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CONSULTANCY REPORT
TO ADVISE ON FUTURE DIRECTION OF
ALL-INDIA COORDINATED RESEARCH PROJECT ON
INTRACELLULAR BLOOD PROTISTA

by

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following visit to India

from

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requested by

Winrock International

for

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and

Indian Council of Agricultural Research

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EXECUTIVE SUMMARY

The consultant was invited to India to make recommendations on the incorporation of modern techniques of biotechnology into the USAID-supported All-India Coordinated Research Project on Intracellular Blood Protista which was initiated to develop improved methods for the control of theileriosis, babesiosis and anaplasmosis, three tickborne diseases constraining cattle and buffalo productivity in India. The consultant reviewed the progress of the Project, met with key Indian, USAID and Winrock officials in New Delhi, and visited with administrators and scientists at the three major institutes currently involved in the Project (i.e., Punjab Agricultural University in Ludhiana, Haryana Agricultural University in Hisar, and the Indian Veterinary Research Institute in Izatnagar).

Two major recommendations are made by the consultant. The first recommendation is that USAID/India should immediately buy into a USAID/State-funded project based at the University of Florida and developing improved vaccines and diagnostic tests for anaplasmosis and babesiosis using biotechnology. This action would allow modern molecular diagnostic tools to be used immediately in epidemiological and socioeconomic surveys of the two diseases in India and would determine the feasibility of utilizing the environmentally friendly pheromone-based tick decoy technology developed at the University of Florida as a cost-effective method for tick control in India. The second recommendation is that USAID/India should fund a new project on utilization of biotechnology to develop and commercialize improved vaccines and diagnostic tests for the three tickborne diseases and to develop and commercialize innovative biocontrol methods for the vectors of these diseases in India. It is suggested that the new project should be a collaborative program between the University of Florida from the United States and the National Institute of Immunology and the National Dairy Development Board from India, with coordination through the Indian Department of Biotechnology.

These recommendations have, in the opinion of this consultant, the following advantages: (1) they allow modern technology to be transferred to the current Project before its USAID support ends; (2) they would quickly develop a major center for veterinary biotechnology in India; (3) they would develop a biotechnology program focussed on development of innovative products for commercialization; and (4) they would establish a long-term Indo-US collaborative program in biotechnology involving both the public and private sectors.

INTRODUCTION

The Government of India launched several projects in order to introduce high-yielding exotic-cattle germplasm into indigenous cattle breeds to promote their milk-production potential. These actions have resulted in an increase in number of highly valuable crossbred cattle in India, and the landless and marginal farmers are being motivated to purchase these high-producing crossbred animals to promote their economic resources. However, the crossbred animals are highly susceptible to tickborne hemoparasitic diseases, especially theileriosis (*Theileria annulata* infection), babesiosis (*Babesia bigemina* infection) and anaplasmosis (*Anaplasma marginale* infection). These diseases have posed a serious constraint to the progress of the cross-breeding program that is underway throughout India. Consequently, in 1987 the All-India Coordinated Research Project on Intracellular Blood Protista (hereafter referred to as the Project) was initiated to develop improved methods for the control of theileriosis, babesiosis and anaplasmosis in cattle and buffaloes. The Project was funded jointly by the U.S. Agency for International Development (USAID) and the Indian Council of Agricultural Research (ICAR), and it involved six Indian institutions (Haryana Agricultural University, Punjab Agricultural University, the Indian Veterinary Research Institute, Tamil Nadu University for Veterinary and Animal Sciences, Rajendra Agricultural University, and the National Dairy Development Board) with an ICAR Coordinating Unit and Central Laboratory located on the Haryana Agricultural University campus at Hisar.

ICAR decided that the initial phase of the Project would emphasize research on the epidemiology and development of diagnostics and vaccines to control theileriosis. ICAR now wishes to expand its research to babesiosis and anaplasmosis and to introduce biotechnology to the program. To achieve this second phase, this consultant was invited to India, and this report details his recommendations to USAID.

BACKGROUND

During its first four years, the Project has made the following achievements:

1. Development of cell-culture schizont vaccines for theileriosis.
2. Development of various diagnostic tests including dot ELISAs for theileriosis and *Babesia equi* infection, an indirect fluorescent antibody test for theileriosis, and capillary-tube agglutination tests for babesiosis and anaplasmosis.
3. Development of a highly effective method for chemotherapy of theileriosis using buparvaquone.

Four theileriosis vaccines, all using similar cell-culture technology, have been developed independently by four institutes, Haryana Agricultural University (HAU), Punjab Agricultural University (PAU), the Indian Veterinary Research Institute (IVRI) and the National Dairy Development Board (NDDB), with the one developed by NDDB having been commercialized. However, the four vaccines have not yet been compared and, therefore, their relative efficacy is unknown. The diagnostic tests developed, while demonstrating scientific progress, have not utilized modern technology and thus are not optimal for either diagnostic or epidemiological purposes.

Since 1987, the training activities of the Project have emphasized short-term training in the United States and workshops in India. Four Indian scientists (Dr. A.K. Mishra from IVRI, Dr. S. Sarup and Dr. R.D. Sharma from HAU, and Dr. J. Chellappa from Tamil Nadu University) each attended 20-week training courses at the University of Illinois in conventional techniques for research on hemoparasites. Three other Indian scientists (Dr. J. Kapur from PAU and Dr. G.C. Bansal and Dr. D. Ray from IVRI) started a five-month training course in biotechnology at the University of Florida in October 1991. Two workshops, one of 12-weeks' duration on hybridoma technology and the other of eight-weeks' duration on genetic engineering of protozoan diseases, were organized at IVRI and presented by U.S. scientists with no apparent connections to the Project. They were Dr. R.B. Lal of the Uniformed Services University in Maryland and Dr. A. Lal of Emory University in Georgia, respectively.

Advisory services to the Project since its inception in April 1987 have come exclusively from the University of Illinois.

The Project has made significant progress with its physical facilities. An ICAR Central Laboratory for the Project has been built on the HAU campus at Hisar, and PAU has built extensive laboratory and animal facilities on its campus for its Tickborne Diseases Research Centre which is available for use by the Project. However, neither facility is fully operational due, at least in part, to lack of equipment and trained manpower.

According to ICAR officials, the future objectives of the Project are outlined in ICAR's 1992-97 eighth five-year plan and include the following:

1. Development of improved vaccines for babesiosis and anaplasmosis utilizing biotechnology.
2. Further improvement in prophylaxis against theileriosis through biotechnology.
3. Development of improved methods for the control of the tick vectors.
4. Development of control measures for *Trypanosoma evansi* infection and for *Ehrlichia canis* infection.

OBJECTIVES

1. To prepare recommendations for short-term extended funding of the Project by USAID/India.
2. To prepare recommendations for longer-term funding of a project to utilize biotechnology in the development and commercialization of vaccines and diagnostics for tickborne diseases of livestock and to develop and commercialize innovative biocontrol methods as alternatives to the use of pesticides in the control of the tick vectors.

OBSERVATIONS AND FINDINGS

Indian Council of Agricultural Research

1. ICAR will continue to fund the Project irrespective of whether or not USAID funding continues.
2. Dr. Bhattacharyulu provides excellent administrative leadership to the Project as head of its Coordinating Unit at HAU.

Punjab Agricultural University

1. Research on anaplasmosis is its current tickborne-disease priority.
2. Extensive laboratory and animal facilities are available to the Project but grossly underutilized.
3. PAU has a well-trained veterinary immunologist in Dr. Grewal who provides effective scientific leadership for the PAU component of the Project.
4. The security situation in Punjab remains a problem.

Haryana Agricultural University

1. Research on babesiosis, especially *B. equi*, infection, appears to be its major tickborne-disease interest; donkeys are the major reservoir host of *B. equi* with prevalence rates said to be in excess of 90%.

2. **Good laboratory and animal facilities are available to the Project through the new ICAR Central Laboratory, but for biotechnology in particular the Laboratory will require central airconditioning and emergency generators.**
3. **The HAU component of the Project needs to consolidate its research program under one scientist, with the entire program located in the ICAR Central Laboratory.**
4. **The HAU component of the Project has no scientists with training in biotechnology.**

India: Veterinary Research Institute

1. **IVRI has made little apparent progress in its biotechnology capabilities despite major inputs of equipment and funds from the Department of Biotechnology, USAID, UNDP, and the British Council; it is widely believed that this is at least partially due to the long-term problems with the administrative structure at IVRI.**
2. **The research facilities available to the IVRI component of the Project are in need of renovation and modernization.**
3. **The IVRI component of the Project lacks scientific leadership and direction.**
4. **IVRI is building a BSL-3 high-security animal-disease laboratory in Bhopal, but it will not be completed for 3-4 years.**

Department of Biotechnology

1. **Its head, Dr. Ramachandran, is very interested in supporting a biotechnology input into the Project; as a first step, he suggested a meeting in India in early 1992 of the relevant U.S. and Indian groups.**

National Institute of Immunology

1. **Its scientists exhibited great interest in collaboration with U.S. scientists in a biotechnology phase of the Project.**
2. **The facilities at the Institute are excellent for biotechnology research.**

3. The scientists at the Institute appeared to be well trained, enthusiastic and motivated.

Biotech Consortium India Limited

1. Its Managing Director, Dr. Chandrasekhar, indicated considerable interest in assistance with commercialization of any products developed by the Project.

National Dairy Development Board

Although the consultant was not afforded the opportunity to visit NDDDB, he did speak with Dr. M.P.G. Kurup (Executive Director) on the telephone on 25 October 1991 and did glean the following information about NDDDB during his visits to other institutions:

1. NDDDB appeared very interested in continued involvement in the Project, especially with respect to commercialization of products.
2. NDDDB has a functioning BSL-3 animal facility at Hyderabad that might be suitable for the testing of vaccinia-based subunit vaccines.
3. NDDDB already has formal linkages and/or collaborative programs with the National Institute of Immunology and the Biotech Consortium India Ltd.
4. NDDDB already has a commercial division based in Hyderabad called Indian Immunologicals.

PROBLEMS ENCOUNTERED AND SOLUTIONS

Problem 1

The Project has made scientific progress in the development of a variety of serodiagnostic tests. However, these tests have limitations including suboptimal sensitivity and specificity and lack of ability to detect carrier infections. These limitations restrict the value of the tests for diagnostic and epidemiological purposes and do not allow for meaningful economic analyses to be conducted on the tickborne infections.

Solution to Problem 1

USAID/Washington funded a \$5-million project entitled "Improved Animal Vaccines Through Biotechnology: Phase II - Anaplasmosis and Babesiosis" at the University of Florida in 1987. This project has made considerable progress in the utilization of modern biotechnology to develop improved diagnostic tests for anaplasmosis and babesiosis which are currently being tested in the field in various countries, including Thailand. The nucleic acid probes developed by this project could be utilized immediately in India through a buy-in to the project by USAID/India. Such action would allow the Indian Project to rapidly conduct epidemiological and socioeconomic surveys for anaplasmosis and babesiosis. These surveys should be designed to determine the dynamics of *A. marginale* and *B. bigemina* infections in cattle and buffaloes and in their tick vectors and to determine essential economic parameters. Such surveys are necessary prerequisites to the successful testing and cost-effective deployment of improved vaccines for the diseases.

Problem 2

The Project has made no progress in the control of the tick vectors of the diseases under study.

Solution to Problem 2

USAID/Washington funded a \$2.76-million project entitled "Heartwater Research Program" at the University of Florida in 1989. This project has made significant progress in the development of an innovative pheromone-based technology for the cost-effective control of ticks. This so-called tick decoy system has been shown to be effective in controlling *Amblyomma* ticks in Africa, and it is nearing commercialization. The tick decoy technology has a number of major advantages over the conventional methods for tick control (i.e., dipping or spraying with toxic pesticides), and they include the following:

- i) environmentally friendly:
 - a) is non-polluting;
 - b) greatly reduces use of toxic chemicals;
 - c) has no requirement for water;
 - d) is target-specific;
- ii) economical:
 - a) is inexpensive and simple to produce;
 - b) reduces drain on foreign exchange.

The tick decoy technology developed by this project could be utilized immediately in India through a buy-in to the project by USAID/India. Such action would quickly

determine whether or not the ticks which are important vectors of livestock diseases in India could be cost-effectively controlled using the tick decoy technology.

Problem 3

The Project has not utilized modern biotechnology in its attempts to develop improved vaccines and diagnostics for tickborne diseases in India. Furthermore, the Project only initiated training of Indian scientists in biotechnology recently (October 1991), so there is no core group of scientists trained in biotechnology available to the Project.

Solution to Problem 3

A major research thrust in veterinary biotechnology should be initiated immediately but, to maximize momentum and resources, it should be developed as a new program involving collaboration between an Indian institution already utilizing biotechnology for disease control (e.g., the National Institute of Immunology in New Delhi) and an American institution already developing subunit vaccines and diagnostics for tickborne diseases using biotechnology (e.g., the University of Florida). Such action would allow biotechnology to be used immediately in the development of improved vaccines and diagnostics without the need for lengthy periods for training, recruitment and equipment purchases.

Problem 4

The Project has not developed its potential for commercialization adequately. The National Dairy Development Board, which was a full participant in the Project at its outset, is now only an associate member institution, and it is the only institution involved with the Project which has the ability to commercialize products developed by the Project.

Solution to Problem 4

The National Dairy Development Board should play a central role in the future of the Project.

RECOMMENDATIONS

1. USAID/India should immediately buy into the USAID/ST-funded project entitled "Improved Animal Vaccines Through Biotechnology: Phase II - Anaplasmosis

and Babesiosis" (cooperative agreement no. DAN-4178-A-00-7056-00) through the companion Basic Ordering Agreement (contract no. DAN-4178-B-00-9061-00) in order (a) to allow modern molecular diagnostic tools to be used in epidemiological and socioeconomic surveys of anaplasmosis and babesiosis in India; and (b) to determine the feasibility of utilization of the pheromone-based tick decoy technology as a cost-effective method for the control of ticks of livestock in India. Such a buy-in would provide India with immediate access to innovative tick and tickborne-disease technologies developed through the University of Florida and would allow direct collaboration between University of Florida and Indian scientists. It is recommended that any such collaboration be coordinated through the ICAR Central Laboratory at Hisar.

2. USAID/India should fund a new seven-year stand-alone project on the utilization of biotechnology to develop and commercialize improved vaccines and diagnostic tests for the major tickborne diseases (anaplasmosis, babesiosis, and theileriosis) constraining livestock productivity in India and to develop and commercialize innovative biocontrol methods as alternatives to the use of toxic pesticides in the control of the disease vectors. Such a program should be concerned with the development, evaluation and safety testing of products right the way through to their commercialization to the farmers. It is recommended that this program be negotiated between the University of Florida and the National Institute of Immunology (NII) through the Department of Biotechnology, with the involvement of the National Dairy Development Board especially in commercialization aspects of the program. The other Indian institutions currently involved in the Project (especially HAU, PAU and IVRI) should become collaborators through direct negotiations between ICAR and NII.

CONCLUSIONS

The consultant suggests that his two recommendations be implemented as follows. **Recommendation no. 1** should be implemented by direct negotiations between the consultant himself (representing the University of Florida as the principal investigator on the USAID cooperative agreement in question) and the USAID Mission in New Delhi. **Recommendation no. 2** should be implemented by submission from the University of Florida of a conceptual preliminary proposal to Dr. S. Ramachandran, Secretary of the Department of Biotechnology, outlining a collaborative program between the University of Florida and the National Institute of Immunology with involvement of the National Dairy Development Board. Dr. Ramachandran would then negotiate funding support for the program from the USAID Mission in New Delhi. It is envisioned that the final development of products for commercialization will be conducted between "EcoTech International" (a business being established by investigators at the University of Florida) and an Indian company such as Indian

Immunologicals (the commercial arm of the National Dairy Development Board) through assistance from the Program for the Advancement of Commercial Technology (PACT), an Indo-US R&D joint venture administered by the Industrial Credit and Investment Corporation of India Limited.

APPENDIX

Terms of Reference

The following terms of reference were provided to me by Dr. Maharaj Singh of Winrock International upon my arrival in New Delhi:

"It is proposed to initiate research programme towards development of genetically engineered vaccines against babesiosis and anaplasmosis and to improve serodiagnostic and epidemiological tools to target vaccine implementation and to monitor the effects of vaccination. The proposed consultancy assignment of Dr. Burrige will include:

1. Guidance and direction in organising facilities, equipment and consumables
2. Identify a step-wise progression of research towards clearly defined final objectives
3. Introduction of new techniques and identify the training requirements to ensure that these techniques can be undertaken by Indian scientists
4. To prepare a report for discussion with ICAR, USAID and Winrock."

These terms of reference were prepared by Dr. M.N. Malhotra of the Indian Council of Agricultural Research.

However, at my 25 October 1991 meeting with Dr. Surjan Singh of USAID/India, Dr. Singh indicated that USAID wished my consultancy report to focus on University of Florida/India collaboration through a buy-in to the on-going USAID/ST cooperative agreement no. DAN-4178-A-00-7056-00 utilizing some of the residual funds left in the USAID/India Agricultural Research Program. Furthermore, Dr. Singh wished me to present a proposal for a new project on the control of tickborne diseases of livestock in India through biotechnology.

Based on my role as a consultant to USAID and on discussions with Winrock International, I have based my report on the guidelines provided by Dr. Singh of USAID/India.

Itinerary and Persons Visited**15 October 1991**

Left Gainesville, Florida, by air for Frankfurt, Germany, via Atlanta.

16 October 1991

Arrived Frankfurt in morning and transferred to flight to New Delhi, arriving late that night.

17 October 1991

In the morning, met with Dr. Maharaj Singh (Senior Agricultural Scientist, Winrock International) and Mr. P.S. Srinivasan (Administration Specialist, Winrock International) in New Delhi to discuss arrangements for consultancy. Later that morning, met with Dr. R. Nagarcenkar (Deputy Director-General for Animal Sciences, Indian Council of Agricultural Research) in New Delhi to discuss ICAR's desires for the consultancy. In the afternoon, met with Dr. S. Chandrasekhar (Managing Director, Biotech Consortium India Ltd) in New Delhi to discuss the potential role of his new Consortium in the All India Coordinated Research Project on Intracellular Blood Protista (the Project).

18 October 1991

Travelled by car from New Delhi to Ludhiana with Dr. Y. Bhattacharyulu (ICAR Project Coordinator) to visit Punjab Agricultural University.

19 October 1991

In the morning, discussed the purpose of my visit to the Punjab Agricultural University with Dr. Khem Singh Gill (the Vice-Chancellor) and with Dr. R.D. Sharma (Additional Director of Research for Veterinary & Animal Sciences). Later that morning, was introduced to other administrators and scientists at the Punjab Agricultural University. In the afternoon, received a detailed tour through the facilities of the Tickborne Diseases Research Centre at the College of Veterinary Medicine from its director, Dr. A.S. Grewal. In the evening, had dinner with Dr. Grewal, Dr. Bhattacharyulu, and two of Dr. Grewal's colleagues (Dr. Avtar Singh and Dr. A.P.S. Mangat).

20 October 1991

Had lunch at Dr. Mangat's house with Dr. Grewal and Dr. Bhattacharyulu. Attended a dinner at Sutton House, Punjab Agricultural University, hosted in my honor by the Vice-Chancellor.

21 October 1991

In the morning, toured the facilities of the College of Veterinary Medicine with the Dean, Dr. Balwant Singh. Later that morning presented a seminar at Punjab Agricultural University on "New Technologies for the Control of Ticks and Tickborne Diseases of Cattle and Buffaloes". In the afternoon, had in-depth discussions with Dr. Grewal and his staff concerning their past, present and future role in the Project.

22 October 1991

Travelled by car from Ludhiana to Hisar with Dr. Bhattacharyulu to visit Haryana Agricultural University.

23 October 1991

In the morning, visited the Equine Breeding Stud of the Indian Army Veterinary Corps with Dr. Ramesh D. Sharma (Department of Veterinary Medicine, Haryana Agricultural University) to observe the cattle on a theileriosis vaccination trial. Toured the Stud with Brig. J.M. Rai (the Commandant). Later that morning, visited the ICAR Central Laboratory and Coordinating Unit on the campus of Haryana Agricultural University and listened to presentations of its research on theileriosis and equine babesiosis from Dr. S. Dhar and Dr. D.V. Malhotra, respectively. In the afternoon, initiated writing of a draft report of my consultancy. In the evening, had dinner with Dr. Dhar, Dr. Malhotra, and Dr. Bhattacharyulu.

24 October 1991

Had breakfast with Dr. Ramesh Sharma at his house. After breakfast, discussed the purpose of my visit to Haryana Agricultural University with Dr. B.D. Garg (Additional Director of Research) and Dr. S.S. Khirwar (Joint Director of Research for Veterinary & Animal Science). Then paid a courtesy call on Dr. R.C. Gupta (Dean of the College of Veterinary Sciences). Later in the morning, met with Dr. Ramesh Sharma and his colleagues (Dr. S. Sarup, Dr. A.K. Nichani, Dr. A. Kumar, and Dr. C. Bhushan) to discuss their research on theileriosis, babesiosis, and anaplasmosis. Attended a lunch at the Faculty Club, Haryana Agricultural University, hosted in my honor by Dr. U.P.S. Karwasra (Director of Research). After lunch, travelled by car from Hisar to New Delhi with Dr. Bhattacharyulu.

25 October 1991

In the morning, visited the USAID Mission in New Delhi with Mr. Srinivasan. Discussed my observations from Punjab Agricultural University and Haryana Agricultural University with Dr. Surjan Singh (Program Specialist, Agricultural Research and Education, USAID) and received directions from Dr. Singh concerning the type of report desired by USAID. Later in the morning, visited the UNIDO International Centre for Genetic Engineering and Biotechnology to discuss with some of its scientists (Dr. Fred A.S. Kironde, Dr. Amiya R. Nayak, and Dr. Kanury V.S. Rao) possibilities for collaboration with the Project. After lunch with Dr. Kironde and Dr. Nayak, spent the afternoon at the Winrock International office in New Delhi.

26 October 1991

Spent the day relaxing in New Delhi.

27 October 1991

Travelled by car from New Delhi to Izatnagar with Dr. Bhattacharyulu to visit the Indian Veterinary Research Institute.

28 October 1991

In the morning, met with **Dr. P.N. Bhat** (Director of the Indian Veterinary Research Institute) to discuss his views on the future role of the Institute in the Project, particularly with respect to biotechnology. Then met with **Dr. A.K. Srivastava** (Scientist-in-charge of the Director's Laboratory) to discuss the Laboratory's work on the genetic engineering of bacteria and hormones. Later that morning, met with **Dr. P.C. Harbola** (Scientist-in-charge of the National Biotechnology Centre) to discuss the programs of the Centre. After lunch, met with scientists in the Division of Parasitology (**Mr. S.C. Srivastava, Dr. R.V.N. Srivastava, Mr. M.H. Khan, Dr. A.K. Mishra, and Dr. J.R. Rao**) to discuss their current and future roles in the Project. That evening, attended a dinner at the International Guest House, Indian Veterinary Research Institute, hosted in my honor by **Mr. S.C. Srivastava**.

29 October 1991

Travelled by car from Izatnagar to New Delhi with **Dr. Bhattacharyulu**.

30 October 1991

In the morning, met with **Dr. S. Ramachandran** (Secretary, Department of Biotechnology, Ministry of Science & Technology) to discuss the possible role of the Department in continuation of the Project. At **Dr. Ramachandran's** suggestion, then visited the National Institute of Immunology to discuss possibilities for collaborative research. At the Institute, met with scientists in the Gene Expression Laboratory (**Dr. Pramod Khandekar**), the Embryo Biotechnology Laboratory (**Dr. Maneesh Taneja**), the Hybridoma Laboratory (**Dr. Souravi Ghosh and Dr. Manoj Sharma**) and the Product Development Cell of the Bioprocessing Engineering Laboratory (**Dr. Asak Mukhopadhyay**). After lunch, prepared draft report for presentation to USAID, ICAR and Winrock International the next day.

31 October 1991

In the morning, met with **Dr. R. Nagarcenkar, Dr. P.S.R.C. Murti** (Principal Scientist) and **Dr. Y. Bhattacharyulu** of ICAR, **Dr. Surjan Singh** of USAID, and **Mr. P.S. Srinivasan** of Winrock International to present my draft report. Later in the morning, met with **Dr. B.P. Srivastava** and **Mr. Ram K. Berry** (Program Specialists in the Office of Technology Development & Enterprise, USAID/India) and **Dr. Surjan Singh** at the USAID Mission to discuss the possibilities for USAID funding for future collaboration between the University of Florida and Indian institutions in the application of biotechnology to the control of tickborne diseases in India. After lunch at the USAID Mission with **Dr. B.P. Srivastava**, returned to the Winrock International office for debriefing by **Dr. Maharaj Singh** and **Mr. P.S. Srinivasan**.

1 November 1991

Left New Delhi in the early morning by air for Gainesville, Florida, via Frankfurt and Atlanta, arriving home late that evening.