Tick-borne cattle diseases and tick control) during 1971-74.

No. 1. Epizootiological survey on tick-borne cattle diseases. Pp.28 + 23 maps.

No. 3. East Coast fever cross-immunity trials, Pp. 22 + 1 map.

No. 4. Life cycle studies of Rhipicephalus appendiculatus Neumann and associated species in the field. Pp. 25.

7. Membership of Professional Bodies

British Ecological Society

Institute of Biology (British)

British Mammal Society

American Society of ~~Mammalogists~~ Acarologists.

(1) Studies on Rhipicephalus appendiculatus at the I.C.I.P. ~~the~~ Kenya. Report of a workshop on Theileriosis held in Nairobi, Kenya, December 1976 (Eds. Henson, J.B & Campbell, M.) pp. 89-93.

R.M. NEWSON

(2) Newson, R.M (1979). The development of Rhipicephalus appendiculatus populations at different host stocking densities. Recent Advances in Acarology, 1, 457-461

(3) Punyua, D.K. & Newson R.M. (1979). Diurnal activity & behaviour of Rhipicephalus appendiculatus in the field. Recent Advances in Acarology

P.T.O.

(4) Dolan, T.T. & Newson, R.M. (1980). Seasonal chemoprophylaxis in adult cattle. Tropical Animal Health & Production, 12, 119-124.

(5). Young, A.S., Leitch, B.L. & Newson, R.M. (1981). The occurrence of a ~~Tha~~ Theileria parva carrier state in cattle from an East Coast fever endemic area of Kenya. Recent Advances in the Control of Theileriosis (Eds. Irvin, A.D., Cunningham, M.P. & Young, A.S.) pp. 60-63.

MSS submitted for publication:

Dolan, R.B., Newson, R.M., Schwarzer, J. + Wilson, A.J. Constraints on camel production in Kenya. II. Titles. (to Tropical Animal Health + Production).

Young, A.S., Newson, R.M and others. Survival of Theileria parva infection in an experimental field situation. (to Parasitology).

CURRICULUM VITAE

Personal Information

NAME : John W. Chiera

[redacted]

NATIONALITY : Kenyan

MARITAL STATUS : Married with two children

CURRENT ADDRESS : ICIPE Box 30772, Nairobi, Kenya

[redacted]

Educational Experience

1958 - 1964 - Attended Mucharage Primary School

1965 - 1968 - Attended Chinga Secondary School

1969 - 1971 - Attended Kenyatta College and obtained SI teaching certificate.

1972 - 1975 - Attended Kenyatta University College and obtained a B. Ed. (Science) honours degree. I did Biology and Mathematics for SI course and Botany and Zoology for the B. Ed. course plus Education in each case.

Position held :

January 1972 - July 1972 - SI teacher in Secondary School

Sept. 1975 - Sept. 1976 - Graduate teacher in Secondary School

Sept. 1976 - Present - Research Assistant with ICIPE on Tick Ecology.

CAREER OBJECTIVE

My interest is on the study of insect pest ecology as related to control.

Research Experience:

I have five-year experience in research and the experiments I have been involved in are reported in ICIPE Annual Reports of 1976 - 1980 and include:-

- The effect of East Coast Fever (ECF) infectivity of allowing ticks to feed only on immune hosts.
- Reproduction and survival of *Rhipicephalus appendiculatus* at different host stocking densities.
- Attraction of unfed females to attached males in Kenyan *Amblyomma* species.
- Effect of host resistance on the development of tick populations.
- Anti-tick properties of molasses grass.
- Climbing behaviour and distribution of *Rhipicephalus appendiculatus* on grass stems.
- The effects of size on the feeding and breeding of *Rhipicephalus appendiculatus*.
- The cumulative effects of host resistance on *Rhipicephalus appendiculatus* in the laboratory.

Courses Attended

- One week symposium on ticks in Neuchatel, Switzerland, September, 1977.

- Three week course on pest and vector management course held at ICIPE.

- International Conference on advances in control of Theileriosis at ILRAD, February, 1981.

- Various seminars on pest research.

CURRICULUM VITAE

DANIEL ... PUNYUA

[redacted]

EDUCATION:	[illegible] - 1964	Attended M/[illegible] and Ilcoibti Primary Schools and [illegible] Secondary School.
	1965 - 1966	Took a one year's Russian Language Course at the Minsk State University- U. S. S. R.
	1966 - 1970	Attended the Armavir Zooveterinary College and graduated with a B.Sc. (Hon) in Veterinary Science - U.S.S.R.
EMPLOYMENT:	1970 - 1973	Worked with the Kenya Veterinary Department.
	1973-	to date worked for the International Centre of Insect Physiology and Ecology as an Associate Scientific Officer in the Tick Research Programme. (Ecology).
FURTHER STUDIES:	1976,	Being on a two year study leave from ICIPE, joined the University of Nairobi- Department of Entomology for a two year Programme leading to a Master of Science degree in Entomology. Part one of the programme was a one year's taught course with special option in pure entomology. Part two, which is the research project was completed and presented to the University of Nairobi by the end of April 1978. The topic of the research project is the "Activity of Rhicephalus appendiculatus in relation to its micro-environment:

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SCIENTIFIC PUBLICATIONS

D.K. PUNYUA

1. Purnell, R.E., Cunningham, M.P., Musisi, F.L., Payne, R.C. and Punyua, D.K. (1975).
   "The Establishment of an Experimental field population of Theileria parva infected ticks".
   Trop. Anim. Hlth, Prod. 7: 133-137.

2. Radley, D.E., Brown, C.G.D., Cunningham, M.P., Kimber, C.D., Musisi, F.L., Purnell, R.E., Stagg, S.M. and Punyua, D.K. (1975).
   "East Coast Fever: Challenge of immunized cattle by prolognged exposure to infected ticks".
   The Vet. Record. 96: 525-527.

3. Radley, D.E., Newson, R.M., Cunningham, M.P and Punyua, D.K. (1976).
   "Effects of prolonged exposure of T. parva immunized cattle in an experimentally infected paddock".
   Proceedings of the International Conference on Tick-borne diseases and their vectors. C.T.V.M., Univeristy of Edinburgh, U.K.

4. Newson, R.M. and Punyua, D.K. (1976).
   "Life cycle studies of R. appendiculatus in an ecologically marginal area with other associated species of hard ticks".
   Proceedings of the International Conference on Tick-borne diseases and their vectors. C.T.V.M., University of Edinburgh, U.K.

5. Punyua, D.K. and Newson, R.M. (1978).
   "Diurnal activity behavious of R. appendiculatus Neumann 1901, in the Field". Proceeding of the 5th International Congress of Acarology, East Lausing-Michigan, U.S.A. Recent Advances in Acarology, Edited by J.G. Rodriguez, Acad. Press, Vol. 1: 441-447.

6. Punyua, D.K. (1978).

"Diurnal and Seasonal Activity of Unfed adults of Rhipicephalus Appendiculatus, Neumann 1901, in relation to some factors in the micro-environment". M.Sc. Thesis, University of Nairobi.

7. Punyua, D.K. (1977).

Effect of Temperature, Humidity and Photoperiod on the behaviour of Rhipicephalus appendiculatus. Paper presented to the ICIPE Tick Workshop - "Physiological significant of Tick Behaviour, 10th -14th Oct. 197

CURRICULUM VITAE : JULIO J. DE CASTRO

PERSONAL DETAILS.

Name: Julio J. de Castro.

[redacted]

Nationality: Uruguayan

Marital Status: Married. No children.

[redacted]

Present Address: ICIPE, P.O. Box 30772
Nairobi - Kenya.

EDUCATION AND QUALIFICATIONS.

School: Instituto J.M. Campos. Mercedes, Uruguay -1964-1969

University: Universidad de la Republica Oriental del Uruguay.
Facultad de Veterinaria. Montevideo. 1970-1975.
Doctor in Veterinary Medicine.
Graduated: November 1975.

University College of North Wales. Bangor, Gwynedd.
MSc. in Animal Parasitology.
Graduated: September 1980.
Dissertation: Demodex Spp. on cattle in North Wales

The University of Reading. Reading. Berks.
Advanced Course in Veterinary Epidemiology and Economics.
Date: 18th September to 18th December 1981.

WORK EXPERIENCE.

1975-1979, I worked in General Practice (Large Animals) as a Veterinary Surgeon in Uruguay (South America).

OTHER ACHIEVEMENTS.

I won a Scholarship of the Rotary Foundation of Rotary Internationa to study at the University College of North Wales for the Academic Year October 1979 to September 1980. I obtained the best marks on the course.

I am at present the holder of an F.A.O. 'Andre Mayer' Fellowship (1981-1983) to study the 'Economic Impact of Ticks on the production of Beef and Milk in Africa' at the International Centre of Insect Physiology and Ecology.

USEFUL SKILLS.

Electron Microscopy.
Computer Operating.
Driving, full Kenyan, Uruguayan and British Licences
Typing, Spanish: 50 w.p.m., English: 35 w.p.m.

LANGUAGES.

First language: Spanish. Fluent in English.
Conversant with French, Italian and Portuguese.

ACTIVITIES AND INTERESTS.

Sports: Tennis, Soccer, Volleyball, Basket ball and fishing.
Photography and Natural History.

CURRICULUM VITAE

NAME: Ciharu Suto

[redacted]

PLACE: Yamatedori, Showaku, Nagoya, Japan

MARITAL STATUS: Married, 1 child

EDUCATION:

Takasaki High School 1958 - 1961 (Takasaki, Gunma)

Tokyo University of Education 1961 - 1965 (majoring in Applied Zoology)

Nagoya University, Graduate School, 1965 - 1970

Thesis of Master's Degree: Studies on the flacherie virus of the silkworm, *Bombyx mori* L.

Thesis of Docter's Degree: Characterization of a virus newly isolated from the smoky-brown cockroach, *Periplaneta fuliginosa* (Serville)

Awarded D. Med. Sci. (Nagoya University), conferred 1979

APPOINTMENTS:

Appointed Researcher, Japan Society for Promotion of Science Award 1970 - 1971

Resaerch Scientist, Nagoya City Health Research Institute 1971 - 1976

Instractor, Department of Medical Zoology, Nagoya University School of Medicine 1976 - 1980

Current position held: Lecturer, Department of Medical Zoology

OTHER INTERESTS:

Member of Japan Society of Sanitary Zoology

Member of Japan Society of Parasitology

Member of Japanese Society of Applied Entomology and Zoology

Member of Society of Japanese Viologists

PUBLICATIONS OF CHIHARU SUTO

1971

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1976

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1977

Kawamoto, F., C. Suto, N. Kumada, and M. Kobayashi: Cytoplasmic budding of a nuclear polyhedrosis virus and comparative ultrastructural studies of envelopes. Microbiol. Immunol., 21: 255 - 265.

1978

Suto, C., F. Kawamota, and N. Kumada: Pathological studies on the cockroach. I. Spontaneous occurrence of hindgut ulcer in the smoky-brown cockroach, Periplaneta fuliginosa (Serville). Jap. J. Sanitary Zool., 29: 197 - 204.

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1981

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ANNEX

Memorandum of Understanding between Institutes in Kenya engaged on Research into Animal Diseases, their Vectors and their Impact on Animal Productivity

INTRODUCTION

This Memorandum is drawn up between Institutes in Kenya engaged on research into animal diseases, their vectors and their impact on animal productivity. Attention is focused on Tick-borne Diseases, Trypanosomiasis and their Vectors, and all other aspects related to these infections.

The purposes of the Memorandum are to create a forum and framework for the exchange of ideas and information, to promote collaboration between scientists, to maximise utilization of resources and expertise, to facilitate training programmes and to avoid duplication of effort.

The Memorandum is not, and is not intended to be, a document to impose coordination of Institute activities nor to influence an Institute's policies, structure or funding.

The Memorandum provides a formal framework on which to build mutual collaboration between Institutes in Kenya engaged on any aspect of Tick-borne Diseases or Trypanosomiasis research.

Signed 17 Sept 1981

MEMORANDUM

Memorandum of Understanding between The International Centre of Insect Physiology and Ecology (hereinafter referred to as ICIPE), The International Laboratory for Research on Animal Diseases (hereinafter referred to as ILRAD), The Kenya Trypanosomiasis Research Institute (hereinafter referred to as KETRI), Kenya Veterinary Research Laboratories (hereinafter referred to as Vet. Labs.), Kenya Agricultural Research Institute, Veterinary Research Department (hereinafter referred to as VRD), Inter-African Bureau for Animal Resources (hereinafter referred to as IBAR), The International Livestock Centre for Africa (hereinafter referred to as ILCA), The Integrated Project in Arid Lands (hereinafter referred to as IPAL), The Faculty of Veterinary Science, University of Nairobi (hereinafter referred to as Vet. Fac.), The Faculty of Science, University of Nai obi (hereinafter referred to as Sci. Fac.), The Faculty of Medicine, University of Nairobi (hereinafter referred to as Med. Fac.).

These Institutes will be collectively known as "The Nairobi Cluster of Institutes in Kenya Cooperating in Research on Tick-borne Diseases, Trypanosomiasis and their Vectors" ("Nairobi Cluster" for short).

The mandates of the signatories of the Nairobi Cluster are as follows:-

ICIPE states that:

ICIPE is a world Centre with its major objectives being: the identification of vital gaps in our knowledge of insect pests and of insects having beneficial use to man; the conduct of fundamental research in those areas that might lead to novel, long-term, ecologically acceptable methods of insect population regulation relevant to tropical countries; the publication and dissemination of research findings in these fields; the training of young, promising scientists and technologists in insect population management research and application; and the strengthening of the capability of the African scientific community.

ILRAD states that:

The mandate of ILRAD has been established by the Technical Advisory Committee (TAC) in consultation with the Consultative Group on International Agricultural Research (CGIAR) and the ILRAD Board of Trustees. It is to develop effective control methods for trypanosomiasis and theileriosis, two diseases that are important in Africa Asia and America. The philosophy of ILRAD is to amalgamate basic and applied research, in order to achieve a better understanding of the epidemiology, pathogenesis and immunological processes of the two diseases. In addition it will study the underlying mechanisms of trypanotolerance in livestock and game animals, and ultimately hopes to find immunological methods to control both diseases.

Training at all levels is integrated into the research carried out at ILRAD. Staff from national organizations, through training, meetings conferences etc. should be brought together to establish close links with ILRAD staff.

KETRI states that:

KETRI is a National Research Institute with a mandate to undertake all aspects of research which would lead to the control and treatment of trypanosomiasis in man and animals and to practical reclamation of tsetse infested land; and whose current activities include trypanocidal drug development, epidemiology and economics of trypanosomiasis and camel trypanosomiasis. The Institute is a collaborating centre on trypanosomiasis drug development for the World Bank/UNDP/WHO Special Programme for Research and Training in Tropical Diseases. KETRI is a training Institution for the University post-graduate students and is required by law to publish and disseminate research findings.

ILCA states that:

The International Livestock Centre for Africa (ILCA) is an autonomous research and information centre whose activities are funded by the Consultative Group on International Agricultural Research.

The mandate of ILCA is to assist national efforts that aim to change production and marketing systems in tropical Africa so as to increase the production of livestock and the output of livestock products and improve the quality of life of the people of this region.

In particular, ILCA is intended to serve:

i) as an international centre for interdisciplinary research to promote the development and demonstration of improved livestock production systems, optimising the use of human and natural resources in Africa;

ii) as focal point for training activities that will increase regional competence in a systems approach to livestock production and development; and

iii) as a multidisciplinary documentation centre for the livestock industries of Africa.

In carrying forward its programme, the Centre will devlop close linkages with national and regional organisations undertaking research and training activities in the same or closely related fields of interest.

IPAL states that:

The Integrated Project in Arid Lands (IPAL) was established by UNESCO with financial support from UNEP in 1976 with the aim of finding direct solutions to the most urgent environmental problems associated with desert encroachment and ecological degradation of arid lands. It forms part of the international UNESCO programme, "Man and the Biosphere" (MAB) which has links not only with UNEP's Desertification Unit but also with FAO, in response to the Plan of Action adopted by the 1977 United Nations Conference on Desertification. It is an example of the type of pilot activity that UNESCO and UNEP, together with other organizations and a number of governments, are trying to promote to provide the scientific basis for the rehabilitation and rational management of arid and semi-arid zone ecosystems, through integrated programmes of research (including survey, observation and experimentation), training and demonstration. Phase III of the project, 1980-1983, is supported by funds in trust to UNESCO provided by the Federal Republic of Germany.

Vet. Lab. state that:

The Veterinary Research Laboratory of the Kenya Government established at the turn of the century, was the first institution for animal disease research in this country and has at one time or other been engaged in veterinary research on a very broad front.

The Laboratory retains its original mandate for research on any veterinary problem judged to be of importance to Kenya. In exercise of this mandate due recognition and support is given to other laboratories which in recent years have embarked on veterinary research.

Being directly linked to the veterinary field services and having ready access to the countrywide veterinary extension network, the Government Laboratory is the conduit through which veterinary research findings are applied or validated, be these from laboratories here in Kenya or outside.

The Laboratory itself and its regional laboratories operate disease investigation and diagnostic services. The Laboratory also develops and manufactures a variety of bacterial, viral and other vaccines.

Vet. Fac. states that:

The Faculty of Veterinary Medicine, which is one of the oldest Faculties of the University of Nairobi was constituted as a degree granting Faculty as of 1st July 1962 with the aims and facilities of producing internationally recognized Veterinarians. Secondly the Faculty aims at producing its own teaching staff of high standing able to conduct research into the problems of theLivestock Industry without being forced to rely on expatriates. The Faculty offers B.V.M.: M.Sc. and Ph.D. degrees.

The above parties wish to embark on a cooperative agreement on research collaboration and research training as it relates to ticks and Tick-borne Diseases, and Trypanosomiasis and tsetse flies in Kenya, and all related aspects of these vectors and diseases affecting health and production of man and livestock. NOW, THEREFORE, the parties have agreed on the general terms and conditions as herein contained.

ARTICLE I

The purpose of this Memorandum of Agreement is to further the following objectives:

1) to develop cooperative and collaborative activities in the furtherance of the common interests of the above-named institutions;

2) to promote the exchange of scientists and trainees between the above-named institutions for research, training and related activities;

3) to intensify and strengthen the capacities and capabilities of each institution in the field of ticks and Tick-borne Diseases, and trypanosomiasis and tsetse fly research and technology through the cooperative use of materials and facilities;

4) to facilitate the exchange of scholarly and scientific information and materials.

ARTICLE II

To implement the aims and purposes expressed in ARTICLE I it is mutually understood and agreed that:

1) regular meetings will be held between Directors and Scientists to discuss and develop collaborative research programmes, to disseminate scientific information and to conduct any other business relevant to the affairs of the Nairobi Cluster. The proceedings of these meetings will be minuted and circulated to all signatories of this Memorandum to ensure conformity with the aims and purposes described in ARTICLE I;

2) the programme of work under this cooperative agreement may be reviewed periodically to evaluate the progress of the training and research by designated representatives or their parties;

3) collaborative and cooperative operations will be conducted through Operational Committees composed of scientists actively engaged in research in the appropriate fields;

4) the business of the Nairobi Cluster shall be coordinated by a Chairman, Vice Chairman and Secretary appointed by the Cluster. These officers will work in consultation and collaboration with all members of the Cluster.

ARTICLE III

The parties to this Agreement may, by mutual consent, add, modify, amend or delete any words, phrases, sentences or articles in this Memorandum.

VRD states that:

The terms of reference of the Veterinary Research Department, Kenya Agricultural Research Institute, Muguga, include the development of additional methods of control for theileriosis and *Theileria* tick vectors. The program is divided into the following areas: the development of additional methods of controlling tick vectors in collaboration with the ICIPE tick programme; the development of methods of immunization of cattle against theileriosis and their assessment in the field; the identification and evaluation of drugs effective for the treatment of theileriosis and detailed studies to determine the epidemiology of theileriosis in the field.

IBAR states that:

The mandate of the Interafrican Bureau for Animal Resources of the Organization of African Unity (OAU/IBAR) includes the collection, collation and dissemination of research results on infectious and contagious livestock diseases of viral, bacterial, mycotic and protozoal origin. The Organization keeps close contact with and, encourages and offers assistance to, Research Institutions working particularly on Ticks and Tick-borne diseases, and Tsetse flies and Trypanosomiasis. The Organisation attends and organises training courses, seminars and meetings in the interests of African states.