PD-AAN-867
XD-AAN-867-A

CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) — PART I

Report Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Physiology and Ecology of Ticks	931-1038	S&T/AGR/AP
	4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY) 84-1 Terminal Review 1/12/84 ☐ REGULAR EVALUATION ☒ SPECIAL EVALUATION	

5. KEY PROJECT IMPLEMENTATION DATES			6. ESTIMATED PROJECT FUNDING	7. PERIOD COVERED BY EVALUATION
A. First PRO-AG or Equivalent FY 78	B. Final Obligation Expected FY 83	C. Final Input Delivery FY 83	A. Total $ 703,800 B. U.S. $ 703,800	From (month/yr.) 3/24/82 To (month/yr.) 8/28/83 Date of Evaluation Review 11/28 - 12/2/83

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
1. Project completed. No further implementation or monitoring actions required. 2. As a result of this project S&T/AGR has implemented a follow-on five-year project "Host Resistance/Integrated Tick Control Research" (Project No. 936-4083) which began on September 1, 1983.		

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☐ Financial Plan
- ☐ Logical Framework
- ☐ Project Agreement
- ☐ Implementation Plan e.g., CPI Network
- ☐ PIO/T
- ☐ PIO/C
- ☐ PIO/P
- ☐ Other (Specify) ______
- ☐ Other (Specify) ______

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

- A. ☐ Continue Project Without Change
- B. ☐ Change Project Design and/or ☐ Change Implementation Plan
- C. ☐ Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Project Manager, S&T/AGR/AP:WPWarren ______ Date 1/11/84
S&T/AGR/AP:JYohe ______ Date 1/23/84
S&T/AGR:JRoyer ______ Date 1/25/84
S&T/PO:FCampbell ______ Date 1/26/84

12. Mission/AID/W Office Director Approval

Signature

Typed Name

Anson R. Bertrand, Dir., S&T/AGR

Date

PROJECT EVALUATION SUMMARY (PES) PART II

13. Summary

The stated objective of this research project was to investigate the ecology and physiology of cattle ticks with the goal of developing environmentally sound and economically feasible control technologies for ticks and tick borne diseases. The review determined that the project was implemented in a manner consistent with the stated objective and also with recognized scientific research methodology.

As a result of successful biological and ecological work on the tick together with the use of other research findings on pest generated host resistance, an efficient pest control method is in sight. Together with promising vaccines and drugs being tested by veterinarians against theileriosis, an integrated control of the tick as well as the transmitted disease should now become practicable. This multiple component approach makes it very difficult for the pest to develop defensive strategies. It can be applied on a large scale in the field at relatively low costs. Furthermore, it is ecologically sound and can be adapted to many ecological situations.

The overall quality of the research in the project has been of high standard and the evaluation methods has been generally sound. This has been the result of excellent leadership of a well qualified and dedicated team of scientific and technical staff. The good contacts by the Project Leader can be cited as an important aspect in the project. These include ICIPE research support units, biochemical and immunological studies on resistance in cooperation with the International Laboratory for Research on Animal Diseases (ILRAD) and the Chemistry and Bioassay Research Unit, use of field stations with resistance Zebu cattle and other breeds in cooperation with veterinarians from the Kenya Agricultural Research Institute (KARI) and ILRAD, and farmers.

14. Evaluation Methodology

The evaluation consisted of a review of the project's Final Annual Report and Financial Statement from the International Center for Insect Physiology and Ecology (ICIPE), and the First Triennial Review carried out on behalf of the sponsoring group for ICIPE. Copies of these reports are attached to this PES.

15. External Factors

The project was directed towards the integrated management of ticks, which reduce livestock production by sucking blood from their hosts and especially by transmitting diseases. Livestock in Africa and many other parts of the world are severely affected. Control of ticks by acaricides needs expensive and frequent applications. Interruption of treatment leads to immediate increase in tick infestation which causes enormous losses in livestock. This happened recently in Zimbabwe on a very large scale when acaricide control broke down as a result of hostilities, and more than 1 million cattle died of tick-borne diseases and debility caused by massive tick infestation. Other common disadvantages of pesticide treatment are induced resistance of the pest to the pesticide, pesticide residues in meat and dairy products, and the maintenance of susceptibility to the ticks and diseases because of lack of induced resistance in the host. It was in this problem setting that the Tick Physiology and Ecology project was designed and implemented. A major limiting factor has been the lack of transportation and sufficient experimental animals. Due to insufficient experimental animals there has been lack of quantitative data and there has been little use of biostatistics until recently.

16. Inputs

The total life of project funding by S&T/AGR was $703,800 U.S. and the consolidated expenditures for the period 29 September 1978 to 28 August 1983 were the following:

Personnel Costs	$427,378	
Travel	23,918	
Consultants	2,000	
Materials, Services, Expenses	182,035	
Equipment	20,433	
Funds to Israel	48,000	(visiting scientist)
Total	$703,764	U.S.

17. Outputs

As a result of successful biological and ecological work on the tick together with the use of other research findings on pest generated host resistance, an efficient pest control method is in sight. African livestock develop resistance to brown ear ticks during infestation, as the result of antibody formation in the host induced by antigens from tick saliva. This "type 1 resistance" leads to considerable reduction in tick vitality and results in lessened ability to transmit theileriosis. In pastures with resistant cattle, the tick population is significantly reduced and a new balance between host and pest is established. In addition, methods were tested to evoke antibody formation in the cattle ("type 2 resistance) by means of antigens from different parts of the ticks, to isolate and characterize the antigens, to detect the target organs or processes in the tick which are affected by the antibodies, and on an increasing scale, to study the resistance of livestock in field experiences. More recently, studies were conducted on crossbreeds of cattle, combining high productivity and strong natural ability in developing "type 1 resistance". This approach provided quantitative data on the impact of ticks on native and introduced cattle, and on the resulting tick population.

Together with promising vaccines and drugs being tested by veterinarians against theileriosis, an integrated control of the tick as well as the transmitted disease should now become practicable. This multiple component approach makes it very difficult for the pest to develop defensive strategies. It can be applied on a large scale in the field at relatively low costs. Furthermore, it is ecologically sound and can be adapted to many ecological situations.

The cooperative network with KARI and ILRAD is a good example of a well coordinated project. The output in terms of publications has not been high (9 in 1980), 5 in 1981, 6 in 1982), but several staff members are preparing manuscripts, so a significant increase in the number of published papers is expected.

18. Purpose

The project purpose was to investigate the ecology and physiology of cattle ticks with the goal of developing environmentally sound and economically feasible control technologies for ticks and tick borne diseases. In keeping with this purpose, the above mentioned physiology, ecology, and immunology studies were performed in a coordinated way to produce an immune response in cattle which reduce the numbers of feeding ticks and arrest the development of those that reach the feeding stages. The outputs described in number 17 above are consistent with the approved project purpose and the review was able to document significant progress toward the achievement of the purpose.

19. Goal/Subgoal

As stated in the log frame, the project's goal was to "develop improved methods of control of ticks". With a project goal varying only slightly from the project purpose, it is fair to conclude that those comments made relevant to the achievement of project purpose would also be appropriate to the project's goal.

20. Beneficiaries

The project's direct and immediate beneficiaries were the ICIPE scientists who have received support for their scientific endeavors through project funding. In a similar way, the project contributed to ICIPE's institutional building process through its support of two of the center's principal research components, tick physiology and ecology. The project has provided the center and it scientists an opportunity to expand their scientific expertise, research an important animal science problem, and enhance the body of scientific knowledge relative to it. The scientists in developed countries and international centers (ILCA and ILRAD) are also beneficiaries of this project.

As the center develops effective and economical tick control methods, LDC farmers especially those of East Africa, will be the beneficiaries. The appropriate application of project generated tick contol methods will result in increased meat and milk production as tick borne cattle diseases are reduced to more tolerable levels. Among other benefits, farmers both large and small, will not be so dependent on expensive and labor intensive acaricide dips. Not only will there be an increase in farmer incomes as livestock production increases, but consumers should also benefit from increased supplies and stable prices.

21. Unplanned Effects

The project did not encounter any unanticipated social, health, environmental, technical, or economic constraints that necessitated any modification in the project's design or implementation plan.

22. Lessons Learned

The overall quality of the research in the project was of a high standard which was the result of excellent leadership of a well qualified and dedicated team of scientific and technical staff. The ability of project management to collaborate effectively with scientists from other institutions was an important aspect of the project. Collaboration included ICIPE research support units, biochemical and immunological studies on resistance in cooperation with ILRAD and the chemistry and bioassay research unit, use of field stations with resistant Zebu cattle and other breeds in cooperation with veterinarians from KARI and ILRAD, and farmers. Cooperation which included sharing of equipment, knowledge, and facilities was responsible for much of the progress made under this project.

23. Special Comments

As is indicated in the Project Evaluation Summary (PES) - Part II, (numbers 13-22), ICIPE has made a definite commitment to the research and development of an immunological tick control methodology. Because of the commitment, S&T/AGR has funded a five-year project "Host Resistance/Integrated Tick Control Reserch" (project number 936-4083) which began on September 1, 1983.

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XD-AAN-867-A

THE INTERNATIONAL CENTRE OF
INSECT PHYSIOLOGY AND ECOLOGY
P.O. BOX 30772, NAIROBI, KENYA

USAID GRANT NO. AID/DSAN-G-0067
PROJECT NO. 931-1038: Final Annual Report

Staff:

M.P. Cunningham
R. M. Newson
D. Punyua
J. Chiera

INTRODUCTION

Ticks are found in all areas of Africa which are suitable for livestock including approximately 10 million km^2 presently infested with tsetse, and livestock production is seriously affected because of disease transmission and debility caused by tick infestation.

The most important diseases transmitted to cattle by ticks are theileriosis, anaplasmosis, babesiosis and ricketsiosis all of which occur throughout the continent. Theileriosis caused by Theileria annulata occurs in North Africa and extends into Sudan. Theileriosis caused by T. parva and T. lawrencei occurs in East, Central and parts of Southern Africa. Drugs and methods of vaccination have been available for sometime for the control of anaplasmosis, babesiosis and ricketsiosis. Work carried out by the UNDP/FAO Regional Project (Research on tick-borne diseases and tick control) RAF/67/077 from 1967 to 1977 at Muguga in Kenya, and since then continued at the Veterinary Research Department of the Kenya Agricultural Research Institute (KARI) and at ILRAD Nairobi. As a result, curative drugs and experimental vaccine against East Coast Fever (ECF) have been produced. Successful field trials with the experimental vaccine have been carried out in Kenya and Tanzania, and more recently in Western Kenya and in coastal province. In addition, a DANIDA/FAO project has been established in Malawi which is expected to produce ECF vaccine for Malawi and neighbouring countries. A successful field trial has recently been carried out by the staff of the Veterinary Research Department, Muguga, in western Kenya using two curative drugs against ECF, one of which has been registered for use by veterinarians.

The traditional method for controlling ticks and the diseases they transmit is the close interval application of acaricides in dips or sprays to livestock. To control ECF, two weekly applications are necessary. This procedure has many disadvantages: the high cost of installing, maintaining and staffing dips and spray races, the high cost of acaricides, the development by the ticks of resistance to acaricides, high levels of acaricide residues in beef and dairy produce. But perhaps the greatest disadvantage of using acaricides for the control of ticks is the fact that an inherently unstable situation results where regularly dipped cattle are completely susceptible to disease and naive to tick infestation. If for any reason acaricide application fails, catastrophies can occur. This happened recently in Zimbabwe on a very large scale when acaricide control broke down as a result of hostilities, and more than 1 million cattle died of tick-borne diseases and debility caused by massive tick infestation.

What are the prospects? As stated above, curative drugs and vaccines are now available for the control of the diseases of cattle transmitted by ticks. In addition, it has been known for many years that cattle can be made resistant to ticks, and the technique is now being used in Australia to control Boophilus microplus, the vector of babesiosis.

Bovine resistance to tick infestation was reported in the early part of this century and it was found that cattle in Queensland, Australia developed resistance to *B. microplus* following infestation. However, it is only within the last 10 years that this finding has been applied in the field, necessitated by the widespread development of resistance to acaricides by *B. microplus* and made possible by the availability of curative drugs and a vaccine for the control of babesiosis. Over the years, a great deal of work has been carried out on this subject but very little in Africa.

Investigations were started at the ICIPE in an attempt to produce resistance in cattle to ticks. All of the work so far has been done on *R. appendiculatus* because of its importance as a vector of *T. parva* and because of its widespread distribution in East, Central and Southern Africa.

Following the Australian work, it was quickly found that cattle become resistant to *R. appendiculatus* when approximately 500 adult ticks are allowed to feed on them. Resistance also develops when cattle are exposed to ticks in paddocks. Resistance has been produced in *Bos taurus* as well as in *B. indicus* cattle, and is long lasting - at least 2 years.

Resistance appears to be stimulated in cattle in response to antigens inoculated in the saliva of the feeding tick. When ticks feed on a resistant animal, they excrete antigens in the saliva. These antigens stimulate an immediate type hypersensitivity reaction, and marked swelling occurs at the site of attachment of the tick, within 20 minutes of attachment. This reaction interferes with the ability of the tick to feed properly. The effect is most marked against larvae, less against nymphs and least against adult ticks. In highly resistant cattle, very few larvae, less than 25% of nymphs and less than 50% of adult ticks are able to complete feeding, and the engorged weight is also reduced. The smaller ticks which are produced after moulting have a reduced survival potential when exposed to temperature and humidity stress and the females produce smaller egg batches.

Work Carried Out

1. Effect of Host Resistance on *R. appendiculatus* Population Development

The experimental design (Figure 1) 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:

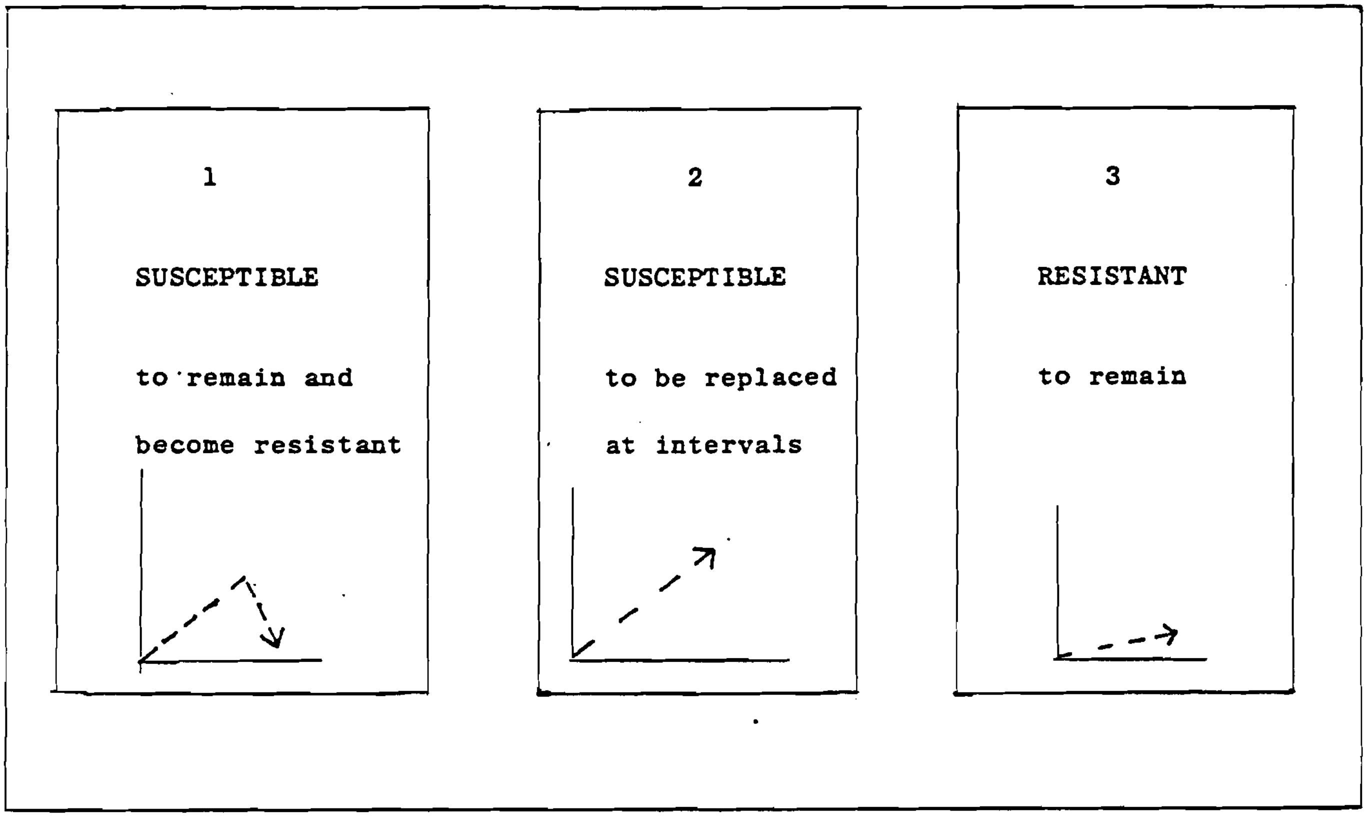

Figure 1: Experimental design for effect of host resistance on *R. appendiculatus*

Each plot approximately 0.6. hectares

Unfed Larvae introduced, approximately $20/m^2$

2 Cattle per plot introduced ten days later

(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

(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) moulted 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 one year later; and, 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 1).

Table 1 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	432	2377	19
Skin Scrapes per cm 2				
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 100m 2				
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 are available to be picked up. Adult ticks do not attach to the cloth.

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

Table 2:

Changes in scutal size (in mm) in experimental tick populations after one year (Mean ± SD).

	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)
1 year later	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 ± 1.13(18)
1 year later	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)
1 year later	2.57 ± 0.24(148)	2.94 ± 0.29(55)	2.38 ± 0.40(14)

(No. 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.

2. 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 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* 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 antibodies 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 number 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 rabbis 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%.

3. 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 piroplasma, 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 remaining resistant animal, which did not become 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 8.2mg. On the infected resistant animal 50% of the nymphs engorged and the average weight was 6.7mg. 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 sporozooites, 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.

Finally, following the success in controlling tick populations reported above, a large scale trial is being planned at Intona Ranch, Migori, where many wild animals support the tick population and where East Coast Fever is enzootic. At Intona Ranch, a 50 acre paddock is being prepared from which wild animals have been eliminated. Exclusion of game will be achieved by a solar energised electric fence. 30 improved Boran steers will be introduced into the paddock, which have been immunised against East Coast Fever, and which have naturally acquired resistance to tick infestation. The ability of these cattle to control the tick population in the paddock, and the transmission of East Coast Fever will be investigated.

SCHEDULE A

THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

RESEARCH ON TICK RESISTANT CATTLE IN THE ECOLOGICAL MANAGEMENT OF TICKS

GRANT NO. AID/DSAN-G-0067 PROJECT NO. 931-1038.11

PROJECT OFFICE : S & T/AGR/AP

ACTUAL EXPENDITURE FOR THE PERIOD 29TH SEPTEMBER 1982 TO 28TH AUGUST 1983

(IN U.S. $)

		NOTES	AMOUNT
II.	PERSONNEL COSTS	1	97,220
II.	MATERIALS, SERVICES AND EXPENSES	2	102,780
			200,000

1. PERSONNEL COSTS

(a) Scientific Staff

	US $
Dr. M.P. Cunningham, Scotish, Principal Research Scientist	30,492
Dr. R.M. Newson, English, Senior Research Scientist	22,958
Dr. C.K.A. Mango, Kenyan, Research Scientist	14,758
Mr. D.K. Punyua, Scientific Officer	11,646
	79,854

(b) Technical Support Staff

Mr. J.G. Mugane, Junior Technician	3,803
Mr. J.N. Ndungu, Technical Assistant	2,936
Mr. M.C. Ngumah, Technical Assistant	3,193
Mr. F.M. Thuo, Technical Assistant	2,935
Mr. G.M. Hindi, Technical Assistant/Stockman	2,235
Mr. M.G. Kimondo, Stockman	1,132
Mr. N.R. Tome, Stockman	1,132
	17,366
Total Personnel Costs	97,220

2. MATERIALS, SERVICES AND EXPENSES

Supplies and Expendables	7,050
Field Expenses	5,875
Vehicle Running Expenses	4,701
Insurances	823
Drugs and Vacines	6,168
Equipment Maintenance	588
Report Costs	617
Insectary Services	2,349
Animal Food	6,463
Cattle	13,160
Share of Field Station Costs	41,122
Photographic Services	1,057
Share of ICIPE Costs	12,807
	102,781
Total	200,000

THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

RESEARCH ON TICK RESISTANT CATTLE IN THE ECOLOGICAL MANAGEMENT OF TICKS

GRANT NO. AID/DSAN-G-0067 PROJECT NO. 931-1038.11

PROJECT OFFICE : S & T/AGR/AP

CONSOLIDATED EXPENDITURE FOR THE PERIOD 29THE SEPTEMBER 1978 TO 28TH AUGUST 1983 (IN U.S. $)

	AMOUNT
Personnel Costs	427,378
Travel	23,918
Consultants	2,000
Materials, Services, Expenses	182,035
Equipment	20,433
Funds to Israel	48,000
	703,764

SYT/AGR

SPONSORING GROUP FOR ICIPE

REPORT OF
THE TRIENNIAL REVIEW
OF THE
INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY
(ICIPE)

WORLD BANK, WASHINGTON, D.C.

SECTION 4: LIVESTOCK TICKS

General Information

120. The programme was started in 1972 as a major and core programme of ICIPE, and received relatively strong financial support, especially through donors such USAID, EEC, and DDA (Switzerland). The present Programme Leader was appointed in 1977. In the current programme there are 4 senior staff, 3 other scientific staff and 7 technical staff. The total budget for 1983 amounts to U.S.$357,000. (Annex 4).

Objectives and Background

121. The progrmame is entirely directed towards integrated management of ticks, which generally inhibit livestock production by sucking blood from their hosts and especially by transmitting diseases. Livestock in Africa and many other parts of the world are severely affected. Control of ticks by acaricides needs expensive and frequent applications. Interruption of treatment leads to an immediate increase in tick infestation which causes enormous losses in livestock as happened, for example, when the dipping programme broke down in Zimbabwe and about one million cattle died. Other common disadvantages of pesticide treatment are induced resistance of the pest to the pesticide, pesticide residues in meat and dairy products. and the maintenance of susceptibility to the ticks (and the diseases) because of lack of induced resistance in the host.

122. The goal of the programme is to develop alernative control mechanisms for one of the major pest ticks in Kenya and Eastern Africa, the brown ear tick (R. appendiculatus), which transmits a severe disease, the East Coast Fever (Theileriosis). The study includes work on population dynamics (survival, development and reproduction under different external factors, including tolerant and resistant hosts), host-pest relationships, physiology, and behaviour of the pest, aimed at demonstrating promising method of interfering with the pest's activities and vitality. The final goal is to develop, test and apply a method of integrated pest management. This will include vaccination against East Coast Fever (ECF), chemotherapy together with biological control of the tick, and minimal use of acaricides where necessary. Such a programme is well suited to ICIPE's mandate. One possible approach is an acquired resistance of cattle to tick infestation, combined with protection of the host animal against ECF by vaccination and/or application of curative

drugs. This would provide ecologically safe control methods less harmful to the consumer of livestock products, and less expensive pest control. The objectives of the programme were well defined when it first started and those objectives have not been changed.

Management

123. The Programme Leader and his colleagues have a strong degree of control over research projects and have had a considerable input into the budgeting process, though it was felt that there was perhaps insufficient consultation about the final decisions.

124. The programme has enjoyed strong leadership, a satisfactory flow of information between the projects, and a good interdisciplinary cooperation within and outside ICIPE. Doctoral and postdoctoral training has been satisfactory and has involved national and international contacts for training in different approaches. Opportunities for overseas visits and attendance at international conferences have been very limited. A serious gap in the programme was caused by the enforced resignation of one of its most promising scientists.

125. By using facilities at cooperating institutions, but more importantly through the strong loyalty of the staff, in spite of the severe financial problems, the programme has managed to overcome the difficult years of 1981/1982.

Strengths

126. As a result of successful biological and ecological work on the tick together with the use of other research findings on pest-generated host resistance, an efficient pest control method is in sight. African livestock appear to develop resistance to brown ear ticks during infestation, as the result of antibody formation in the host induced by antigens from tick saliva. This "type 1 resistance" leads to considerable reduction in tick vitality and results in lessened ability to transmit the disease. In pastures with resistance cattle, the tick population is significantly reduced and a new balance between fever. In pastures with resistant cattle, the tick population is significantly reduced and a new balance between host and pest is established. At present, methods are being tested to evoke antibody formation in the cattle (type 2 resistance) by means of antigens from different parts of the ticks, to isolate and characterize the antigens, to detect the target organs or processes in the tick which are affected by the antibodies, and on an increasing scale, to study the resistance of livestock in field experiments. Recently, studies have started on crossbreeds of cattle, combining high productivity and strong natural ability in developing type 1 resistance. This approach will provide quantitative data on the impact of ticks on naive and infested resistant cattle, and on the resulting tick population. Together with promising vaccines and drugs being tested by veterinarians against theileriosis, an integrated control of the tick as well as of the transmitted disease might become practicable. This

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multiple component approach should make it very difficult for the pest to develop defensive strategies. It can be applied on a large scale in the field at relatively low costs. Furthermore it is ecologically sound, and could be adapted to many ecological situations.

127. The overall quality of the research in the tick projects is of a high standard; the evaluation methods are generally sound. This is the result of excellent leadership of a well-qualified and dedicated team of scientific and technical staff. The good contacts by the Programme Leader were cited as an important aspect in the programme. These include ICIPE research support units, biochemical and immunological studies on resistance in cooperation with ILRAD and the Chemistry and Bioassay Research Unit, use of field stations with resistant Zebu cattle and other breeds in cooperation with veterinarians from KARI and ILRAD, and farmers. Training in immunology of ICIPE staff is done at ILRAD and overseas laboratories (Utrecht, Holland; Neuchatel, Switzerland). Cooperation with ICIPE's Sensory Physiology and Histology and Fine Structure Research units provided valuable information on several tick sense organs, and on the structure of the relevant receptor cells. However, the significance of these results for possible tick control is limited at the moment.

128. The cooperative network is a good example of a well-coordinated programme. Considering the number of cooperative projects, the outcome in terms of publications has not been high (9 in 1980, 5 in 1981, 6 in 1982), but several staff members are preparing manuscripts, so a significant increase in the number of published papers is expected; this is to be commended.

Limitations

129. Due to insufficient experimental animals there has been lack of quantitative data and there has been little use of biostatistics until recently. Another more basic problem is that the work on the immunology of induced resistance is really beyond the scope of ICIPE's scientific and technical resources. A major limiting factor has been the great lack of transportation.

Future Plans

130. The plans for ecological work are well defined. Results, especially on induction of type 2 resistance, will be confirmed and quantified using infested naive and resistant cattle. An increase in the field studies using resistant cattle is planned, the search for strains of livestock that are highly productive yet resistant is in its initial stage. Field trials to develop practical methods of integrated pest control will be undertaken. This requires more field facilities, cattle, probably more technical staff and transport.

131. A major study project is planned on the immunological basis of cattle resistance, on tick antigens, especially from tick eggs, and on

target processes and substances (juvenile hormone-binding proteins) in ticks for host antibodies. Most of this work will be done in the Chemistry Unit of ICIPE in close cooperation with immunologists at ILRAD.

Potential Users of New Technology and Knowledge

132. The programme is producing a range of useful results. The tick study could serve as the model study for other tick projects in Kenya and other tropical countries. If the bigger-scale field experiments are successful, there will be promise of a control technique for a major pest which affects livestock in many countries. Other scientific institutions could use the model in order to design research on tick ecology and control.

Recommendations

133. (a) The Team strongly supports the multifaceted integrated control programme with its continuance of vaccine and drug use, host resistance to tick infestation, acaricides, and exclusion of game.

(b) The programme needs more support for field work, using larger numbers of cattle. More transport will be needed.

(c) A multifactorial model of tick population dynamics and host-pest relationships, especially with resistant, vaccinated, and drug-treated cattle should be formulated. It might well become a model for other systems as well as posing important questions and approaches for further investigations in the programme.

(d) Extension of the immunological and protein chemistry studies will present problems since such an approach will require the full range of modern biochemistry with sophisticated methods and modern instrumentation. If the plan is to be followed, a substantial section of the Chemistry and Bioassay Research Unit would have to be involved. Staff would need to be trained in the relevant techniques, and other institutions would need to be involved to provide expertise and technical assistance. The essential prerequisite will be a clear definition of research priorities of the cooperating groups, a realistic budget plan and cooperation at an international level. This should include the assistance of an experienced immunologist. It is strongly recommended that such planning be made before the full-scale programme is started.

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