EVALUATION OF THE SAREC/NARESA

WATER BUFFALO RESEARCH PROGRAM IN SRI LANKA

1983 - 1988

by

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PREFACE

Since ancient times, the buffalo has played a unique role in Sri Lanka's agriculture particularly as a draught animal in the rice fields. Despite the ability to survive in the harsh tropical environments, the Lanka buffalo has received very little scientific attention to improve its productive efficiency and draught capabilities.

This report presents an evaluation at the request of the Swedish Agency for Research Cooperation with Developing Countries (SAREC) on the SAREC/NARESA Water Buffalo Research Program which has been in progress since 1982. To conform to modern usage and to dispel the notion, that the buffalo (Bubalus bubalis) is a semiaquatic species, the term "buffalo" is used throughout this document.

The evaluation is based upon documents received from SAREC and an evaluation mission to Sri Lanka in November/ December 1987. The report briefly reviews the livestock industry in Sri Lanka, then evaluates individual research projects within the program and finally draws conclusions and makes recommendations for future research on the buffalo in Sri Lanka.

I am greatly indebted to SAREC for permission to advance my mission to Sri Lanka from February 1988 to November 1987. The task of writing this report has been greatly facilitated by the enthusiastic support of Mr. Carl-Gustaf Thornstrom, SAREC Research Officer who made it certain that I had all the project documents prior to the evaluation mission. I wish to extend my sincere gratitude to Professor B.M.A.O. Perera, coordinator of the program, for the excellent arrangements made for the mission, Dr. M.C.L. de Alwis, Director of the Veterinary Research Institute for transport facilities, all Grantees for their cooperation and participation in a special seminar and Mr. M.A.T. de Silva, Deputy Director General of Naresa for his keen interest and support of the program.

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1. TERMS OF REFERENCE

The Terms of Reference quoted below are from a letter sent to the consultant by Mr.G.C Thornstrom acting on behalf of the Swedish Agency for Research Cooperation with Developing Countries (SAREC)[1].

"Since 1982 SAREC has sponsored NARESA (Natural Resources, Energy and Science Authority) for the implementation of a national research program on the indigenous water buffalo in Sri Lanka. During the period 1982-1987 SAREC has provided this research program with a total grant of SEK 2,515.000 approx USD 400.000. SAREC's overall objective is to assist developing countries in their endeavours to strengthen their national research capacity. The water buffalo research program was given priority to by NARESA for foreign funding during 1982.

On the basis of this general background information the Consultant will evaluate or, where appropriate, comment upon:

1. The general outline of the initially proposed research program including weight given to management, health, nutrition and reproduction respectively.

2. The quality of the research reports and dissertations with special emphasis on new and original contributions to the existing body of theory.

3. The adequacy of the methods and the contribution to the development of general research methodology.

4. The procedures for the selection of research topics both in the context of an overall research program with integrated subprojects and in the context of national needs in Sri Lanka.

5. The research infrastructure (laboratories,library service international contacts) including research farms at Mawela and Narangalla in terms of adequacy and level of operation.

6. The follow-up of the research work in form of seminars, workshops and conferences; their character, scope and periodicity.

7. The appropriateness of the publications and dissemination of the research results in relation to the target groups, especially NLDB (National Livestock Development Board) and the draught animal and dairy development program of the Mahaweli Authority.

8. The practical applicability and the possible impact of the research findings to building up research capacity in Sri Lanka.

9. Time perspective of the research program in order to reach practically useful results including role of SAREC in a five years perspective.

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[1] see Letter ref 9.49/SAREC 1.SRI.01 dated 1987 06 29

The consultant will visit Sri Lanka during November/December 1987 for discussions with scientists of the program and officials at NARESA, NLDB and Mahaweli Authority. The evaluation will be completed with a regional seminar in Peradeniya in November 1988. The Consultant will present a single written report in English to SAREC preferably not exceeding 75 pages not later than May 31, 1988."

2. SCIENTIFIC BACKGROUND OF PROGRAM

2.1 Sri Lanka

Sri Lanka, located 8 degrees north of the equator at the southern tip of the Indian continent is an island of 66,000 square kilometers and a human population of about 16 million. Sri Lanka's climate is tropical and is characterised by little variation in daylength and the weather is warm to hot with high humidity; environmental temperatures fluctuate between 20 to 32 C. The island comes under the influence of two monsoons annually, that from the southwest between May and August brings rain to the southwest coast and that from the northeast brings rain to the east coast from November to February. On the annual rainfall pattern, Sri Lanka can be divided into Wet, Intermediate and Dry zones. Most of the country is within the dry zone, while the centrally-located upcountry is in the intermediate zone and the south-west part in the wet zone. The annual rainfall may be over 600 cm in the wet zone through 100-150 cm in the intermediate zone to less than 75 cm in the dry zone.

2.2 The Livestock Industry in Sri Lanka[2]

Historically, Sri Lanka has been an agricultural country, with agriculture including livestock contributing to about 25 % of the Gross Domestic Product. Livestock products - meat, milk, eggs and hides account to only about 3.5% of the output of the agriculture sector.

Sri Lanka's livestock population in 1983 was estimated at about 6.4 million poultry, 1.7 million cattle, 0.6 million buffalo, 0.5 million goats, 77,000 pigs and 27,000 sheep. Whereas poultry farming is a highly commercialized enterprise, other livestock species are mostly in the hands of smallholder farmers who own very limited land. In Sri Lanka, the annual per capita consumption of meat and milk was 1.19 kg and 18 kg respectively. The price payable by the National Milk Board in 1984, for a litre of buffalo milk with an average butter fat of 7.5% was Rs 6.75 and for cow milk with an average butter fat of 3.5% was Rs 3.95. Almost all of the buffalo milk produced in the country is sold as curd whereas cow milk is processed for liquid consumption.

2.2.1 Ministries and Agencies in the Livestock Sector

Two Ministries are responsible for the development and promotion of the livestock sector in Sri Lanka. They are the Ministry of Rural Industrial Development and the Ministry of Mahaweli Development.

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[2] Extracted from "Sri Lanka Livestock Statistics 1984/85, Ministry of Rural Industrial Development in collaboration with the German Agency for Technical Cooperation (GTZ), December 1985.

2.2.1.1 Ministry of Rural Development

The primary role of the Ministry of Rural and Industrial Development is to develop the livestock industry in Sri Lanka through the Department of Animal Production and Health, National Milk Board, Ceylon Oils and Fats Corporation and the National Livestock Board.

Department of Animal Production and Health: This department, the statutory arm of the Ministry of Rural Industrial Development, is the implementing agency for the Animals Act No. 29 of 1958, Contagious Disease (Animals) Ordinance of 1956 and the Pasture (Land Reservation) Act No. 4 of 1983. In addition, it promotes livestock farming for economic production of milk, meat and draught power. Both the public and private sectors receive a free veterinary and artificial insemination service through veterinary centres established throughout the country. The manpower training for the livestock industry and promotion of research in animal production and health are other activities of the department.

National Milk Board: This Board promotes the dairy industry in Sri Lanka. The Board collects milk from farmers through a network of Milk Collecting Centres distributed throughout the country at a guaranteed price and after processing the milk, markets the product through an islandwide network of outlets and distributors. The Board also trains personnel of Cooperative Societies and Dairy Producers' Association on quality control of milk, conducts studies and surveys on economic dairy production and technology.

Ceylon Oils & Fats Corporation: The Corporation manufactures quality animal feed from the byproducts of the oil extraction process particularly from the coconut industry and sells compounded livestock feed through marketing outlets and agents. The Corporation provides a technical advisory service to encourage production of local raw materials for the livestock industry and conduct research and development on non-conventional feed resources.

National Livestock Board: The Board maintains several large livestock farms throughout the country for crossbreeding and upgrading of livestock to meet the milk, meat and draught power needs of the country. The Board organizes dairy farmers into Dairy Producers' Associations to facilitate the delivery of a curative and preventive veterinary care service, supply of feed, distribution of improved crossbred animals and suitable varieties of pasture, marketing of livestock products and training of dairy farmers.

2.2.1.2 Ministry of Mahaweli Development

The Mahaweli Authority of Sri Lanka, one of the agencies in the Ministry of Mahaweli Development, promotes livestock farming in the Mahaweli Project Area, mostly in the dry zone which has the largest concentration of cattle and buffaloes in Sri Lanka. Major livestock activities are to rescue the potential draught cattle and buffaloes in project areas with dwindling grazing reserves and to develop suitable dual purpose (milk and draught) animals through an upgrading program to fulfil the draught power needs of the rural farmer and also to raise the family income through sale of milk.

2.3 Role of the water buffalo in the agriculture sector

2.3.1 Population, types and distribution

The buffalo population of Sri Lanka in 1982 was estimated at about 576,000 [3]. Of two types of buffaloes - swamp and river, the indigenous buffalo or the "Lanka buffalo" is classified on physical characteristics as the swamp type, despite possessing a diploid chromosome number (2n=50) identical to that of the river type. There are over 400,000 head of Lanka buffaloes owned mostly by smallholders for draught purposes in the rice growing areas of the country. A small population of imported river buffaloes of the Murrah, Surti and Nili-Ravi breeds are maintained for milk production in Government farms.

The district of Kurunegala, located within the wet zone, has the highest buffalo population, estimated at about 176,000. The remainder of the population is mainly concentrated in the dry zone with the districts of Anuradhapura, Polonnaruwa, Trincomalee, Batticaloa and Hambantota having over 50,000 buffaloes.

2.3.2 Management and uses

Most buffaloes in Sri Lanka are managed with minimal inputs. In the wet and intermediate zones, animals are confined and stall-fed, while in the dry zone free grazing is practised in the paddy fields after the rice harvest and in the vicinity of the jungles. Matings occur mostly in the communal grazing grounds. Apparently, no effort has been made to improve the genetic potential of the Lanka buffalo until quite recently. The calving season is between November and February. Calves are allowed to suckle their dams but in some villages calves are tethered during the night. Weaning is not practised and calves remain with their dams until lactation ceases. There is a high incidence of mortality in calves due to parasitism and in adults due to haemorrhagic septicaemia.

Traditionally, the indigenous buffalo has been used primarily for draught power in the rice growing areas of Sri Lanka. They provide the animal power for tilling of paddy land and to a minor extent in threshing of paddy after the harvest. Although their milk yields are low, the indigenous buffalo is milked mostly for curd production. The river breeds are mainly kept for milk production and for crossbreeding with the Lanka buffalo. The crossbreds are dual purpose animals used for both milk and draught. Slaughter of buffaloes of breeding age is prohibited by law in Sri Lanka.

2.4 Buffalo research in Sri Lanka

2.4.1 Historical background

The importance of the buffalo for draught has long been recognized, but it is only during the past decade that serious attention has been given by international agencies to promote research in this neglected species. In 1978, the International Atomic Energy Agency (IAEA) established a Co-

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[3] Source: Department of Census and statistics

ordinated Research Program "On the Use of Nuclear Techniques to Improve Buffalo Production in Asia". Sri Lanka was one of the participating countries in a 5-year program [4]. During this program, laboratory facilities and nuclear techniques were developed for Sri Lankan scientists to undertake in-depth studies relating to reproduction, nutrition, parasi-tology and environmental physiology of the buffalo.

While the IAEA program was in progress, SAREC selected Sri Lanka to support a buffalo research program. Following a national workshop on Water Buffalo research in Sri Lanka in 1980 [5], the Government of Sri Lanka submitted a research proposal to SAREC for funding. The project commenced in 1983. Later, the Overseas Development Administration (ODA) of the United Kingdom and the Australian Council for International Research (ACIAR) have been supporting buffalo research through training programs and funding research projects which complement the work being conducted under IAEA and SAREC.

2.4.2 Workshop on water buffalo research

Buffalo research received a major boost in 1980 with the hosting of the first workshop on buffalo research in Sri Lanka under the sponsorship of SAREC. This workshop provided a forum for Sri Lankan scientists engaged in buffalo research to present the state of knowledge on the indigenous Lanka buffalo, to identify problem areas which needed research and to develop an integrated program of multidisciplinary research for increasing the productivity of the buffalo in Sri Lanka [6].

2.4.3 SAREC/NARESA water buffalo research program

The research priorities identified by the workshop mentioned above formed the basis of an application submitted by the Sri Lanka Government to SAREC for promotion of buffalo research in Sri Lanka [7]. The first phase of the buffalo program, spanning over 3 years (1983-1986), supported 10 research projects and the establishment of two buffalo farms for teaching and research. Under the second phase (1987-1988), most studies are being continued with five additional studies.

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[4] "The Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia". Proceedings of the Final Research Coordination Meeting Held in Manila, 1984, IAEA, Vienna

[5] SAREC REPORT R3: 1982

[6] SAREC REPORT R3: 1982 p 6

[7] Refer Appendix 1

3. EVALUATION OF PROJECTS WITHIN THE SAREC/NARESA WATER BUFFALO RESEARCH PROGRAM

3.1 Introduction

The water buffalo program and the individual projects within the program were evaluated on the following basis:

- The overall objectives of the program.
- The original application for funding, progress reports submitted at Interim Review Seminars, the Project Seminar, published papers, and post graduate thesis.
- The Consultant's interviews with Grantees, visits to laboratories, farms and study areas[8].
- A special seminar held on December 1987 to enable every SAREC grantee to summarise the research accomplished since the last progress report.

3.2 Research Projects

3.2.1 Management, utilization and socioeconomic patterns

The management, utilization and socioeconomic factors associated with the use of draught buffaloes in village farming systems is being examined under four separate projects, each project emphasising areas where individual scientists had the necessary expertise.

3.2.1.1 Project SAREC/9/BF/16: Growth, reproduction and overall economics of Lanka buffalo in relation to management and feeding systems (S. Tilakaratne/ E.F.A. Jalatge)

Objective

To monitor the growth and development of the indigenous Lanka buffalo in the four agro-ecological zones in Sri Lanka.

Major thrusts

Buffalo herds were visited at 3-month intervals to measure weight, chest girth and height and collect information on feeding, management, productivity, and patterns of disease and reproductive performane of about 700 buffaloes in 59 herds in Dambulla (Dry Zone), Melsiripura (Intermediate Zone), Dompe (Wet Zone) and Galagedara (Mid Country).

Research progress

With the resignation of Dr. Tilakaratne (Grantee) at the end of 1984, the project was transferred to Dr. E.F.A. Jalatge of the VRI. Apparently, the data collected by Dr. Tilakaratne is not available

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[8] Refer Appendix 3

except for one report[9]. The mean birth weights of Lanka buffalo calves estimated by regressing weights on age upto 6 months were 10-24 kg for males and 10-21 for females. The mature weights were 270-321 kg for males and 236-291 for females. The average buffalo has a chest girth of 161.5 cm and 111.5 cm at the withers. Chest girth and body weight were highly correlated.

The data collected by Dr. Jalatge since April 1985 have yet to be analysed.

Research highlights

- In all agro-ecological zones, buffaloes are mainly used in the rice fields for ploughing, puddling and threshing. Milking is confined only to herds in the Melsiripura region.

- Animals grazed on low quality grasses with no supplementary feeding.

- Adult body weight fluctuated throughout the year depending upon the availability of forage.

- Calvings were seasonal and occurred mostly during the months of October to December.

- Calf mortality was high (30-40%) due to unthriftiness resulting from a combination of several factors including parasitism and poor mothering ability of the dams. Adult mortality was higher in the dry (20%) than wet zone (12%).

Evaluation

The difficulty of identifying animals appears to be one of the major constraint in developing a longitudinal study. A permanent animal identification system should be developed as ear tags alone are not satisfactory. Since restraint facilities and transportation of weighing scales pose problems, a body scoring system should be adopted to monitor body condition of animals at various times of the year in the future. Although a correlation exists between heart girth and body weight, it has little field application compared with a system of body scoring. The latter method could be more effective in drawing the attention of the farmer regarding the nutritional status of his adult animals prior to the breeding season or work in the rice fields.

Due to a lack of published data in journals or proceedings of Interim Review Seminars and since Dr. Jalatge has not analysed his data, it is difficult to comment on the achievements of this project. Information is needed on the herd composition and annual calf crops to estimate if differences in herd fertility exist within and among agro-ecological zones. It is also doubtful if this study could provide data on the

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[9] "Growth Performance of Lanka Buffalo in Different Agro-ecological Zones at the Interim Review Seminar (NARESA-SAREC) held on 29 October, 1984.

overall economics of Lanka buffalo in relation to the management and feeding systems,which was the major objective of the study.

Benefits

The potential benefit from this study is the knowledge that calf mortality is a serious problem in buffalo herds in all agro-ecological zones.

3.2.1.2 Project SAREC/9/BF/17: Measurement of draught capabilities of buffaloes (S.G. Ilangantileke / S.K. Seneviratne)

Objective

To evaluate the draught capabilities of buffalo breeds (Murrah, Surti and Lanka) as influenced by feeding levels, sex, weight of animal and soil type.

Main thrusts

During Phase I, a drum-type dynamometer to measure draught power of buffaloes under various field conditions was developed by Dr. S.G. Ilangantileke[10] who has since resigned from his post in the University. During Phase II, Dr. S.K. Seneviratne of the Department of Mechanical Engineering, University of Peradeniya preferred the use of strain gauges[11] and is also monitoring the physiological responses of the animal at work.

Research progress

A 'merry-go-round' device, installed at the Mawela farm to measure 'capability or strength' of a buffalo under controlled conditions, was demonstrated on November 18, 1987. The draught power (load applied), speed of work (duration and number of revolutions), physiological responses (respiration, sweating and pulse rates and rectal and surface temperature), relative humidity and ambient temperature were being recorded on a 3-year old male buffalo subjected to a load of 12 kg over a 3-hour period. The draught power required for ploughing is about 20-25 kg. On completion of the above trials, the draught power and physiological responses of buffaloes working in a paddy field would be measured.

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10 "Utilization of Drum-type Loading Device to Evaluate Draught Capabilities of Buffaloes" at the Interim Review Seminar (NARESA/SAREC) held on 29 October, 1984.

11 "Measurement of Draught Capabilities of Buffaloes" at the Interim Review Seminar (SAREC/NARESA) held on 26 March, 1987.

Research highlights

- A simple, cheap, portable and readily installed device capable of measuring draught power has been developed. The only permanent structure needed is a base plate of concrete at the site. The load can be controlled and the static as well as the dynamic forces can be measured.

- Measurement of physiological responses of the buffalo at work.

Evaluation

The original plan to measure draught power of different breeds of buffaloes on various diets was changed. Instead the draught power and physiological responses of buffaloes working in different soil types are under investigation. The measuring device is most impressive, considering that the draught power measuring devices in many laboratories in the world are bulky, not portable and expensive. There are plans to install a similar device in the research farm at Narangalla farm. The major drawback of the measuring device is that the loading bar is horizontal rather than inclined and therefore, may not simulate the traditional plough used in the paddy fields.

Telemetry should be considered for measuring physiological responses without interrupting the animal's work. In the future, draught capabilities of buffalo and cattle should be compared under different soil types. Dr. Seneviratne should visit the Institute of Technology in South India to make an in-depth study of the harness used for draught animals. This project should be given high priority in any future SAREC support.

Benefits

With the development of a simple device to measure draught power and physiological responses, it will now be possible to determine the efficiency of buffaloes and cattle in the different activities associated with paddy cultivation.

3.2.1.3 Project SAREC/9/BF/26: Microeconomics of rural cattle and buffalo production: A comparative study in the Kurunegala district of Sri Lanka (C.P. Bogahawatte)

Objectives

To establish the comparative economics of cattle and buffalo production under rural farming systems.

Major thrust

This study commenced during phase II of the program and was based on interviews using a structured questionnaire of 210 randomly selected cattle and/or buffalo farmers to ascertain management practices, analyse herd profitability, establish multiple regression equations for milk production, and determine the demand for animal feed and animal power.

Research progress

Owing to the political unrest in the study area, the 6-month field survey planned originally for the dry zone had to shifted to the Kurunegala district, which has all three climatic zones and the highest buffalo population in the country. The survey has been completed.

Research highlights

- The average herd size in the study areas was higher for buffalo (16.7) than cattle (9.3).
- Both cattle and buffaloes were used for draught for only about two months of the year. Milk yields (1-2 litres/animal/day) and draught capabilities were similar for both species.
- About 70% of farmers interviewed preferred buffalo for draught and cattle for milk production despite the higher fat content and the higher farm gate price for buffalo than cow milk.
- Since it was more profitable to rear the dual or milk breeds of buffalo than cattle, there is a diseconomy in rearing cattle for milk in this district.

Evaluation

During the span of about six months, the project has highlighted important features of buffalo rearing for draught and milk. Without data on reproduction, health and mortality rates for both species it would be unwise to conclude that there is diseconomy in rearing cattle for milk in the study area.

Benefits

The results suggest that higher milk production could be achieved in both species by feeding concentrates and providing better animal facilities. In the selection of mechanical or animal power for draught power in rice farming, consideration should be given to the shorter daily working hours of the animal, the cost difference between tractor and animal power and type of soil.

For the cattle and buffalo subsectors to contribute to the agricultural economy of Sri Lanka, the rural farmer needs to change his attitude. The most important contribution must come from expanding the traditional role of the buffalo from a draught animal to that of a dual purpose animal, capable of providing the farmer the draught power needed and a regular cash income. To achieve this objective, the farmer needs the assistance of government and other related organisations to provide him suitable genotypes, quality feed, an efficient herd health and reproductive programs, marketing facilities and most important an attractive price for milk.

The project forms part of a thesis to be submitted Mr. D.P. Athuladmudali for the award of a Master of Philosophy degree, University of Sri Lanka.

3.2.1.4 Project SAREC/9/BF27: A socioeconomic study of the utilzation of buffaloes in peasant society (W.T.Siriweera)

Objectives

To understand the problems involved in the utilization of buffaloes in the Mahaweli system C and to suggest how draught power could be used more effectively as well as economically.

Major thrust

The research program attempts to identify the problems associated with the utilization of buffaloes in Mahaweli system C settlements of Hebarawa, Galporuyaya and Viranagama. For comparison, a traditional village with extensive buffalo utilization (Udattawa in the Minipe district) within the same ecological zone but outside the Mahaweli area was selected.

Research progress

Three questionnaires covering field preparation process, socio-economic census and harvesting process were used. In data collection, the participant observation method was adopted with research assistants residing in the study areas. The survey is completed and the raw data are being analysed.

Research highlights

Following discussions with Dr. Siriweera, his coworkers and interviewing three settlers in the study area, the consultant is of the view that there are major constraints for greater utilization of buffalo for draught.

- Dearth of grazing land.
- Preference for tractors for ploughing.
- Difficulty of managing buffaloes compared with cattle in a semi-confined system.
- More uses for cattle than buffalo during the offseason particularly to haul farm produce to the market.

Evaluation

Since the information gathered during the survey has not been analysed, it is difficult to evaluate the project. Dr. Siriweera will only submit a report to NARESA by the end of April and not in January 1988, as previously agreed. Serious attention should be given to findings in this study. Dr. Siriweera's collaborators, Drs. Y.R. Amerasinghe and P.V.J. Jayasekara of the Department of Economics, University of Peradeniya should be funded for in-depth studies on the economics of buffalo farming in the Mahaweli system C.

There is an alarming trend towards replacement of the draught buffalo by mechanization or cattle. This trend could be averted if buffaloes are reared for both draught and milk. The newly established Milk Collection Centre at Girandurukotte and the higher price for buffalo milk would be a major incentive to motivate the settlers to rear buffaloes. However, in the Mahaweli Development Authority's Draught Animal Program at Girandurukotte the major emphasis is to develop suitable crossbred cattle rather than buffalo for both milk and draught.

Benefits

Establishing demonstration farms to train farmers on managing buffaloes in close confinement utilizing agrobased byproducts such as rice straw treated with urea should be the future strategy for the Mahaweli System C area. If the government policy is to improve the lot of the farmer and make him self reliant, dependence upon mechanization, should be reduced thereby preventing surplus extraction of farmers' money out of the village and savings on foreign exchange. SAREC's input in such a strategy should be to support projects which attempt to transfer the available research findings in genetics, management, nutrition, reproduction and disease control to field situations.

3.2.2 Nutrition

Two projects are included under this heading. The first project examines the mineral status of buffaloes while the second initiated during phase II studies the mineral composition of buffalo milk.

3.2.2.1 Project SAREC/9/BF/06: Studies on mineral nutrition of Lanka Buffaloes (S.S.E. Ranawana)

Objectives

To survey the mineral status of indigenous buffaloes

Major thrusts

That livestock in the tropics suffer from mineral deficiencies which adversely affect productivity is well-recognized. Indigenous buffaloes in Sri Lanka are managed on a free grazing system on unimproved fodder without any mineral supplementation. The major thrusts in this study are to establish mineral levels in forages and blood of buffaloes and to determine if a relationship exists between seasonal fluctuations in forage quality and the mineral status of the buffalo. Potential mineral sources for correcting mineral deficiencies in livestock were also investigated.

Research progress

The survey on minerals will be completed after samples have been collected from the wet zone. Except for cobalt, the macro and microminerals have been analysed in both plant and animal tissues. A mineral block has been developed which would be tested under village conditions.

Research highlights

- Native grasses depending upon season, were often deficient in Na, P, Cu and Zn; tree leaves and shrubs were also low in Na, Cu and Zn but were rich in calcium.

- Serum levels in buffaloes were below normal for several minerals particularly phosphorus, copper, zinc, selenium and probably cobalt.

- Crystalline limestone was slow to release Ca and Mg which could result in poor bioavailability of these minerals.

- Burnt limestone was used to formulate a cement based mineral block (15% cement and 9% P).

- Low blood levels of phosphorus during lactation might be due to the higher drain of phosphorus into buffalo milk than cow milk.

Evaluation

This project has made considerable progress and advanced our understanding of buffalo nutrition in Sri Lanka. The survey has demonstrated the existence of mineral deficiencies in the buffalo. Phosphorus deficiency in the lactating buffalo is significant because of the relationship between this mineral and ovarian function in ruminants.

A simple delivery system for minerals has been developed. Field trials should conducted to test the efficacy of these mineral blocks for the buffalo. Studies on postpartum ovarian function should examine the benefits of phosphorus supplementation (10% P in mineral blocks) in reducing the long calving intervals of the indigenous buffalo.

Benefits

Since indigenous buffaloes are grazed on natural pastures deficient in minerals, mineral supplements could improve the productivity of the buffalo under range conditions. For example, a phosphorus deficiency in lactating buffaloes might delay the resumption of the oestrous cycle after calving and lead to long calving intervals. Therefore it would useful to provide buffaloes mineral blocks containing 10% phosphorus during certain seasons. The advantages claimed for this block are that the composition of the block could be adjusted to suit the needs of the animal during various seasons and that it could be made by the farmer himself.

3.2.2.2 Project SAREC/9/BF/23: Composition of indigenous buffalo milk and changes due to various factors (C.P. Kodikara)

Objectives

Th determine the composition of buffalo milk and factors causing variation.

Major thrusts

As published information was not available and in order to establish standards for buffalo milk and milk products, the major emphasis in this study was to determine the physical characteristics and composition of buffalo milk.

Research progress

Results obtained from over 250 milk samples from 27 Lankan buffaloes in two farms in the Puttalam district revealed that the composition was within the range for the Indian buffalo. In the Mawela farm, the effect of age and stage of lactation on the composition of buffalo milk is being studied.

Research highlights

- Establishment of the normal composition of milk of the indigenous buffalo.
- Quantitative estimation of magnesium, zinc and iron levels in buffalo milk.
- Separation and fractionation of casein.

Evaluation

The physical and chemical composition of buffalo milk has been established but the effects of season, nutritional status and stage of lactation on milk composition should have been given greater attention. The cellular content of milk merits attention in view of the occurrence of mastitis (see Project SAREC/9/BF/14).

Apparently, the project is directed more towards processing buffalo milk for milk products instead of relating the composition to stage of lactation, feed quality or management practices. The investigators could obtain valuable information on these aspects from Milk Collecting Centres processing buffalo milk. For example, the centre at Girandurukotte collects and processes buffalo milk and maintains excellent records on the composition of buffalo milk supplied by farmers. The investigators should communicate with this centre.

SAREC should not expand the scope of the buffalo program to support a future project oriented towards processing buffalo milk to develop milk products. This is an area better left to the National Livestock Development Board, the National Milk Board and the commercial sector such as Nestles.

Benefits

This is one of the first studies on the chemical and physical composition of milk. The results are useful in establishing standards for buffalo milk and for the dairy development program in Sri Lanka.

For example these standards could be used to establish payment and quality control schemes for buffalo milk and milk products and overcome problems related to handling of milk, processing of milk for milk products.

A postgraduate student is attached to this project and is expected to submit a thesis for the Master of Philosophy degree, the University of Peradeniya.

3.2.3 Reproduction

Of five projects in the field of reproduction, three are in reproductive physiology, one in infectious infertility and the other on cytogenetics.

3.2.3.1 Project SAREC/9/BF/01: Reproductive physiology of river type buffaloes (R. Rajamahendran/ A.R. Mohamed)

Objectives

To study the reproductive physiology of Murrah buffaloes in Polonnaruwa Livestock Farm

Major thrusts

The project combines an analysis of breeding records and monitoring hormonal levels to assess ovarian activity. It attempts to identify the factors responsible for seasonality of reproduction in the Murrah (dairy type) buffalo in a large government farm in the dry zone of Sri Lanka and the ways to achieve year-round calving.

Research progress

The original project submitted to SAREC for funding was to improve the reproductive performance of indigenous buffaloes with artificial breeding techniques However, with the sudden resignation of Dr. Rajamahendran (Grantee) from the University in October 1984, the studies were abandoned and no data are available.

The revised project, conducted by Dr. A.R. Mohamed, Veterinary Research Officer (Reproduction) at the VRI, is designed to study the reproductive performance of Murrah buffaloes at the Polonnaruwa government farm and also to collect data on Lanka buffaloes in the same district.

The breeding records over a 12-year period have been analysed. Ovarian activity of buffaloes are being monitored by progesterone levels in milk and blood. To have a continuous supply of buffalo milk throughout the year, induction of ovarian activity during the 'offseason' was attempted by hormonal therapy and feed supplementation.

Research highlights

- Seasonal pattern in ovarian activity of Murrah buffaloes in the dry zone was related to rainfall and seasonal availability of forage.

- Fodder was abundant between October and February and again during May but little or no feed during other months of the year.

- Most buffaloes conceived between November and March, with peak conceptions between December and February. Between June to November, ambient temperatures were high and animals also lost weight.

- During the dry months of the year, clinical and hormonal studies have revealed that the failure to conceive was due to anoestrus (inactive ovaries).

- The peak calving season (Nov-December) coincided with the onset of the rains.

- Gonadotropic hormone failed to initiate ovarian activity. However supplementary feeding of concentrates from March to November resulted in a big improvement in the reproductive performance of indigenous buffaloes and a small improvement in the Murrah breed.

Evaluation

The objectives of the revised project are more relevant to the overall objectives of the water buffalo research program. Convincing evidence has been presented on regulation of the breeding cycle of the buffalo by an interaction of environmental factors particularly ambient temperature, seasonal fluctuations in feed availability and rainfall. However, if blood samples collected for hormone analyses are still available, mineral levels should be measured to establish the limiting macro and micronutrients in relation to postpartum ovarian activity. Future investigations should incorporate blood mineral analyses particularly in the anoestrous buffalo.

Any feed formulations for supplementary feeding during the dry season or to induce ovarian activity during the off-season should be done in collaboration with the nutritionist (Dr. S.S.E. Ranawana) at the VRI. Concentrate supplementation alone may be inadequate as minerals deficiencies do exist during the dry periods (see Project SAREC/9/BF/06). It is recommended that cement-based mineral block should be incorporated into any future study on the effects of feed supplements on reproduction.

Benefits

Having identified the main breeding season, advice should be given to farmers on the importance of getting their buffaloes pregnant during the breeding season because of the remarkable improvement in the reproductive performance of the Lanka buffalo. Since breeding females belonging to farmers are usually tethered and have little freedom for matings, attention should be given to increasing the bull: cow ratio and provide ample opportunities for matings.

3.2.3.2 Project SAREC/9/BF/02: Clinical and hormonal studies on reproductive functions of indigenous buffaloes (B.M.A.O. Perera)

Objective

To understand the normal reproductive physiology of the female Lanka buffalo and possibilities of improving reproductive efficiency.

Major thrusts

Since little was known about reproduction in the buffalo, the major focus was to understand the physiology of reproduction with special emphasis on ovarian function particularly during the postpartum period. Progesterone profiles of postpartum buffaloes were examined to determine if the long calving intervals were due to a failure of the cycle to be restored after calving (postpartum anoestrus).

Research progress

A field survey was conducted in a sample of 11,863 buffaloes in 528 holdings distributed in 16 of 24 districts of Sri Lanka. In addition, 1300 breedable females were rectally examined to determine their reproductive status. At Narangalla Buffalo Research Station, the effect of restricted suckling and supplementary feeding on postpartum ovarian activity is receiving attention

Research highlights

- Management, seasonal changes in feed availability, calf mortality, suckling regimes, adult mortality and limited opportunities for matings are major factors influencing fertility in female buffaloes.

- Interviews with buffalo owners revealed that age at first calving was about 3-4 years, the calving interval was 18 months and each female produced 6-9 calves during its lifetime which often extended to as much as 20 years.

- Buffaloes in some villages were more fertile than in others probably due to the restricted suckling management in the former.

- Postpartum ovarian activity occurred earlier in the restricted suckling group than in the ad lib suckled groups with or without supplementary feeding.

Evaluation

This project has contributed significantly to reproduction of the Lanka buffalo. The project was well-planned beginning with a survey, then identifying suckling as a major factor for extended calving intervals and finally demonstrating under controlled conditions that restricted suckling could reduce calving intervals in the Lanka buffalo. Under field conditions, calves would have to be tethered or housed separately from their dams to restrict suckling. It is suggested that calves older than two months be fitted with home-made antisucking devices and

allowed to graze along with their dams. It would be interesting to know whether growth rates of calves on a restricted suckling schedule are depressed.

There have been several publications in international journals which have been well-received by the scientific community.

Benefits

Several benefits have accrued from this study. Methods are now available for the clinical and hormonal diagnosis of ovarian function and pregnancy. Many aspects of female reproduction have been defined such as the oestrous cycle, gestation and the postpartum period.

Of particular interest for the farmer would be the demonstration that restricted suckling could improve fertility.

Within the project, one postgraduate student obtained his Master of Philosophy degree, University of Peradeniya while another is completing a PhD thesis.

3.2.3.3 Project SAREC/9/BF/12: Studies on infectious conditions of infertility in the buffalo (G.S. Peiris)

Objective

To determine the incidence, and control of bacterial diseases causing infertility in buffaloes.

Major thrust

This study emphasises the incidence of bacterial diseases which are known to cause abortion and repeat breeding in cattle

Research progress

Serum, milk and vaginal mucus from breeding females and preputial samples from breeding male buffaloes belonging to state sector and private farms were subjected to standard serological and cultural tests for brucellosis, leptospirosis, trichomoniasis and vibriosis.

Research highlights

- Prevalence of brucellosis in six state sector farms and 12 veterinary surgeon ranges in the Eastern, North Central and North Western Provinces and in the Hambantota district in the Southern Province.

- Serum samples collected from individual cows from buffalo herds were positive for both brucellosis (Rose Bengal test and the Serum Agglutination Test) and leptospirosis (Rapid Macroscopic Slide Agglutination Test).

- Absence of Campylobacter fetus and Trichomonas fetus in the buffalo

- The presence of serological reactors to leptospirosisand the public health hazard to workers in the paddy fields

Evaluation

The study has provided some useful results on the status of buffaloes to some of the bacterial diseases causing abortion in cattle. The diagnostic tests used in this study are those adopted for cattle in the developed countries. While brucellosis was known to exist in buffaloes, the presence of serological reactors to leptospirosis in herds with a history of abortion is a new finding and should be further investigated because of the public health hazard for those working in paddy fields. In this study, commercial leptospiral antigens were used as a screening test to establish the possible serotypes present in Sri Lanka. There is a need to establish the serovars of leptospira present in the country and to determine the importance of leptospirosis as a zoonosis in Sri Lanka.

It is recommended that SAREC support a more comprehensive survey of infectious infertility with particular emphasis on control of brucellosis and leptospirosis in cattle and buffalo. A veterinarian should be trained immediately in the laboratory diagnosis of infectious infertility as Dr. G.S. Pieris (Grantee), has retired.

Benefits

The high incidence of brucellosis demonstrated in this study in state and private farms, led the Department of Animal Health and Production to adopt a control program of vaccinating adult buffaloes with a low dose of S_{19}. Since then, there has been a drastic reduction in abortions among buffaloes. It is significant to note that the antibody titre disappears by 22 weeks to the Serum Agglutination Test (SAT) whereas it disappears by 12 weeks postinjection to the Rose Bengal Test (RBT). A clear-cut policy should be adopted to control this disease in both cattle and buffalo. While vaccinating the adult herd, the calfhood program should be strengthened so that vaccinating adults would no longer be necessary.

The presence of serological reactors to leptospirosis in aborting buffaloes would suggest that reproductive rates of the buffalo could be improved by control measures. The public health hazard of leptospirosis has also been demonstrated particularly for paddy field workers.

3.2.3.4 Project SAREC/9/BF24: A comparative study on pubertal development and semen characteristics of indigenous and river-type buffalo (K.K. Kuruwita)

Objective

To study physiological and endocrinological changes asso-ciated with male puberty in order to establish the age at puberty.

Major Thrust

The major thrust in this study is to establish criteria for determining the age at puberty through a study of histological changes in the testes and blood testosterone levels.

Research progress

At fortnightly intervals, 10 newborn males maintained under standard management conditions were weighed, scrotal diameter and volume measured and blood samples for testosterone collected. Starting at 6 months of age and at 3-month intervals, two animals were castrated for testicular histology and repetitive blood sampling were performed during a 4-hour period for measurement of testosterone. In addition, animals were challenged at 3-month intervals with Gonadotropin Releasing Hormone (GnRH) for plasma testosterone and Luteinising Hormone (LH) studies.

Research highlights

As this study commenced during phase II, results are not available or have not been analysed to date.

- Presence of mature sperm in the seminiferous tubules at 17 months of age.

Evaluation

This the only study on the male buffalo in the SAREC/NARESA water buffalo research program. It attempts to relate the endocrinological and physiological changes associated with puberty. Of the two definitions of male puberty: onset of spermatogenesis and the first appearance of sperm in the ejaculate, the latter is more practical and relevant to the program objectives. Thus it would be more appropriate to determine the optimum time at which males could be used for breeding purposes rather than focus on issues which are of academic interest and time consuming. The logical methodology would be to start collecting semen from males from about 18 months of age because there is evidence in both river and swamp type that although spermatogenesis commences at about 14-16 months, spermatozoa only appear in the ejaculate at about 24 months.

Benefits

This study has very little practical application in its present form. If semen collection is incorporated into the study, then scrotal circumference measurements could be used as a potential index of fertility.

3.2.3.5 Project SAREC/I Gustavsson:A study of cytogenetics in Lanka buffalo (P. Abeynayake/ I. Gustavsson)

Objective

To establish the taxonomy of domestic and wild buffalo.

Major Thrust

This study focuses on the cytogenetics of the Lanka buffalo

Research progress

Facilities have been established to study karyotypes of the buffalo. Chromosome analysis of over 25 blood samples have confirmed a diploid chromosome number of 50 for the Lanka buffalo.

Research highlights

- Confirms a diploid chromosome number of 50 in the Lanka buffalo.

Evaluation

Although this project is not listed under the SAREC/NARESA water buffalo program, it is relevant to the program. There is a great deal of uncertainty on the diploid chromosome number of the Lanka buffalo which phenotypically resembles the swamp type but has the diploid chromosome number (2n=50) of the river type.

With Professor I. Gustavsson's participation, it is hoped that this study could shed important differences between the Lanka and the river type of buffalo. Dr. Abeynayake is advised to collaborate with other scientists in Malaysia and Thailand working on the production characteristics of buffaloes with different chromosome numbers under the ACIAR program. An effort should also be made to collect blood samples from feral buffaloes in the national parks of Sri Lanka.

Benefits

- Facilities for cytogenetic studies have been established.
- Production characteristics of crossbreds between the Lanka and river types could be related to their chromosome numbers, banding patterns and gene maps.

3.2.4 Health

Five projects, two each in parasitology and bacteriology and one in virology examine mortality of calves and adult buffaloes and mastitis.

3.2.4.1 Project SAREC/9/BF/03: Studies on Theileriosis in the Lanka buffalo (D.J.Weilgama)

Objective

To establish the species of Theileria present in buffaloes in Sri Lanka, with respect to incidence, vectors and pathogenicity.

Major Thrust

This study attempts to establish, through an islandwide haematological survey, the role of theileriosis, which hitherto has been considered nonpathogenic in buffaloes.

Research progress

The incidence of the disease was established by examination of Giemsa stained blood smears and lymph node smears from Lanka, Murrah and Surti buffaloes. Since farmers were reluctant to sell 1-month old calves from farmers and weaned calves were invariably positive to Theileria sp., pathogenicity studies could not be conducted. The project has been concluded and the final report is in preparation.

Research highlights

- Theileriosis occurs in buffaloes throughout the country particularly in the dry zone.
- Of the two species encountered - T. annulata and Theileria sp., the prevalence of T. annulata in Sri Lanka is low, restricted to certain areas of the country and causes high mortality.
- Theileria sp. occurred commonly as a subclinical disease causing anaemia, reduction in growth rates and milk production and immuno-suppression so that infected animals are susceptible to foot and mouth disease and haemorrhagic septicaemia.
- Only Haemophysalis bispinosa adults transmitted Theileria sp. under experimental conditions.

Evaluation

This study has examined the importance of theileriosis in the buffalo which hitherto has been regarded as a nonpathogenic organism in the buffalo.

Although theileriosis is not a major disease of buffaloes and ranks below babesiosis and anaplasmosis in cattle, the role of the buffalo as a reservoir for infection of cattle should be studied.

Other hemoprotozoans ought to be investigated particularly Trypanosoma evansi which is emerging as an important disease associated with infertility in ruminants.

Benefits

The significant finding emerging from this study is that theileriosis could affect productivity (growth and milk) and the working efficiency of the buffalo.

(b) Project SAREC/9/BF/04:Studies on *Toxocara vitulorum* infection in buffaloes (S.T. Fernando)

Objective

To elucidate the pathophysiology, immunology, treatment and prevention of *T. vitulorum* infestation in the buffalo calf.

Major Thrust

Since *T. vitulorum* causes high mortality among buffalo calves in Sri Lanka, the major thrust was to establish the life cycle of *T. vitulorum*. The immunological response to *T. vitulorum* infection was studied in pregnant buffalo cows and calves.

Research progress

The humoral and cell mediated immune response in pregnant buffaloes have been studied in herds where patent *T. vitulorum* infection was prevalent in 3-6 week old calves. Infective larval excretions (ES) have been isolated which are highly protective against reinfection. The trend in antibody response showed a marked depression at the time of parturition with third and fourth larval stages appearing in the milk.

Research highlights

- Precipitins were noted in the sera of most cows before and after parturition, but *T. vitulorum* eggs were not present in the faeces of adult cows.

- Colostral antibodies were passively transferred to the calf as early as 24 hours after birth and persisted until they were about one month of age. However, these precipitins apparently do not protect calves from the development of a patent infection.

- Infection in suckled calves which did not show a positive serum precipitin reaction became patent from 18-26 days of age.

- Worm counts in the faeces of calves reached their peak 4-6 weeks of patency and most calves died.

- A strong 'self cure' reaction was noted with the elimination of several live worms in the faeces of calves which were able to resist the pathological effects of the infection. *T. vitulorum* infection in buffalo calves is not associated with a reinfection.

Evaluation

T. vitulorum, a highly fatal disease of buffalo calves worldwide, accounts for 30 to 40% of calf mortality in buffaloes. This is one of the first studies which has examined the disease very critically. Establishment of the life cycle of T. vitulorum and the age at which mortality occurs is a major contribution to our understanding of this disease. Apparently there are two phases in T. vitulorum infection. In the latent phase, infective larvae remain dormant in the body of adult cows (latent phase) and in the patent phase, eggs of T. vitulorum are excreted in the faeces of calves at about 21 days of age and are associated with diarrhoea and unthriftiness in most buffalo calves.

More attention should have been given to the control of the disease at the village level while continuing the immuno-logical aspects of the infection.

Benefits

Control programmes to prevent toxocariasis in buffalo calves is now available. A study supported by ACIAR, has developed a preventive program of treating buffalo calves with an anthelmintic (levimisol) by the second week after birth; treated calves remain resistant to a patent infection thereafter. Although the anthelmintic is effective in controlling a patent and even a fatal infection in calves, the most effective strategy is to destroy encysted larvae in the pregnant buffalo.

3.2.4.2 Project SAREC/9/BF/09: Epizootiological and pathological studies on Haemorrhagic Septicaemia (M.C.L. de Alwis)

Objectives

To determine the susceptibility of different breeds of buffaloes to haemorrhagic septicaemia (HS), the pathology of the disease in buffalo and the significance of HS carrier animal in the epidemiology of the disease.

Major thrust

The major emphasis in this study is on the role of the carrier in the spread of the infection and early recognition of the disease.

Research progress

Haemorrhagic septicaemia (HS) carrier animals were produced by controlled experimental exposure to HS. Selected animals that did not die were monitored by antibody titres and some were slaughtered.

Research highlights

- The clinical signs of HS in order of occurrence were inappetance, pyrexia, submandibular oedema, respiratory distress and recumbency and death. Pericarditis and pulmonary congestion were the most consistent postmortem changes.

- Intermittent appearance of the organism in the nasopharynx was evident in carrier animals. The most consistent site of isolation of the organism from HS-exposed animals were the tonsils and less often from the nasopharynx, lymph nodes such as the retropharyngeal, submandibular,and the salivary glands and spleen.

- Among buffaloes exposed to HS, a high proportion become 'latent carriers'- a state indicated by the development of antibody. In such animals, the organism persists in the lymphoid tissue particularly the tonsil but may appear in the nasopharynx intermittently when they become 'active carriers' or shedders.

Evaluation

The pioneering contributions of HS studies by the Grantee is well-recognised in the Asian region. The high mortality rates associated with HS in the buffalo has forced most countries in the world to adopt a program of vaccination. The studies conducted in this program has helped to define the clinical signs, the pathology and significance of the 'carrier ' animal in the spread of the disease. The evidence is convincing that the older practice of vacci-nating animals in an endemic area before transporting them is of little value. Conversely it is the in-contact animals that should be vaccinated before introducing animals from an endemic area .

Because the carrier animal is important in the spread of the disease, efforts should be made to eliminate the carrier status by antibiotic therapy. There is little information on the pharmacokinetics of antibiotics and sulphonamides in the buffalo. The minimal inhibition concentration of these drugs should be established for the buffalo for future use in treatment of HS.

There is a need to develop a vaccine which has a longer duration of immunity and also investigate vaccine failure as a cause for fresh outbreaks in vaccinated herds. Although the project has been completed, SAREC should support any future studies on HS particularly in the development of control programs in Sri Lanka.

Benefits

It is generally believed that some cattle or buffalo in any population are carriers and that the organism persists between outbreaks in such animals. Carriers are presumably the source of infection to susceptible in-contact animals and in fresh outbreaks. But the carrier does not come down with the disease because of the high antibody level.

Although vaccination programs are effective in the control of the disease, the past practice of vaccinating buffaloes before they are transported from an endemic to a nonendemic area is of little value. As earlier stated, it is the susceptible in-contact animals that should be vaccinated before animals from infected areas are introduced.

Results of this study forms part of a Master of Philosophy thesis, University of Peradeniya

3.2.4.3 Project SAREC/9/BF/14 Survey of incidence and aetiology of mastitis in buffaloes (D.D. Wanasinghe)

Objectives

To establish the incidence and aetiology of mastitis in buffaloes and cattle under similar management and environmental conditions.

Major thrust

This study has focussed on the bacterial infections associated with mastitis in the buffalo and has attempted to compare the incidence of mastitis in buffalo and cattle under similar management systems.

Research progress

A survey was conducted to establish the incidence and aetiology of mastitis in buffaloes and cattle under similar management and environmental conditions. Quarter milk samples of over 500 buffaloes and 240 cattle in various parts of Sri Lanka were tested by the California Mastitis Test (CMT) and were subjectedto bacteriological examination.

Research highlights

- The incidence of mastitis was lower in buffalo than cattle.
- About 98% of the infections in buffalo were by streptococci whereas in cattle staphylococci and streptococci were equally detected.
- Since only 43% of the CMT positive quarters of buffaloes yielded pathogenic bacteria, organisms other than bacteria eg., Mycoplasma sp., may be involved in mastitis in buffalo.
- A high incidence of agalactia occurred in the river buffalo.

Evaluation

The study has revealed that streptococci species is the common pathogen causing mastitis in the buffalo, but does not provide any recommendations on the control of mastitis although it was the main objective of the study.

The problem of agalactia in the Murrah and Surti breeds during the latter half of lactation has been based upon lactation records in the government livestock farm at Polonnaruwa over a 10-year period. The data indicate that lactation was very irregular with intermittent cessation of milk (agalactia) for periods ranging from 1 to 2 weeks. The possibility that a gap in the lactation record of an animal could be due to either a failure in recording or that the animal was not milked should have been eliminated during the course of the study before attempting to provide a physiological explanation for a temporary cessation of milk secretion.

The Grantee has no plans of continuing the project. Therefore, any future SAREC support should be to study the economics of a control program for mastitis. Since mastitis could affect milk composition, it would not be difficult to combine this study with that investigating factors affecting milk quality (Project SAREC/9/BF/23).

3.2.4.4 Project SAREC/9/BF/25: Studies on viruses of the alimentary tract of buffalo calves (M. Mahalingam)

Objective

To develop serological techniques for diagnosing the viral agents in calf diarrhoea.

Major thrust

The major emphasis in the study is to ascertain the role of rotaviruses in the etiology of calf diarrhoea and mortality in the buffalo.

Research progress

Over 200 faecal samples were collected from 150 buffalo calves that were diarrhoeic (27%) or in contact with diarrhoeic animals (73%) at sampling for the detection of the rotavirus antigen by the indirect double antibody sandwich ELISA method.

Research highlights

About 37% of diarrhoeic and 12% of nondiarrhoeic buffalo calves had rotavirus group antigen in their faecal samples.

- There was a highly significant association between the presence of the antigen in the faeces and diarrhoea.
- In 57% diarrhoeic calves several atypical rotaviruses, not detected by the ELISA technique, are involved.

Evaluation

This is the first report on detection of rotaviral antigen in buffalo calves in Sri Lanka. Rotavirus has been isolated in tissue culture from 5 faecal samples. A fault in the roller culture equipment, has prevented the virus from growing to higher titres in monkey kidney cell lines.

Having demonstrated the importance of rotaviruses in calf diarrhoeas in buffalo, the study should focus attention on the pathophysiology of diarrhoea particularly on the ensuing electrolyte imbalance in order to treat affected calves. Attention should also be given to the epidemiology of calf diarrhoea.

SAREC should assist in linking this project with a virus laboratory where standardized reagents and technical assistance could be

obtained. To detect these atypical rotaviruses PAGE (Polyacrylamide Gel Electrophoresis) technique may have to be employed. It is recommended that Dr. Mahalingam (Grantee) should visit a laboratory specializing in the PAGE technique.

Benefits

The study has strengthened the research capabilities of the Faculty of Veterinary Medicine and Animal Sciences in virology. It will now be possible to examine other viral diseases such as Infectious Bovine Rhinotracheitis in Sri Lanka.

3.2.5 Infrastructure

3.2.5.1 Research Farms

Under the SAREC/NARESA Water Buffalo Research Program, two farms for the Lanka buffalo were to have been established, one for about 80 animals in or near Kandy and another for about 200 animals in the dry zone.

(i) SAREC/9/BF/21: Buffalo research farm (small)

Objective

To strengthen teaching and research programs of the Faculty of Veterinary Medicine and Animal Science.

Major Thrust

This buffalo farm provides basic facilities for the staff of the Faculty of Veterinary Medicine and Animal Science to conduct research and teach veterinary students farm animal practice.

Activities

The farm located a few kilometers from the University Campus at Peradeniya, became operational in 1985. Basic facilities for animal experimentation are available. A herd of about 50 Lankan buffaloes are housed during the night and allowed to graze during the day in established pastures. Currently, several experiments on reproduction, parasitology, pharmacology are in progress. A facility to measure the draught power of the buffalo has also been constructed.

Evaluation

The farm was visited on November 18, 1987. Apparently, this is the only farm facility within the vicinity of the University for academic staff to conduct research on the buffalo without interfering with their teaching commitments. This farm provides the basic needs in terms of animals and facilities. The farm is managed by a veterinarian who is also conducting research for a postgraduate degree.

There is an urgent need to install a weighing scale. The handling facilities could be further improved by providing a suitable restraining device for blood collection, rectal examination or surgery, particularly because it is also a training centre. For routine semen collection, a

restraining device should be constructed. Most animals examined, particularly the calves were pot-bellied and had a harsh coat. This suggests either a nutritional deficiency or a heavy worm burden rather than the effects of experimentation as claimed by the management.

The overall performance of the farm has been most impressive and, for the first time in the history of the University, a farm facility is available for teaching and research in buffalo production and health. This facility should continue to serve the needs of academic staff of the Faculty of Veterinary Medicine and Animal Science. Any future support by SAREC should give high priority for the maintenance of this farm.

(ii) SAREC/9/BF/22: Development of the Buffalo Research Station at Narangalla Estate, Kuliyapitiya

Objectives

To provide facilities for multidisciplinary, collaborative research for improving the stock of indigenous buffalo for use in the agricultural economy of Sri Lanka.

Major thrust

The major focus of this farm is to establish the productive potential of the Lankan buffalo under controlled conditions through long-term studies.

Activities

This farm, belonging to the National Livestock Board, is located in the intermediate rainfall zone. The research station, within a coconut estate of about 100 hectares of land, commenced its activities at the beginning of phase II of the buffalo program. The farm is managed by an officer of the National Livestock Board.

The herd size (on 17/11/87) of Lankan buffaloes stood at 88 breeding females, two adult breeding bulls and about 40 subadults. Most of the animals were on an ACIAR project on toxocariasis in buffalo calves. The herd is grazed under the coconut palm on about 50 hectares of pasture of **Brachiaria sp.** An artificial lake formed by constructing a dam across a nearby stream provides a wallowing facility. SAREC/NARESA projects in progress include studies on postpartum reproduction, mineral status, parasitology, growth and development, lactation and parasitology.

Evaluation

The evaluation is based upon a visit on 17/11/87 which was towards the end of the rainy season. The pastures were in excellent condition and animals were in good body condition. The laboratory facilities for the research station were nearing completion. Laboratory space is more than adequate for routine work.

Construction of animal facilities was in progress. Following scrutiny of the sketch plans, it was suggested that the weighbridge be relocated at

the front end of the race so that only animals required could be diverted into the weighbridge.

The pasture species in the Station has withstood intensive grazing and credit should be given to the Estate staff for the excellent management of the pastures. Grazing management is critical during the dry period when most pastures would be destroyed if heavily grazed. Therefore, efforts should be made to produce hay or silage for drought feeding.

Until the carrying capacity of the pasture is established, the herd size should remain within 150 head. To supplement the income of the farm and also to ascertain the production potential, buffaloes should be milked. Facilities should be established for routine semen collection, evaluation and preservation from superior bulls. A routine herd health program as for cattle should be instituted.

Benefits

The original objective of establishing a large research farm has been achieved and it is hoped that at the end of the SAREC/NARESA program, the National Livestock Development Board will maintain the station as a "Model Research Farm", providing Sri Lanka scientists an excellent facility to conduct long-term research on the Lanka buffalo.

Considering that this Station will be the only buffalo research farm in Sri Lanka, the best genotypes could be preserved for eventual dissemination through an artificial insemination program.

Past problems such as animal identification, routine sampling, weighing and data recording from buffaloes belonging to farmers are reduced, paving the way for longitudinal studies on establishing the productive potential of the Lanka buffalo. Processing and storage of samples in the station would eliminate the need to haul equipment to and from Peradeniya which is about 120 km away and two hours of driving.

The Research Station could be utilized as a centre to train students from the Faculty of Veterinary Medicine and Animal Science.

3.2.5.2 Research Laboratories

Most of the laboratories at the Veterinary Research Institute , Peradeniya and at the Faculty of Veterinary Medicine and Animal Science were well-equipped but maintenance of equipment was a major problem. Late delivery of spare parts for important equipment and consumables, sometimes more than six months, were some reasons advanced by Grantees for the slow progress in their projects.

3.2.5.3 Library facilities

The staff of the Faculty of Veterinary Medicine and Animal Science use the Faculty of Medicine library which subscribes to important veterinary and animal science journals, but most issues reach the shelves six to 12 months later. The Postgraduate Institute of Agriculture library too caters to the needs of the animal and agricultural scientists. The library facilities at the Veterinary Research Institute are less satisfactory with outdated textbooks and journals. The NARESA library

has recently been updated to include an information dissemination service among scientists in selected fields, helping researchers to retrieve scientific information from both national international documentation services.

3.2.6 Dissemination of information

The workshop on buffalo research sponsored by SAREC in 1980 marked the beginning of an era of information dissemination on buffalo farming in Sri Lanka. Until then, scientific information was limited to a few projects supported by the IAEA. With the participation of many Sri Lankan scientists in the SAREC/NARESA buffalo program, knowledge has steadily increased on various aspects of buffalo farming. While information was being spread through participation in national conferences, those researchers working simultaneously on IAEA and SAREC/NARESA grants presented valuable research findings at the international level in the fields of reproduction, disease, and nutrition culminating in outstanding contributions in international journals.

As buffalo research gained momentum, veterinarians and agriculturists became interested in postgraduate research which was a major contributory factor in the successful collection and dissemination of research findings from field data. More research findings have been presented in conferences and published in scientific journals from projects where postgraduate students participated than in those conducted by grantees themselves. There is also a dearth of information in projects where grantees have resigned. The theses that have been published[5] are of very high quality considering the difficulties working at the smallholder level.

During phase I of the program two Interim Review Seminars were held in 1983 and 1984, followed by a Project Review Seminar in November 1985. During phase II, an Interim Review Seminar was held. Despite these seminars, there has been little or no interaction amongst the disciplines. This was clearly evident at the special seminar held during the consultant's visit to Sri Lanka. It is important for every Grantee to know the activities in the other research projects for maximising the use of available resources and avoid unnecessary duplication of effort.

4. CONCLUSIONS

At a workshop on buffalo research held in Sri Lanka in 1980, attention was drawn to the limited research on the Lanka buffalo and identified important problem areas for future investigations. The action taken by SAREC to strengthen the research on buffalo production and diseases in Sri Lanka is timely and will have an important impact on the future role of this ruminant in Sri Lanka as well as in other Asian countries.

4.1 Overall program

- Most of the original objectives of the SAREC/NARESA Water Buffalo Research Program specified in the memorandum of understanding[13] are realistic and the projects are designed to provide solutions to problems existing in buffalo farming in Sri Lanka.

- SAREC is justified in extending the program into Phase II. The additional projects are within the stated objectives and scope of the SAREC/NARESA Water Buffalo Research Program and has strengthened research in socioeconomics of buffalo production.

- The program has significantly contributed to research methodology, postgraduate training and has filled many gaps in our knowledge on production and health of the buffalo in Sri Lanka.

- The multidisciplinary projects are highly compartmentalized with little or no attempt at seeking solutions to existing problems at the smallholder level.

- Considering the dwindling land reserves and the eventual management of buffaloes on limited land, emphasis should have been given to research on feed resources in this program.

- New technologies developed during the program have not been tested under smallholder conditions.

4.2 Utilization

- In all agro-ecological zones, buffaloes are mainly used in the rice fields for ploughing, puddling and threshing for only about two months of the year. Milk yields (1-2 litres/animal/day) and draught capabilities were similar for both cattle and buffalo

- Buffaloes are being gradually replaced in the rice fields by tractors and cattle.

4.3 Socioeconomics

- There is a need to develop a dual purpose buffalo, capable of providing the farmer the draught power and a regular cash income.

- Assistance given by government and other related organisations to smallholder farmers should include suitable genotypes, quality feed, an efficient herd health and reproductive programs, marketing facilities and most important an attractive price for milk.

4.4 Physiology of work

A portable device capable of measuring draught power has been tested and found to be suitable for the buffalo under different soil conditions.

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[13] Refer Appendix 1

Methods have been developed for measuring physiological responses of the buffalo at work.

4.5 Nutrition

- There is a dearth of grazing land as well feed resources for the buffalo during most months of the year.

- Due to a lack feed resources, buffaloes are more difficult to manage than cattle in a confined or a semi-confined management system.

- Mineral deficiencies occur in the Lanka buffalo.

- A simple delivery system for feeding minerals to buffaloes and cattle has been developed.

4.6 Reproduction

- The seasonal nature of the breeding cycle and long calving intervals under range conditions make it difficult for a buffalo to calve during the peak months of two successive years.

- Seasonal breeding in buffaloes in the dry zone was related to rainfall and seasonal availability of forage.

- Most buffaloes conceived between November and March, with peak conceptions between December and February. Between June to November, Ambient temperatures were high and animals also lost weight between June and November.

- Long calving intervals are due to anoestrus resulting from a failure in the restoration of oestrous cycles after calving. A reduction in calving intervals is possible through restricted suckling management.

- Abortions among buffaloes have been drastically reduced through a control program of vaccinating adult buffaloes with a low dose of S19.

4.7 Diseases

As in many other countries in Asia, limited information is available on the epidemiology and pathogenesis of infectious diseases causing high mortality in buffaloes in Sri Lanka .

- Calf diarrhoea and mortality due to and rotaviruses infections are serious problems in buffalo herds in all agro-ecological zones. Toxocariasis can be effectively controlled by strategic anthelmintic treatment of 2-week old calves.

- Epidemiology, clinical signs and pathogenesis of haemorrhagic septicaemia have been studied. Vaccination of carrier animals is ineffective in controlling the spread of HS to susceptible animals.

4.8 Infrastructure

- Farm facilities at Mawela and Narangalla are adequate for teaching and long-term research needs of scientists engaged in buffalo research.

- Laboratories at the VRI, Peradeniya and at the Faculty of Veterinary Medicine and Animal Science are well-equipped but maintenance of equipment poses problems.

4.9 Dissemination of information

- Some outstanding publications in reproduction and parasitology have appeared in the scientific literature.

- Research findings on haemorrhagic septicaemia have been used by neighbouring countries for controlling the disease.

- The Interim Review Seminars have played an important role in monitoring the progress of on-going research, a stimulus to publish research findings and a forum for interaction among scientists.

- The propagation of research findings to the target groups especially National Livestock Development Board and the Draught Animal and Dairy Development program of the Mahaweli Authority has just begun and it is expected to gain momentum as researchers work closely with farmers in the future.

5. RECOMMENDATIONS

Buffalo farming under smallholder conditions in Sri Lanka is seen in the context of the smallfarmer whose primary occupation is crop production. Buffaloes are reared mainly for draught purposes with milk production of secondary consideration. Sufficient benchmark information has been accumulated through a program of multidisciplinary research during the past five years. However, socioeconomic constraints and the importance of the total production environment necessitate that future efforts be focussed 'on farm research'.

5.1 General

5.1.1. The interdisciplinary approach is needed to solve field-oriented problems that benefit the small farmer on a short-term basis.

5.1.2 Research should identify the links among economics, management, nutrition, reproduction and disease control in the smallholder buffalo production systems in Sri Lanka.

5.1.3 Technologies are needed that are cost-effective and can be incorporated into the local farming systems.

5.1.4 Participation of the farmer in critical phases of a research project is needed to determine whether results are of any practical benefit with a potential for adoption at the village level.

5.2 Management, utilization and socioeconomic patterns

Research on management practices and efficient utilization of the Lanka buffalo is needed to overcome poverty and improve the standard of living of the rural farmer. Future studies should:

5.2.1 Improve draught efficiency of the buffalo through improvement in heat tolerance of the buffalo, a reduction in incidence of subclinical diseases and a better design of harness and equipment.

5.2.2 Identify and overcome biological and socio-economic constraints associated with the development of a dual purpose buffalo for draught and milk.

5.2.3 Compare draught efficiency and capabilities of buffalo and cattle under different soil types and different uses.

5.3 Nutrition

With dwindling grazing land, low quality agro-industrial by-products are likely to remain or to increase in importance as a major feed source for the buffalo. Research should focus on:

5.3.1 Feeding systems that will maximize both the utili-zation of these by-products and the productivity of buffaloes that are reared on these diets.

5.3.2 Improvement of diet quality, both by treatment to improve their utilization and by the addition of catalytic amounts of protected proteins or concentrates obtained wherever possible from locally available resources.

5.3.3 The possible existence of vitamin or mineral defi-ciencies on low quality diets.

5.3.4 The establishment of demonstration farms to train farmers on managing buffaloes in close confinement utilizing agrobased byproducts such as rice straw treated with urea.

5.4 Reproduction

In efforts to arrest the alarming decline in population, urgent attention should be given to increasing the reproductive rate of the Lanka buffalo. Studies should include:

5.4.1 Baseline data on fertility of buffaloes under smallholder management systems are urgently needed so as to determine the impact of climate, nutrition and disease on male and female reproduction.

5.4.2 Reducing the seasonality in calving for the purpose of achieving a year-round supply of milk in the river buffalo and to improve the reproductive rates of the swamp buffalo.

5.4.3 Management strategies, wherever possible, to reduce the age at first calving and calving to conception intervals through improvements in nutrition and suckling management.

5.4.4 Improvements to conception rates to AI through advances in oestrus detection and semen preservation techniques could contribute to the genetic improvement of the Lanka buffalo in crossbreeding programs.

5.5 Health

The impact of infectious diseases on buffalo productivity is poorly documented except for two diseases which inflict severe losses. Further studies are needed on:

5.5.1 Establishing the role of infectious diseases that cause both clinical and subclinical diseases in the buffalo

5.5.2 Identifying anthelmintics or management strategies to control toxocariasis in buffalo calves.

5.5.3 Combating haemorrhagic septicaemia through treatment of clinical cases and elimination of the organism in carrier animals and development of a vaccine with a longer duration of immunity.

5.5.4 Determining the importance of leptospirosis as a zoonosis in Sri Lanka

5.6 Dissemination of information

Dissemination of information could benefit scientists, extension agents and farmers to update their knowledge on buffalo farming. This could be achieved by:

5.6.1 Selecting a panel from amongst the grantees to pool their resources in the preparation of a document suitable for field veterinarians, agriculturists and extension agents on buffalo production in Sri Lanka. The document should include the methodology of conducting surveys, and collecting and analysing data to identify problems in buffalo farming.

5.6.2 Preparing a practical training manual that provides advice to smallholder farmers on breeding, feeding, management, design of yokes and disease control practices.

5.6.3 Providing financial incentives to scientists and extension agents for extension publications.

6.COMMENTS

6.1 Impact of the SAREC/NARESA buffalo program

The Lankan buffalo which has provided the draught power to the rural farmer for centuries is facing many challenges from cattle and mechanical power. Therefore, the future outlook for the buffalo, as in

many other Asian countries, is not too bright unless international support is forthcoming to improve its productive efficiency.

Considering the many constraints that confront buffalo research in Asia, it was encouraging to note that progress has been made in many disciplines such as disease, reproduction and nutrition. Technologies have been developed to reduce calf mortality, control haemorrhagic septicaemia, a "killer disease" of adult buffaloes and reduce calving intervals. But a long-term outlook is needed when research findings are applied at the smallhoder farm level. As stated repeatedly in this report, it would be advantageous to adopt on-farm research programs.

In the years ahead, both the researcher and the smallfarmer must change their attitudes and their outlook towards buffalo farming. The future role of the buffalo will depend to a great extent on developing technologies and management systems to maximise productivity on minimal land. It will be necessary that the attitudes and opinions of the rural farmers be canvassed and explanations of the new practices and technologies thus far generated be carried out by the various implementation agencies. Once the project clientele are convinced that the new farming methods will be profitable and advantageous to them, there will be s strong probability of widespread adoption.

The greatest impact of research would be to determine its applicability in field situations. The ideal location for testing on-farm research would be in Girandurukotte, one of the study locations of the buffalo program, in system C of the Mahaweli Development Authority. It has the potential of being transformed to a Milk Collection Centre for buffaloes along the lines of the Milk Colony at Anand with producer participation. The centre has highly competent staff both in livestock extension and training and the infrastructure which could immensely facilitate technology transfer and reduce the workload of the researcher.

6.2 Future Role of SAREC

SAREC has made a significant contribution to strengthen research in animal production and diseases in Sri Lanka through the buffalo research program. But, unless research findings are transferred to the smallholder through a new generation of veterinarians and animal scientists trained in on-farm research during the next decade, the future contribution of the buffalo to draft and milk in Sri Lanka could decline.

Therefore it is recommended that SAREC's strategy should be to support buffalo research by placing greater emphasis on strengthening postgraduate research. This strategy is also necessary as Sri Lanka will face a severe shortage of scientists if the "brain drain" continues unabated. Through either a series of workshops or seminars, individual research projects should be developed and research teams comprising veterinarians, animal scientists, sociologists as well as extension specialists conduct problem solving type of research at the smallfarmer level.

Successful on-farm research programs with a farming system perspective will be in a strong position to identify important issues that require additional and specialized resources and longer run perspective which

SAREC support and expertise may be utilized.

Finally it is suggested that future SAREC programs should be broadened to include the milk and draught power of both buffaloes and cattle as both coexist in the same rural environment each performing a specific role. With these guidelines and recommendations, the consultant firmly believes that SAREC should seriously consider supporting the continuation of the SAREC/NARESA water buffalo program for the next five years during which sufficient technologies would have been transferred to the smallfarmer. The benefits could have a tremendous impact upon Sri Lanka's efforts to eradicate poverty in her peasant societies.

Appendix 1

Memorandum of Understanding between Swedish team and SAREC Committee of N.S.C. at Meeting held on 23.10.1981 at the National Science Council

NSC will for this purpose appoint an Advisory Committee on Water Buffalo Research. The Committee will include the Secretary General (who shall function aas the Chairman of the Committee) one other member ,of the NSC and four representatives from the major research areas in the programme

(i) Management, utilization and socio-economic patterns
(ii) Nutrition and environmental physiology
(iii) Reproduction
(iv) Animal Health

Buffalo Research Committee

The Buffalo Research Committee will be appointed to co-ordinate and implement research programmes on the Water Buffalo. This Committee will consist of one representative each from the major research areas, one representative from the Agrarian Research and Training Institute, one representative each from the Departments of Agricultural Engineering and of Animal Science, Faculty of Agriculture of University of Peradeniya. The Secretary of the SAREC Committee will represent the N.S.C. at meeting of the Buffalo Research Committee.

The Chairman of the Committee will be the Deputy Director Dept. of AP H and Head of the V.R.I.

The functions of this Committee will be:

1. To coordinate the research activities on the water buffalo.

2. To arrange meetings and workshops.

3. To publish a newsletter and provide extension information.

4. Report on progress of research activities to the Advisory Committee.

5. To direct the research activities on the research farms.

6. To provide financial reports to the Advisory Committees.

7. To recommend funding of research projects and re-allocation of funds where necessary.

8. To promote inter-disciplinary research within the programme.

Reporting

The Buffalo Research Committee and chief investigators shall submit progress reports to the NSC every six months. The NSC will submit to SAREC progress and financial reports annually by the 30th of September each year.

Research Programme

The research programme shall be based on the research priorities recommended by the Workshop on Water Buffalo Research in Sri Lanka, November 24-28, 1980. The research programme will make provision for international contacts, yearly workshops, for publications and for the administration of experimental farms.

Within the budget frame of the project, funds will be placed in Sweden for documentation services and travel to coordination meetings by members of the SAREC Advisory Board on Water

Buffalo Research.

Farm Units

It is essential for the programme that farms for the indigenous water buffalo are established, one for 80 animals in or near Kandy and one for 200 animals in the dry zone.

The Sri Lanka Government agencies will make land available for the programme.

The evaluation will comprise the following:

- Scientific quality of the programs's publications
- Infrastructures (research farms and labs) annd its quality and relevance for ongoing research within the program
- The research programs's relation to extension activities within the area of draught and dairy animals
- Long and short term objectives for the research program as refleced in ongoing activities

Broad Objectives

The primary aim of the Project is the economic exploitation of the potential of the water buffalo as a source of farm power and as a source of milk to the small farmer. The Project also seeks to assist in the integration of the buffalo into emerging agricultural farming systems by evolving systems of management utilising primarily the resources available to the farmer.

Immediate Objectives

The Project will provide much needed information through a coordinated programme of research and dissemination of research information. It will seek to create an awareness on the potential value of the buffalo in integrated farming systems. During the three year period, it will promote research in four major areaas, namely -

1. Management, utilization and socio-economic patterns
2. Nutrition and environmental physiology
3. Reproduction
4. Health

Inputs

The Project will be a joint collaboration between the National Science Council of Sri Lanka, representing the Government of Sri Lanka and the Swedish Agency for Research Cooperation with Developing Countries representing the Government of Sweden. The Government of Sri Lanka will make available the land for the establishment of two research farms and the administrative and scientific staff. This will be provided jointly by the Department of Animal Production and Health and the Faculty of Veterinary Medicine and Animal Sciences. The Government of Sweden will make available the funds and consultative support for the research programme for a period of three years.

Outputs

The Project will provide research information and assist in

(a) improving the efficienccy of the buffalo through improved feeding and management;

(b) improve the efficiency of utilization of the buffalo as a draught animal.

By these means, the Project will improve the lot of the farmer by

(a) reducing his dependence on machninery and fuel

(b increase the farm income throug milk production

(c) reduce dependence on inorganic fertilizers through utilization of farmyard manure.

Plan of Operation

The National Science Council or Sri Lanka and the Swedish Agency for Research Cooperation with Developing Countries will function as the implementing agencies for their respective countries. The National Science Council (NSC) will be responsibel for overall coordination and adminstration of the programme in Sri Lanka. The NSC will for this purpose appoint an Advisory Committee neaded by the Secretary General of the NSC. The NSC will also appoint a Buffalo Research Committee whose functions will be as follows:

1. To coordinate the research activities

2. To recommend to the NSC on funding of research activities

3. To arrange workshops and coordinating meetings

4. To report prograss of research to NSC

5. To submit financial report to SC

6. To publish research information and extension information

7. To promote and stimulate interdisciplinary research within the programme.

Two buffalo research farms will be established, one at Nikeweratiya for 200 animals and the otner at Peradeniya for 40 animals.

The NSC will make available to SAREC a progress and financial report every year.

Appendix 2

TABLE 1 . SUMMARY OF PROJECTS - SAREC/NARESA WATER BUFFALO RESEARCH PROGRAM (1983-1988)

Project No	Project Title	Main Objectives	Investigator(s)
BF/01	Reproductive physiology of river type buffaloes	Study reproductive physiology of Murrah buffaloes	R. Rajamahendran/ A.R. Mohamed
BF/02	Clinical and hormonal studies on reproductive functions of indigenous buffalo	Understand normal physiology and possibilities of improving reproductive efficiency	B.M.A.O. Perera
BF/03*	Studies on Theileriosis in Lanka buffalo	Establish species of Theileria with respect to incidence, vectors and pathogenecity	D.J. Weilgama
BF/04	Studies on Toxocara vitulorum infection in buffaloes	Elucidate pathophysiology, immunology, treatment and prevention of the parasitic infestation	S.T. Fernando
BF/06	Studies on mineral nutrition in the buffalo	Determine the mineral status of buffaloes in relation to availability and requirements	S.S.E. Ranawana
BF/09*	Epidemiological and pathological studies on Haemorrhagic Septicaemia	Study clinical course, pathology and carrier status of the disease	M.C.L. de Alwis
BF/12*	Studies on infectious conditions of infertility in the buffalo	Study incidence, pathology, treatment and control of disease conditions causing infertility in buffaloes	G.S. Peiris
BF/14*	Survey of incidence and aetiology or mastitis in in buffaloes	Establish incidence and aetiology of mastitis in buffaloes and cattle under similar management and environment	D.D. Wanasinghe
BF/16	Growth, reproduction and overall economics of Lanka buffalo	Monitor growth and development of the indigenous Lanka buffalo in four agro-ecological zones	N. Tilakaratne/ E.F.A. Jalatge
BF/17	Measurement of draught capabilities of buffaloes	To evaluate the draught capabilities of different breeds of buffaloes on various soil types	S.G. Ilangantileke/ S.K. Seneviratne
BF/21	Development of Buffalo Research farm (Small)	Strengthen teaching and research programmes of the Faculty of Veterinary Medicine and Animal Science	K.K. Kuruwita
BF/22**	Development of the Buffalo Research Station at Narangalla Estate	Provide facilities for multidisciplinary research for buffalo improvement	B.M.A.O Perera
BF/23**	Composition of indigenous buffalo milk and changes due to various factors	Determine composition of buffalo milk and factors causing variation	C.P. Kodikara

TABLE 1 . SUMMARY OF PROJECTS - SAREC/NARESA WATER BUFFALO RESEARCH PROGRAM (1983-1988) (Contd)

Project No	Project Title	Main Objectives	Investigator
BF/24**	A comparative study on pubertal development and semen characteristics of indigenous and river type buffalo	Study physiological and endocrinological changes in male puberty and semen characteristics and age at puberty	K.K. Kuruwita
BF25**	Studies on viruses of the alimentary tract of buffalo calves	Establish role of rotaviruses in the etiology of calf diarrhoea and mortality	M. Mahalingam
BF26**	Microeconomics of rural cattle and buffalo production: evidence from the dry zone districts of Sri Lanka	Establish role of cattle/buffalo in the rural economy	C. Bogahawatte
BF27**	A socio-economic study of the utilization of buffaloes in peasant society	Understand the problems involved in the utilization of buffaloes in the Mahaweli system C and suggest more effective use of buffaloes	W.T. Siriweera
!	Cytogenetics of water buffalo (Bubalus bubalis)	Study taxonomy of domestic and wild buffalo	P. Abeynayake

*Phase I (1983-1986) project completed or terminated
**Phase II (1987-88) project
!SAREC grant to Professor I. Gustavsson

Appendix 3

ITINERARY OF MISSION TO SRI LANKA
M.R. JAINUDEEN

12-Nov-87 Arrival in Sri Lanka.
13-Nov-87 Colombo.
14-Nov-87 Colombo.
15-Nov-87 Arrival in Kandy.
16-Nov-87

09.00 Meeting Dr. M.C.L. de Alwis, Deputy Director and staff of the Veterinary Research Institute (VRI), Peradeniya.

14.00 Meeting Dr. J.A.de S. Siriwardena, Director General, Department of Animal Production & Health, Peradeniya.

15.00 Prof. B.M.O.A. Perera, Coordinator, Buffalo Research Program, Department of Veterinary Clinical Sciences; University of Peradeniya, Peradeniya: Finalising meetings and visits.

17-Nov-87

09.00 Prof. S.T. Fernando, Dean, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Peradeniya: Organisation of the Faculty, teaching and research facilities.

10.30 Prof. B.M.O.A. Perera, Department of Veterinary Clinical Sciences, University of Peradeniya, Peradeniya: Briefing on plans for development of the Research Farm at Narangalla and current research activities.

14.00 Dr.V.Y. Kuruwita, Department of Veterinary Clinical Sciences, University of Peradeniya, Peradeniya: Briefing on plans for development of the Small Research Farm at Mawela and current research projects.

18-Nov-87

09.00 Research farm (small) at Mawela: Inspected animals and facilities and discussions with Dr. V.Y. Kuruwita and farm staff (Project BF/21).

11.00 Research farm at Mawela: Demonstration on measuring draught power of buffalo by Dr. S.K. Seneviratne, Department of Mechanical Engineering, University of Peradeniya.

04.00 Mr. D.P. Athulathmudali, postgraduate student of Dr. C. Bogahawatte: Discussions on microeconomics of rural cattle and buffalo production in the Kurunegala district (Project BF/26).

15.00 Postgraduate Institute of Agriculture, University of Peradeniya: Attended a Postgraduate Seminar given by Mr. D.P. Athulathmudali on " On microeconomics of rural cattle and buffalo production: A comparative study in the Kurunegala district".

19-Nov-87

09.00 Dr. M.C.L. de Alwis, VRI: Discussions on Haemorrhagic Septicaemia (Project BF/09).

14.00 Dr. D.D. Wanasinghe, VRI: Discussions on Mastitis and Agalactia (Project BF/14).

20-Nov-87

07.00 Research farm (large), Narangalla: Briefing by Dr. S.S.E. Ranawana, Research Officer, VRI on existing facilities, on-going research and developmental plans. Inspected the laboratory facilities under construction and buffaloes grazing under coconut (Project BF/20).

21-Nov-87

08.00 Dr. V. Mohan, postgraduate student: Inspected breeding records of buffaloes in the Mawela farm and demonstrated the use of the 1-2-3 Lotus program on IBM PC to calculate calving intervals and display progesterone profiles.

23-Nov-87

09.00 Prof.S.T.Fernando, Department of Paraclinical Sciences, University of Peradeniya: Discussions on Toxocara vitulorum (Project BF/04).

14.00 Dr.S. Mahalingam, Department of Paraclinical Sciences, University of Peradeniya: Discussions on viruses of the alimentary tract of buffalo calves (Project BF/25).

24-Nov-87

09.00 Dr. E.F.A. Jalatge, VRI: Dicussions on growth and reproductive performance of the indigenous buffalo (Project BF/16).

14.00 Dr. S. Ranawana, VRI: Discussions on mineral nutrition in the buffalo (Project BF/06).

25-Nov-87

09.00 Dr. A.R. Mohamed, VRI: Discussions on the reproductive performance of river buffaloes (Project BF/01).

14.00 Dr. G.S. Peiris, VRI: Discussions on infectious infertility in the buffalo (Project BF/12).

26-Nov-87

09.00 Dr. W.T. Siriweera, Department of Social Sciences, University of Peradeniya: Discussions on socioeconomics of buffalo utilization in agriculture (Project BF/27).

27-Nov-87

07.00 Girandurukotte: Inspected study locations in the Mahaweli System C (Project BF/27) and interviews with farmers and research assistants

11.00 Mahaweli Livestock Farm, Girandurukotte: Briefing on the draught animal programme in Mahaweli System C.

30-Nov-87

11.00 VRI: Inspected library facilities and laboratories

14.00 Dr. D. G. Weilgama, VRI: Discussions on theileriosis and other protozoan parasites of the buffalo (Project BF/03).

01-Dec-87

09.00 Dr.C.P. Kodikara, Department of Paraclinical Sciences, University of Peradeniya: Discussions on milk composition in the buffalo (Project BF/23).

11.00 Dr. J. Roberts, Department of Paraclinical Sciences, University of Peradeniya: Discussions on field studies on Toxocara i+nfection in buffalo calves.

02-Dec-87

09.00 Dr. S. Ranawana, VRI: Demonstrations on use of the IBM PC computer to store and retrieve data on nutrition.

14.00 Dr.S.K. Karunaratne, Veterinary Hospital, Peradeniya: Inspection of facilities and discussions on diseases of buffaloes.

03-Dec-87

09.00 A Seminar presented by SAREC grantees on the Buffalo Research Program at the VRI.

07-Dec-87

09.00 Prof. F.S.C.P. Kalpage, Chairman, Univeristy Grants Commission: Discussions on research programs in the Faculty of Veterinary Medicine and Animal Science, University of Peradeniya.

14.00 Attended opening session of the Sri Lanka Association for the Advancement of Science, Bandaranaike Memorial Hall, Colombo.

08-Dec-87

10.00 Attended the Buffalo Research Committee Meeting held at Queen's Hotel, Kandy, to brief the committee on observations during the mission.

09-Dec-87

10.00 NaturalResources,Energy & Science Authority (NARESA), Colombo: Briefing by Mr. M.A.T. de Silva, Director of Scientific Affairs on the organization of NARESA and shown the library facilities and data storage system.

11.30 Dr.R.P.Jayewardene,Director-General,NARESA: Discussions on scientific research in Sri Lanka.

10-Dec-87 Departure from Sri Lanka.

P

NARESA/SAREC Water Buffalo Research Programme

Scientific Publications (1983 - 1988)

Grant No. (SAREC/9/BF-01) ; Dr A.R. Mohamed -

Reproductive Physiology of river type buffaloes

1. Mohamed A.R, Wickremasuriya U.G.J.S. (1986)
   Artificial induction of lactation in buffaloes, Sri Lanka Vet. Journal., Vol. 35.

2. Mohamed, A.R, Jayaruban, M.G. (1987)
   Effects of supplimentary feeding and environment on the reproductive performance of buffaloes in the dry zone, Sri Lanka Vet Journal, Vol 36.

3. A.R. Mohamed (1986)
   Accuracy of oestrus detection under field and farm conditions, Sri Lanka Vet Journal, Vol 35.

4. Mohamed, A.R, Jayaruban, M.G. (1987)
   Reproductive performance of Lanka Murrah buffaloes on two nutritional regimes, Sri Lanka Vet Journal, Vol 36.

5. Mohamed A.R, Sivakanesan. R, Rajamahendran, R. Seasonal variation in fertility in buffaloes (1987)
   Paper presented at the Progress Review Seminar, Peradeniya.

Grant No. SAREC/9/BF-02 ; **Prof. B.M.O.A. Perera, Dr V.Y. Kuruwita**

Clinical and hormonal studies on reproductive functions of indigenous buffalo.

6. Perera, B.M.A.O, de Silva L.N.A. (1985) Gestation length in indigenous and exotic buffaloes in Sri Lanka. Buffalo Journal Vol 1, 83-87

7. Perera, B.M.O.A. de Silva, L.B.A, Karunaratna, A.M. (1984)
   Studies on reproductive endocrinology and factors influencing fertility in dairy and draught buffaloes of Sri Lanka In : the use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia, IAEA, Vienna, PP 13-28.

8. Perera, B.M.A.O, Silva, I.D, Veerasekera D.A. Karunaratna A.M. (1986)
   Effects of Gonadotrophin - Releasing Horomone and human Chorionic Gonadotrophin on plasma Testosterone in male buffaloes, Buffalo Journal, Vol 2, 29-35.

47

9. Kuruwita, V.Y, Perera, B.M.A.O, (1985) Application of an enxyme immunoassay technique for measurement of progesterone in buffalo plasma. Proc, Sri Lanka Vet Association, 38.

10. Perera, B.M.A.O, de Silva, L.N.A. (1985) Effect of suckling management and use of milk or draught on reproductive efficiency of Lanka buffaloes. Proc. Sri Lanka Vet. Association, 38.

11. Perera, B.M.A.O, de Silva, L.N.A. (1985) Small farm buffalo production in Sri Lanka Proc, Buffalo Seminar, Bangkok, Thailand.

12. Perera, B.M.A.O. & de Silva, L.N.A, (1985) Gestation length in the Lanka Buffalo. Proc, Sri Lanka Vet Association, 38.

13. Kuruwita, V.Y, Chandratillake, D.,Mohan, V. and Perera, B.M.A.O. I1986) Criteria used for diagnosing the stage of pregnancy by rectal palpation in Lanka buffaloes. Proc. Sri Lanka Vet. Ass. 40.

14. Kuruwita, V.Y. Perera, B.M.A.O., Karunaratne, A.M., Mohan, V. and Van de Wiel, D.F.M. (1985). Application of an enzyme immunoassay technique for measurement of progesterone in buffalo plasma. Proc. Sri Lanka Vet. Ass. 38 (Abstr. in S. Lanka Vet. J. 33, 39).

15. Perera, B.M.A.O., and de Silva, L.N.A. (1985). Small farm buffalo production in Sri Lanka. Proc. Buffalo Seminar, Kasetsart Univ., 29 April - 2 May 1985, Bangkok Thailand. pp 59-75 (Ed; C. Chanatalakhana).

16. Perera, B.M.A.O., de Silva, L.N.A. Kuruwita, V.Y. and Karunaratne, A.M. (1987). Postpartum ovarian activity, uterine involution and fertility in indigenous buffaloes at a selected village location in Sri Lanka. Anim. Reprod. Sc. 14, 115-127.

17. Perera, B.M.A.O., (1986). Use of radioimmunoassay methods for studies on reproduction of buffaloes. In. Nuclear related techniques in Animal Product. and Health, IAEA-SM-292, Vienna, Austria. pp. 179-187.

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