MAHAWELI ENTERPRISE DEVELOPMENT

MED/EIED PROJECT

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FEASIBILITY STUDY ON COMMERCIAL POTENTIAL OF SNAKE VENOMS IN MAHAWELI SYSTEMS

A short-term consultancy report
by
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INTERNATIONAL SCIENCE AND TECHNOLOGY INSTITUTE, INC.

WITH :

ERNST & YOUNG CONSULTANTS (Sri Lanka)
DEVELOPMENT ALTERNATIVES, INC.
HIGH VALUE HORTICULTURE, PLC.
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CONSULTANTS TO THE MAHAWELI AUTHORITY OF SRI LANKA

The Mahaweli Enterprise Development Project

The development of the natural and human resources of the Mahaweli river basin has been a high priority of the Government of Sri Lanka and international agencies since the late 1970's. Largely completed are the construction of dams, irrigation and power systems, roads and other physical infrastructure, the settlement of the land and the formation of the agricultural production base. The challenge for the 1990's is to build a diverse, dynamic economy generating higher incomes for Mahaweli families. In meeting this challenge, the private sector has a leading role to play.

The Mahaweli Enterprise Development Project (MED) is a special initative of the Mahaweli Authority of Sri Lanka, with the support of the United States Agency for International Development. MED promotes private investment and job creation in agribusiness, manufacturing, tourism, minerals and services by directly assisting entrepreneurs and companies with technical expertise, marketing support, training, business advisory services and credit. MED also provides policy analysis support to improve official frameworks for sustainable enterprise development in the Mahaweli areas.

The Employment, Investment and Enterprise Development Division of the Mahaweli Authority is responsible for MED implementation. Technical consultancy is provided by a consortium led by the International Science and Technology Institute, Inc., a private consulting firm with head offices in Washington, D.C. Also in the consortium are Agroskills, Development Alternatives, Ernst and Young, High Value Horticulture and Sparks Commodities. Marketing services are provided by SRD Research and Development Group, Inc.

PREFACE

This report was prepared by ISTI consultant Mr. Anslem De Silva, a Specialist on Snakes. The report was prepared as a feasibility for those who would be interested in the potential of snake venoms as a commercial venture in the Mahaweli.

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I wish to thank Dr. Jim Finucane and Mr. Jayantha Jayewardene of the International Science and Technology Institute, Inc., Mahaweli Enterprise Development Project, Colombo for commissioning me as the Consultant to carry out the feasibility study on commercial potential of snake venom and to submit this report. Professor S Balasuriya, and Mr. M. Sinnatamby, University of Peradeniya for their helpful suggestions and comments on the report. Antivenom manufacturers and venom producers for prompt response and Priyani Pieris and Devika Ekanayake for secretarial help.

1. INTRODUCTION

1.1. World Demand for Venom

There is an increasing world demand for snake venom. The main demand today is for the manufacture of antivenom serum and venom toxoid for immunization. The manufacture of antivenom is undertaken in a number of countries and the approximate annual requirement for Sri Lanka is 100,000, ten ml. doses and for India and Bangladesh this could be in the region of ten times or more. Also a smaller quantity of snake venom is used in medical research in neurobiology, muscle research, treatment of vascular and occlusive diseases, diagnosis of hemostatic disorders and as a tool in pharmacological/biochemical research. The world demand for venom has shown a steady increase over the years due to greater acceptance of antivenom serum by snake bite patients (refer table 1), at the same time there are indications that the supply of venom is decreasing.

1.2. Snakes of Sri Lanka: Medical and Commercial Value

A total of 93 species of snakes have been identified in Sri Lanka. Of these, 34 (37 %) are venomous or medically important. However, of the land snakes; only bites by the Cobra (*Naja naja*) (Fig.1), the Russell's Viper (*Daboia russellii*) (Fig.2), the kraits (*Bungarus caeruleus* (Fig.3) and *B. ceylonicus*), the Merrem's Hump-Nosed Viper (*Hypnale hypnale*) (Fig.4),the Green pit viper(*Trimeresurus trigonocephalous*) and the Saw-scaled viper (*Echis carinatus*) (Fig.5) have caused serious medical problems even resulting in death. These snakes are widely distributed in the country and found in abundance in the Mahaweli settlement areas. Due to the high incidence of bites by the snakes listed above, they are commercially important in the manufacture of antivenom serum.

Venoms of some Sri Lankan snakes like that of the Russell's viper, the Sri Lanka krait and the Hump nosed viper will have added world demand due to high and different toxic effects these venoms have produce in envenomed patients.

The large scale land clearance for agriculture and urbanization activities in the Mahaweli areas and other parts of the country has caused extensive damage to the natural habitats of snakes. Furthermore, a large number of snakes are killed daily either during land clearing or out of fear of snake bite . Hence, at present, some of the reptiles are considered threatened. If this destruction continues there will be a reduction in the snake populations in Sri Lanka which could be detrimental to the balance of the ecology. A snake farm to some extent will help in the preservation of these reptiles as people will be motivated to catch and sell the snakes they encounter rather than to kill them (refer sections 4.1, 4.6 and 7.3).

1.3. Venom and Anti Venom Serum

Venom extraction and antivenom manufacturing centers are found in a number of countries in the world (Annexure 1). In general, poisonous snakes are kept for venom collection in either farms, laboratories or under both conditions.

The venom is 'milked' and is immediately freeze-dried or stored at - 20 Celsius. This freeze-dried venom is either sold for venom research, manufacture of anti venom serum or both.

The anti venom serum used in India and Sri Lanka is prepared by hyperimmunizing horses against the venoms of the cobra (*Naja naja*), Common krait(*Bungarus caeruleus*), Russell's viper (*Daboia russellii*) and the Saw-scaled viper (*Echis carinatus*). Plasma obtained from the hyperimmunized horses is enzyme refined, purified and concentrated. This purified plasma is freeze dried and bottled. When required, it is reconstituted with 10 ml. of distilled water and administered intravenously.

1.4. Objective

The objective of this paper is to provide information on the availability of the snakes, market potential, technology, human resources and sites for a prospective group of investors, organization or an entrepreneur to set up a commercial venture snake venom extraction.

2. MARKET ASSESSMENT

2.1. Venom

India is the potential buyer of Sri Lankan venoms, specially that of the cobra, the Russell's viper, krait, and the Hump nosed viper. The two leading manufacturers of antivenom in India, Serum Institute and Haffkine Bio-Pharmacutials (Annexure 1) are now aware that their antivenom raised from Indian snakes is less effective in the treatment of patients bitten by Sri Lankan snakes. This is mainly due to the variation in the venom composition which differs according to geographic origin (refer 4.2.). Hence, both these firms have indicated their willingness to manufacture specific antivenom for Sri Lanka from imported Sri Lankan venoms. Thus, there is already an interested buyer for the freeze-dried venom.

There is also an international demand for snake venom in its crude freeze-dried form or particular toxins of the venom in purified form (eg.cobratoxin) by various universities, research institutions and antivenom manufacturers in the world. The major demand of the venom of common poisonous snakes in Sri Lanka, like the cobra, the Russell's viper, the common krait and the Hump nosed viper is for the manufacture of antivenom serum for Sri Lanka.

2.2. Local Dealers

At present there are no government or private dealers in Sri Lanka who 'milk' snakes on a commercial or small scale.

2.3 Price Structures

The present market prices of freeze dried venom according Serum Institute of India for the three common venomous snakes are as follows:

Common krait, 1 gram = Sri Lankan Rs. 6,800.00
Cobra, 1 gram = Sri Lankan Rs. 1,700.00
Russell's viper, 1 gram = Sri Lankan Rs. 1,700.00

The following snakes (except *Hypnale hypnale*) are found only in Sri Lanka. Hence, better prices for their venoms could be obtained. Following are tentative prices for these venoms in freeze dried form:

T.trigonocephalous (Green pit viper) 1 gram = Rs. 3,000.00
Hypnale hypnale (Hump nosed viper) 1 gram = Rs. 2,600.00
Bungarus ceylonicus (Sri Lanka krait) 1 gram = Rs. 8,000.00

It is of interest to note that the present selling prices as given by Sigma Chemical Company U.S.A. Catalogue 1992 are much higher than the prices given above, a few prices are given below for comparative purposes :

Common krait per 100 mg. US $ 116.15 (1 gram = Rs.46,400.00)
The cobra per 100 mg. US $ 56.90 (1 gram = Rs.22,760.00)
Russell's viper per 100 mg. US $ 31.45 (1 gram = Rs.12,400.00)

2.4 Quality Standards and Shelf Life

There is no quality standards required for the freeze-dried crude venom which is used to manufacture antivenom serum. Hence quality factors will not effect the pricing. However, while milking snakes, centrifuging the crude liquid venom, freeze-drying, weighing and packing should be carried out under sterile conditions. The freeze dried venom should be stored in dry and sterile containers.

The freeze-dried venom can be kept at room temperature (27 Celsius) for months without loosing its potency if kept away from light, heat, ultra violet/infra red rays. Furthermore, the shelf life, may last for about 25 years or more if stored at + 4 Celsius. The freeze-dried venom could be bottled or lyophilized in ampoules and packed in polystyrene (regiform) containers without any cooling devices and freighted by air or surface.

2.5. International Restrictions

There are international restrictions, such as CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora) and the Department of Wildlife Conservation on the sale and export of fauna, which includes venom. However, CITES and the Department of Wildlife Conservation, issues permits to export venom for scientific and medical research.

2.6. Local Buyers

At present there are no local buyers for the venom. Nevertheless, the Universities and the Medical Research Institute, Colombo. May be potential buyers of small quantities of venom. The State Pharmaceuticals Corporation, is the only importer of antivenom serum to Sri Lanka. They imported nearly 60,000 ten ml. vials of anti-snake venom serum in 1992 from India (Annexure 3). Therefore, if a specific antivenom serum is manufactured abroad or locally the State Pharmaceutical Corporation will purchase it for local demand. Also in the future the private sector too may be potential buyers of the antivenom serum due to the steady increase in the number of snake bite patients seeking western treatment (table 1).

2.7. International Buyers

The Potential buyers of Sri Lankan venom are the Serum Institute of India and Haffkine Bio-Pharmaceuticals Corporation of India. Both these manufacturers, specially the former have expressed their interest to purchase Sri Lankan venoms to manufacture antivenom for sale in Sri Lanka. Also there are inquiries from Universities and research institutions abroad for small quantities of Sri Lankan snake venoms. However, advertisements in reputed journals (eg. Toxicon) regarding the availability of Sri Lankan venoms will bring in even more orders.

3. TECHNICAL ASPECTS

3.1 Venom Extraction Centers

Venom extraction centers with multi income generating ventures are found in a number of countries (Annexure 1). Usually they consists of compartments or "pits" for each of the main species (eg. Cobra, Russell's viper) used for venom extraction. Every effort is made to duplicate the habitat of the snakes. Ideally each compartment or pit should measure 25 feet by 30 feet in the form of an island surrounded by a moat 2 feet in width and 20 inches deep, bounded by an outer smooth surfaced retaining wall 5 feet in height. The water supply in the moat must be kept fresh by a constant inflow and discharge system. Fish should be introduced to prevent mosquito breeding.

Several pits should be excavated on the island for the snakes to hide and covered by earthen wear pots to protect the snakes from sun light, rain and to prevent the snakes from getting disturbed. In general, poisonous snakes are kept for venom collection in either farms,

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laboratories or in both. It has been established at the Haffkine Institute, Bombay, that the quantity of venom extracted is higher in cobras and krait kept in farms than from specimens maintained in the laboratory. Also that the Russell's vipers kept under laboratory conditions had a high yield of venom. Hence. both the farm and laboratory techniques for rearing snakes should be adopted.

3.2. 'Milking' or Venom Extraction

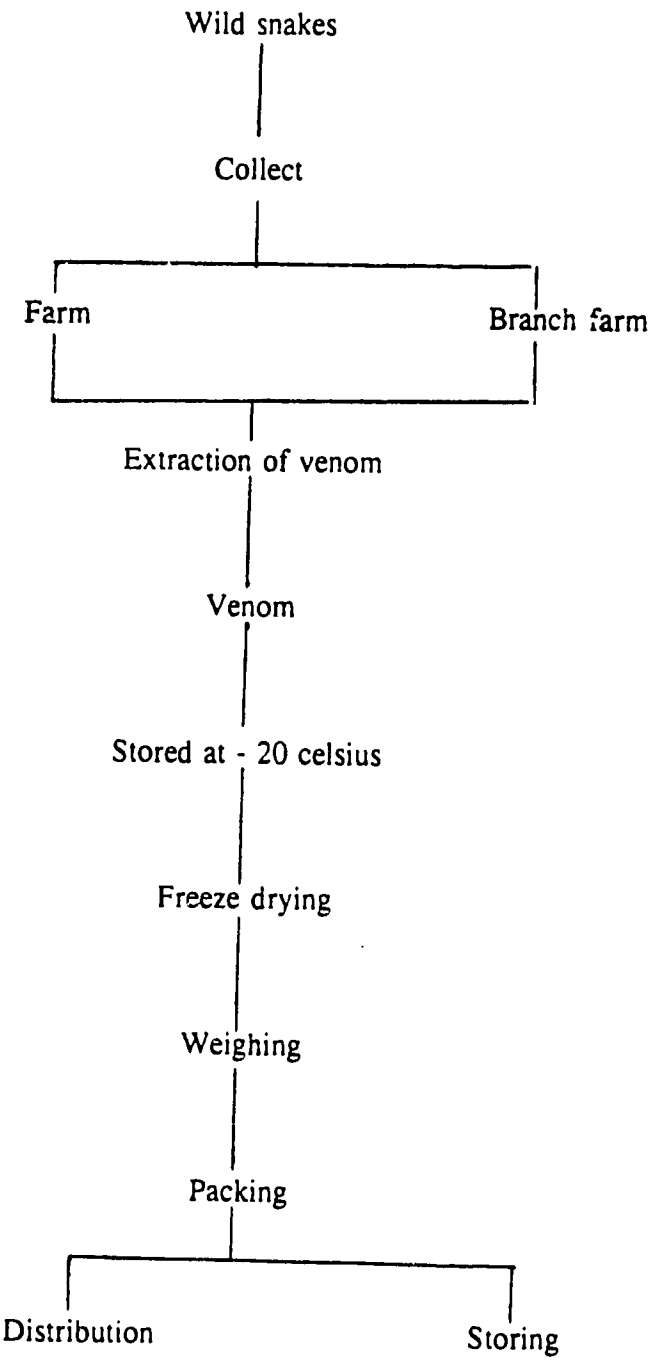
The standard method used in 'milking' snakes in typical farms and venom collecting centers is a simple straight forward technique. The venom is generally extracted immediately on receiving the snakes. The snake is seized by the tail and the head after pinning down the head with a round stick. The venom is collected into a funnel clamped to an upright stand. The funnel leads directly to a sterile container or ampoule. The venom is freeze dried in a standard freeze drying apparatus. The weights of the empty container, with liquid venom and after freeze drying are noted. The venom could be pooled over a period of weeks by keeping the venom at -20 Celsius, after each milking and subsequently freeze dried. The freeze-dried venom is weighed and put into ampoules or containers which are sealed and stored at 4 degrees Celsius.

3.3. Packaging

The freeze dried venom is weighed by a precision electronic balance according to orders received or put into glass vials or bottles in quantities of 1, 10, 50 and 100 mg. and sealed under dry/sterile conditions. These containers will be packed in polystyrene (regiform) containers for delivery or stored at 4 Celsius until required.

3.4. Flow Diagram of Production Process

The operational flow diagrams of processing freeze dried venom is as follows :



3.5. Equipment (laboratory) Required

The equipment required for commercial processing of freeze dried venom are :

a) Snake sticks for catching and pinning down snakes.
b) Safety cabinet for packing dried venom
c) Glass funnel clamped to a firm stand.
d) Deep freezer (- 20 Celsius)
e) Freeze drier with lyophilizing facilities (2 numbers). (Labconco or Modulyo type)
f) Precision electronic balance (to weigh up to 500 grams)
g) Centrifuge
h) Containers for packing freeze dried venom.

Items, c to h, have to be imported directly from abroad or purchased from any reputed local laboratory suppliers. The approximate price for the above items are listed in the Financial analysis (refer annexure 4).

3.6. Buildings, Telecommunications and Transportation

The minimum requirements for buildings are given in Annexure.4.
There should be a good communications system for a new business venture like this, should include Fax machine. As regarding transport in the initial stages a good reconditioned land rover and diesel van is essential. The approximate prices for these items are given in annexure 4.

3.7. Skills and Training Required

Sri Lanka has the necessary expertise to operate a snake farm for the production of freeze dried venom. Hence, the training and skills required by the workers are minimal. Any young motivated adult could be trained as a snake collector in a few days. Training schedule of a collector is given in 4.5. A junior laboratory technician with GCE "O" level passes can be easily trained to handle the centrifuge, freeze drier and the electronic balance. For overall supervision of the snake farm a qualified Herpetologist who will be competent in managing a snake farm should be appointed. The approximate cost for training of the 100 snake collectors are given in the financial analysis.

3.8. Capture and Release vs. Captive Breeding

Two methods are used for the commercial exploitation of snakes in other farms in the world. They are :

a) **Capture and release method**: The wild snakes captured and received by the farm are 'marked' and kept for periods of one to six months when they will be milked, exhibited and studied. At the end of this period these snakes are released back to the same habitat.

b) **Capture and rearing**: In this method the snakes are reared for longer period until the snake dies. This technique will cut down the cost of purchasing snakes, however, high feeding costs, possible infections, disease, low venom output and possible detrimental affects on the environment are likely disadvantages.

c) **Captive breeding**: Milking for large commercial orders from captive bread snakes is not yet practised in the world due to high cost of maintenance and the decreased fertility under captivity, high mortality, delayed reproductive cycle and delay in maturation of the newborn snakes.Hence the better model for the Mahaweli snake farm would be the capture and release method described above. The public opinion against the release of snakes back to the environment could be overcome by implementing a well organized educational program on the importance of snakes in the control of rodent population.

3.9. Possible Levels of Operation

Four scales of operation are proposed. The financial analysis of these four scales are given in annexure 4 tables 1 to 4.

1. Sale of snake venom for manufacture of antivenom serum for Sri Lanka (initially exported to India or any other prospective buyer who will manufacturer antivenom for local needs) and for research only.

2. Sale of snake venoms and other venoms from insects and arthropods.

3. Sale of venoms, tourists attraction, sale of souvenirs, and books on reptiles.

4. Sale of venoms, tourists attraction and other income generating ventures like rental of cafeteria, fees from research students, sale of vegetables and opening branches at Peradeniya or Kurunegala (Refer section 5.1).

4. RAW MATERIAL SUPPLY

4.1. Prevalence of Venomous Snakes

The extent of the whole Mahaweli Project area is approximately 1/3 the total area of the country (Fig.6). Eventhough no estimates of the snake population is available all the types of snakes, arthropods and insects (like bees and wasps) proposed for a snake farm are found in abundance in the area. Furthermore, a very large number of these snakes are killed by the Mahaweli settlers annually. It has been observed that in each Mahaweli system, a minimum of five snakes, mainly the Russell's viper, cobra and non venomous snakes are killed daily in each system. Keeping about 750 snakes of all the species (refer section 4.3) in captivity at a time is not expected to have any significant impact on the ecological balance as the number is a very small percentage of the total snake population of the area. Rodents, are a major group which destroys

agricultural products. The snakes mentioned above (page 1) along with other non venomous snakes play an important role in the ecological control of rodents. Hence snakes are an asset to the Mahaweli program. This project, to some extent will discourage the killings as wide publicity will be given to the community to encourage them to supply live snakes to the center. As a payment will be made for each live snake supplied, this is expected to augment the income of farmers as well.

Furthermore, it is estimated that in Sri Lanka that Ahingkuntakaya or the Gypsies and road side snake showmen catch/receive approximately over 1000 cobras and about 250 Russell's vipers annually which they rear for their livelihood. An unknown number of snakes are caught by people who rear snakes as pets.

Unfortunately, almost all these snakes die eventually without their venom been harnessed.

4.2. Dry Zone Snakes

Traditionally it is believed that the venom of the dry zone snakes are more toxic than the same species inhabiting the wet zone highiands. In fact preliminary observations do indicate this is true. Furthermore, studies conducted in India of the Indian Russell's viper too have shown variation in the venom composition due to geographic origin, also that vipers around Madras were twice as lethal as those from colder Northern India (Delhi).

This means that for production of antivenom for Sri Lanka or eventhough for India, the Mahaweli snakes may be second to none.

4.3. Number of Snakes Milked for Different Scales of Operation

Presently the State Pharmaceutical Corporation imports approximately 60,000 ten ml. vials of antivenom serum annually (Annexure 3) and about 7000 snake bite patients are admitted to western hospitals annually for treatment (table 1). Hence, the number of snakes that should be milked will depend on the venom required for manufacture of antivenom serum for Sri Lanka and or for local needs and export. Thus, two scales of operations are proposed:

a) Requirement for local market.
b) Requirements for local market and export.

Requirement for Local Market

If species specific antivenom serums like what is been used in some other countries (eg. Australia) are available, the effectiveness will be better and the total number of doses required too will be less. On the assumption of using the specific antivenoms the number of snakes required to provide the quantity of freeze dried venom needed for the manufacture of antivenom to meet the local demand is as follows:

Table 2

Number of snakes required to operate scale one
(Quantity of freeze dried venom per month)

Species	Number	Venom Freeze Dried	Price in Rupees
Naja naja	10	2 g.	1,500.00
Daboia russellii	10	2 g.	1,500.00
Bungarus caeruleus	15	0.500 mg	3,000.00
Hypnale hypnale	300	1 g.	22,500.00
Total	335	5.5 g.	28,500.00

Local Requirement and for Export:

The number of snakes required for this operation and the quantity of freeze dried venom that could be collected from them per month is given in Table 3. This number will supply a large quantity of freeze dried venom per month for export after meeting the local needs.

However, in order to make this a commercially viable project the other income generating ventures listed in section 5.1. should be adopted.

Table 3

Number of Snakes required to operate scale two
(Quantity of freeze dried venom per month)

Species	Number	Venom	Price in Rupees
Naja naja	200	40 g.	30,000.00
Daboia russellii	200	40 g.	30,000.00
Bungarus caeruleus	30	1 g.	6,000.00
Bungarus ceylonicus	20	0.500 mg.	4,000.00
T. trigonocephalous	5	1 g.	750.00
Hypnale hypnale	300	1 g.	22,500
Total	755	43.5 g.	93,250.00

4.4. Problems in Securing Raw Material (Snakes)

Of the four main species of snakes (the Cobra, Russell's viper, the Common Krait and the Hump nosed viper) that will be used for venom extraction, the Kraits (*Bungarus caeruleus and B. ceylonicus*) will be difficult to collect/locate from December to May. However, from August to October the kraits are active and may be encountered near human habitations. Hence, krait should be collected during this period and adequate stocks of freeze dried venom should be collected. The Russell's viper, the cobra, scorpions and other insects are usually encountered during the harvesting seasons and with the onset of monsoons in the Mahaweli areas. Hence, these two snakes should be collected during these periods. The Hump nosed viper is not found in abundance in the Mahaweli systems situated in the dry zone. However, it is common in the wet zone specially in the plantations, and could be collected during weeding of plantations like rubber, coffee and cardamom from areas out side the Mahaweli systems.

4.5. Training of Snake Collectors

With the commencement of the project 100 youths selected from System H,B and C should be trained as prospective snake collectors/suppliers. An expert (a herpetologist) should visit the above systems and train the selected youths in batches of 15 to 20. A collector could be trained within two to three days time on how to catch and bag a snake. The training schedule should include lectures, demonstrations and practicals on the following :

a) Identification of snakes with special reference to poisonous snakes.

b) Behavior of snakes.

c) Techniques of catching and bagging a snake. (It should be noted that all the snakes used for initial training should be properly milked before demonstrations).

d) Making simple snake catching implements.

e) Prevention of snake bite.

f) First aid for snake bite.

Each participant should be provided with a set of literature on snakes, a letter or an identity card issued by the snake farm. The names, addresses and national identity cards numbers of the collectors should be forwarded to the Department of Wildlife Conservation for approval. Also the respective hospitals where the collectors operate should be informed to provide easy facilities in case of an snakebite to one of the collectors.

4.6. Ecological Considerations

Our proposal is to keep the snakes in captivity for one to six months for the extraction of venom after which they would be released back to the same environment. This will maintain the ecological balance in the respective areas. The total number of snakes in captivity at any given time should be less than 1000 snakes (refer 4.3). We estimate this to be a very small percentage of the total population of snakes in the Mahaweli area. Therefore, the impact on the ecology is expected to be minimal.

The special training provided to collectors and milkers will ensure that the snakes will not be injured during the process of capture, transport, rearing and milking. Steps should be taken not to anaesthetize or immobilize snakes while milking except on a rare occasion. Furthermore, 60 % of the gravid females collected should be released after milking once, and the balance 40 % should be kept for the captive breeding program.

The snakes after "milking" for one to six months should be "marked" again and released back to its own habitat. This method conforms with the World Conservation Union (IUCN) principal of sustainable utilization of wild species.

5. MANAGEMENT AND ORGANIZATION OF A BUSINESS

5.1. Different Ways to Organize the Business

There are Four main ways to organize the snake farm business:

a) Snake Farm only: where snakes will be milked for the manufacture of antivenom serum for local use and some quantity for export.

b) Farm where snake venoms and other venoms are extracted: According to this system in addition to snake venoms, other venoms such as insects, arthropods would also be milked for commercial purposes.

c) Snake Farm with tourists attraction and in addition, souverniers, books on reptiles will be sold.

d) Snake farm with multi income generating ventures: In addition to what was described above (under c), the following income generating ventures too would make the project commercially viable.

   1) Provide research facilities for a fee from foreign and local students.
   2) Agricultural project where at least 2 hectares around the snake farm will be cultivated.
   3) Rental of a cafeteria.

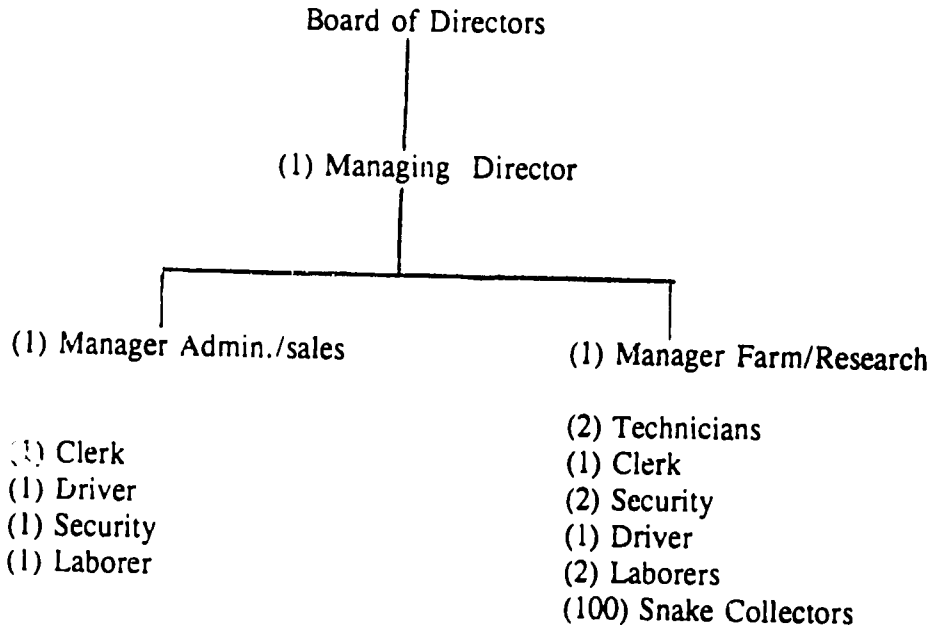
4) Open branches at popular tourist localities such as near Peradeniya Botanical Gardens.

5) Commence a captive breeding and research unit.

The financial analysis of the above four ways of establishing a business are given under financial analysis.

5.2. Management and Organization

A limited liability company should be established and the management of the company shall be through a Board of Directors. A full time Managing Director will be appointed to do the day to day administration. Advice will be sought from foreign institutes dealing with snakes, snake venom and captive breeding and conservation. Provisions for research facilities for local universities and research institutions should be provided. The management of a snake farm multi complex venture will be as follows:



The Board of Directors will consists of the prospective investors and the following personnel on honorary capacity: Director General, Mahaweli Authority, Director Dept of Wild Life Conservation and two representatives from the universities (Colombo and Peradeniya).

5.3. Policy Issues

Approval to collect, rear, breed and to conduct research on snakes, other reptiles, insects and arthropods should be taken from the Department of Wildlife Conservation, Colombo. Inform other relevant government and non-governmental organizations concerned with wildlife and conservation. An environmental assessment report if required should be taken from the Central Environmental Authority, Colombo.

A "group" insurance cover for all workers attached to the project and also for the visitors should be taken. The accidents to the staff and visitors in snake farms abroad are minimal or none. All collectors should be provided with liscens or permits to collect reptiles/insects/arthropods.

The project envisages earnings of valuable foreign exchange, providing health facilities, employment, tourist attraction and conservation of endangered reptiles. Hence an application should be made to the Board of Investment (Greater Colombo Economic Commission) requesting income tax and other concessions given to business in the Free Trade Zone.

6. HUMAN RESOURCE REQUIREMENTS

6.1. Expertise Required

The expertise required for Snake Farm Multi Complex Venture (SFMCV) will be:

One Herpetologist
One Research Assistant/farm manager
Two Technicians

6.2. Training Facilities

Training facilities for the above personnel are available at many International centers like :

a) Japan Snake Institute, Yabazuka, Nitta-gun, Gunma Prefecture, Japan.
b) Thai Red Cross Society, Queen Saovabha Memorial Institute, Bangkok, Thailand
c) Haffkine Bio-Pharmaceuticals Corporation, Parel, Bombay 400 012, India.
d) Serum Institute of India (P) Ltd, 212/2 Hadspsar, Pune 411 028, India.

Training programs and courses range from 1 month to 1 year. Funding for the training of the staff should be requested from USAID, JICA, NORAD.

7. BENEFITS

7.1 Health

It has been estimated that about 65,000 people are bitten by snakes annually in Sri Lanka and snakebite accounts for 700-800 deaths per year and this death rate is one of the highest in the world (table 4). These snake bite patients often rely on local herbal cures due to the belief in the traditional system, easy access to traditional physicians and the ignorance of the availability of an antivenom. Also, the imported anti-venom is not readily available in many hospitals. Over the past decade there has been a steady increase in the number of people seeking western treatment and at present approximately 7000 snake bite patients seek western treatment annually (Table 1). The management of a snakebite patient in a western hospital with antivenom (one course of 100 ml) is estimated to cost between Rs.3000 and 5000, and the cost in the private sector would be double this amount.

Provision of a more effective antivenom produced from local venom is expected to reduce these deaths considerably if it is made available free through the National Health Services.

7.2. Manufacture of Antivenom

By the implementation of this project our own antivenom serum could be manufactured locally. At present, the State Pharmaceuticals Corporation spends about Rs. 12,431,250.00 (imported at US $ 4.25 per ampoule) for the import of antivenom from India (Annexure 3). This imported Indian anti-venom available in Sri Lanka is manufactured using the venom of Indian snakes which differ in some respects from local Sri Lankan varieties. There is considerable variation in the potency and characteristics of snake venom among even the same species from different climatic and geographical environments. Furthermore, recent clinical and laboratory studies have shown that the Indian antivenom has limited efficacy against systemic poisoning by some venomous snakes of Sri Lanka. The Indian polyspecific antivenom is made from the venoms of *Daboia russellii*, *Naja naja*, *Echis carinatus*, *Bungarus caeruleus* but does not include venoms from *Hypnale* species. However, in Sri Lanka, there is a high incidence of bites due to *Hypnale* species (Hump nosed vipers), of which a few patients have even developed acute renal failure leading to death.

It is also possible that antivenom manufactured from Sri Lankan snakes be exported to India and Bangladesh.

Even if the manufacture of antivenom is not undertaken, the project envisages the supply of specific antivenom to neutralize the venoms of Sri Lankan snakes, manufactured in India using the local venoms.

7.3. Employment

Initially, train 100 collectors selected from the Mahaweli settlements (refer 4.5.). These collectors will get an extra income by supplying live snakes to the proposed snake farm at the following estimated prices :

a. Krait (*Bungarus* species) Rs. 200.00 per specimen
b. Cobra/Russell's viper, Green Pit viper Rs. 150.00 per specimen
c. Hump nosed viper Rs. 75.00 per specimen

In addition approximately 15 full time job opportunities will be available.

7.4. Conservation

At present many snakes are killed in the island and specially in the Mahaweli areas. By implementing educational and publicity programs, the people will be discouraged to kill snakes but provide the snakes and earn money. Furthermore, establishment of a non profit making Reptile Research Center affiliated to the World Conversation Union (IUCN), Captive Breeding Specialists Group (USA) and India and the Amphibian and Reptile Research Organization of Sri Lanka (ARROS) will assist the conservation program.

7.5. Research

Our knowledge on the distribution, habits and the biology of even the common snakes is scanty and such studies could be conducted on the snakes received to the farm. Research on the usefulness of venoms in neurobiology, muscle research, treatment of vascular and occlusive diseases and diagnosis of hemostatic disorders could be initiated with the establishment of project of this nature.

7.6. Foreign Exchange Earnings

An appreciable amount of foreign exchange could be earned by the sale of freeze-dried venom and from fees received from foreign students (details of the financial aspects are given in annexure 4).

This income is expected to be far greater than the amount of foreign exchange needed for the purchase of the equipment needed for the enterprise.

7.7. Public Education

Conduct awareness programs on snakes and other reptiles of Sri Lanka to the public and schools.

The summary of the benefits in initiating commercial potential of snake venom is as follows:

1. Provide venom to manufacture specific antivenom serum for Sri Lanka.
2. Provide job opportunities for the Mahaweli settlers.
3. Conservation of snakes.
4. Provide an opportunity to study the ecology of snakes and arthropods inhabiting the Mahaweli as well as the whole country.
5. Provide Public awareness and educational programs on reptiles.
6. Conduct captive breeding of threatened reptiles.
7. Reduce snakebite mortality in Sri lanka.
8. Earn foreign exchange.

8. OPTIONS TO CONSIDER IN ORGANIZATION

As given under financial analysis (annexure 4), it is clear that establishing a snake farm only for the production of freeze dried venom and snake farm tourist attraction only are not commercially profitable. Hence, the only option is to consider in organizing a snake farm with multi income generating ventures (refer 5.1).

9. FINANCIAL ANALYSIS

Revenue is generated from a number of activities such as the sale of snake venoms, sale of other venoms (from bees, scorpion spiders and wasps), tourists attraction including the sale of souverniers, books and also vegetable cultivation, sale of toxoid and toxins. Cash flows have been worked out for the four options as follows:

1. Sale of snake venom only.
2. Sale of snake venoms and other venoms.
3. Sale of all venoms, tourists attraction and including sale of souverniers and books.
4. Sale of venoms, tourists attraction plus others.

A 10 % annual increase in prices is assumed for calculating revenue and expenditure.

The Net Cash Flow:

The net cash flow is the income minus expenditure of the project. It is worked out for a period of 5 years. A discount rate of 8 percent is used for discounting future incomes.

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Sale of venoms only, that is, the first two options results in a loss of 9 to 22 percent over the period. But option 3 give very high returns ranging from 200 to over 700 percent.

Sensitivity Analysis:

Discount rates of 8 %, 10 %, and 20 % are used for this purpose. Options 3 and 4 are variable at all these rates.

The results of the analysis are shown in Annexure 4.

10. RECOMMENDATIONS ON PROJECT LOCATION

The proposed sites are:

10.1. Mahaweli Farm

Of the sites observed, the first and the second best sites for the proposed project is at Ilukegama and Handungama situated in System-H (Annexure 5 and Fig.7). In selecting the sites, the major criteria considered were the extent of the land, availability infrastructure, electricity, water, road access, close proximity to tourist routes/attractions etc.(Annexure 5). The site at Ilukegama, with an extent of about 4 hectares, with infrastructure (with approximately six large stores 30 x 60 ft), water and electricity facilities available is considered suitable for the proposed project.

10.2. Peradeniya Branch

A suitable land (minimum 1/8 hectares) near Peradeniya botanical gardens has to be identified.

10.3. North Central Province Branch

There is scope and facilities for establishing a branch at Kurunegala or in a suitable location in the North Western Province with the assistance of the NWP Provincial Council.

11. RISKS

The risk of getting bitten by venomous snakes to field and laboratory staff could be reduced by proper training in handling, milking, capturing and proper housing of snakes. A supply of anti-venom serum, Adrenalin and Hydrocortisone with sterile disposable 10 ml , 2 ml and 1 ml injection syringes with needles should be kept at a readily and easily accessible place at the center to be taken along with the patient to the hospital. Active immunization of the staff attached to the snake farm should be looked into. Accidents at other snake farms had been minimal or nil.

It is also proposed to stock antivenom in all the medical institutions of the Mahaweli system, specially where the snake collectors are operating. Refresher course on the latest and proven methods in the management of snakebite for the medical and para medical staff at these institutions should be undertaken.

Risks the potential investors will meet are :

1) Due to the seasonal activities of krait, the suppliers will not be able to provide these snakes. Hence to overcome this, krait should be captured in excess and milked during their active periods (eg. September to November).

2) Due to the use of modern equipment the quantity of venom used for research will decrease as earlier equipment required large quantities.Nevertheless, the demand for antivenom will continue. Also there is a reasonable world demand and market for toxins (eg.cobratoxin). These financial risks could be effectively managed by making the snake farm a multi income generating venture (Ref 5.2.) where a steady income is expected.

12. STATEMENT OF FEASIBILITY

Setting up a snake venom business with tourist attraction and other income generating ventures is not only economically profitable but also will help Sri Lanka with a specific antivenom serum thereby reducing the high mortality due to snakebite envenoming, provide jobs/income for few hundred people and provide a center for studies on snakes of Sri Lanka.

The technical and managerial aspects of rearing , milking and freeze drying venom is simple and do not involve high technology. The freeze dried venom is stable for at least 25 years. There is a potential International market for the freeze dried venom, mainly to manufacture antivenom serum and for research. As regards antivenom serum there is a steady increase in the world demand for it. Sri Lanka has the necessary raw material (snakes, insects and arthropods), human resources and expertise required to run the snake venom business.

ANNEXURE 1

SOME PRODUCERS OF TROPICAL ANTIVENOMS

Serum Institute of India (P) Ltd,
212/2 Hadspsar,Pune 411 028, India.

Haffkine Bio-Pharmaceuticals Corporation,
Parel, Bombay 400 012, India.

Instituto Butantan
Av Vital Brazil, CP 65 Sao Paulo, Brazil

Thai Red Cross Society, Queen Saovabha Memorial Institute, Bangkok, Thailand

Institut d'Etat des Serums et Vaccins,
Razi Hessarek BP 656, Teheran, Iran

Pasteur Vaccins, Parc Industrial d'Incarville
277100 Val de Reuil, France

National Institute of Health, Biological Production Division, Islamabad, Pakistan

Commonwealth Serum Laboratories,
45 Popular Road, Parkville, Victoria 3052, Australia

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ANNEXURE 2

PROSPECTIVE BUYERS OF SRI LANKAN VENOMS

Haffkine Bio-Pharmaceuticals Corporation,
Parel, Bombay 400 012, India.

Serum Institute of India (P) Ltd,
212/2 Hadspsar,Pune 411 028, India.

Japan Snake Institute,
Yabasuka, Nitta Gun, Gunma Prefecture, Japan.

Venom Suppliers, P.O.Box 547,
Tanunda, South Australia.

Sigma Chemical Company,
St. Louis, USA.

Universities conducting venom research.

ANNEXURE 3

ANTIVENOM SERUM IMPORTED TO SRI LANKA

Year	Supplier	Quantity	Price/vial
1989	Serum Institute, India	40,000	Rs. 224.44
1990	Serum Institute, India	24,120	Rs. 223.61
1991	Serum and State Trading, India	64,600	Rs. 208.68
1992	Serum and State Trading, India	55,720	Rs. 182.87

Source: State Pharmaceuticals Corporation, Colombo. (Personal Communication, November, 1992)

Annexure 4

FINANCIAL ANALYSIS

CASH FLOW ANALYSIS

INFLOW	Year 1		Year 2		Year 3		Year 4		Year 5	
Sale of venoms										
venom from cobras,										
kraits, vipers	1,468,800.00		1,615,500.00		1,777,000.00		1,954,700.00		2,150,200.00	
venom from other										
snakes	360,000.00		396,000.00		435,500.00		479,000.00		526,900.00	
other venoms	105,000.00	1,933,000.00	115,000.00	2,126,500.00	126,500.00	2,339,000.00	139,200.00	2,572,900.00	153,100.00	2,830,200.00
Gate collection										
Mahaweli Centre	756,000.00		830,000.00		913,000.00		1,004,300.00		1,104,700.00	
Peradeniya Centre	2,700,000.00	3,456,000.00	2,970,000.00	3,800,000.00	3,267,000.00	4,180,000.00	3,593,700.00	4,598,000.00	3,953,100.00	5,057,800.00
Sale of Souvenirs, books etc,										
Souvenirs	6,000,000.00		6,600,000.00		7,260,000.00		7,986,000.00		8,784,600.00	
Books	7,230,000.00		7,953,000.00		8,748,000.00		9,622,800.00		10,585,100.00	
Photographs	3,000,000.00	16,230,000.00	3,300,000.00	16,860,000.00	3,630,000.00	19,638,000.00	3,993,000.00	21,601,800.00	4,392,300.00	23,762,000.00
Cafetaria - Rental	36,000.00	36,000.00	39,600.00	39,600.00	43,500.00	43,500.00	47,900.00	47,900.00	52,700.00	52,700.00
Fees from research students										
(Rs. 100,000/-pa)	500,000.00	500,000.00	550,000.00	550,000.00	605,000.00	605,000.00	665,500.00	665,500.00	732,000.00	732,000.00
Public Education										
and Mobile Exhibitions	60,000.00	60,000.00	66,000.00	66,000.00	72,600.00	72,600.00	79,900.00	79,900.00	87,900.00	87,900.00
Vegetables	315,000.00	315,000.00	346,500.00	346,500.00	382,000.00	382,000.00	420,200.00	420,200.00	462,200.00	462,200.00
Sale of Tonnid & Toxins					5,200,000.00	5,200,000.00	5,720,000.00	5,720,000.00	6,292,000.00	6,292,000.00
Total		22,530,000.00		23,788,600.00		32,460,000.00		35,706,200.00		39,276,800.00

CASH FLOW ANALYSIS (ASSUMING INFRA STRUCTURAL FACILITIES ARE PROVIDED BY MAHAWELI AUTHORITY)
(REFER SECTION 10.1)

OUTFLOW	Year 1		Year 2		Year 3	
Capital expenditure						
Buildings						
Snake pits	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00
Equipment						
Laboratory Equipment						
Deep Freezer	50,000.00		50,000.00		50,000.00	
Refrigerator	30,000.00		30,000.00		30,000.00	
Freezed Drier	375,000.00		375,000.00		375,000.00	
Electronic Chemical Balance	65,000.00		65,000.00		65,000.00	
Mincer	10,000.00		10,000.00		10,000.00	
Glass Ware	50,000.00		50,000.00		50,000.00	
Ampoles	900,000.00		900,000.00		900,000.00	
		1,480,000.00		1,480,000.00		1,480,000.00
Office Equipment						
Typewriter	20,000.00		20,000.00		20,000.00	
Photocopier	125,000.00		125,000.00		125,000.00	
Telephone	100,000.00		100,000.00		100,000.00	
Fax Machine	125,000.00		125,000.00		125,000.00	
Office Furniture	200,000.00		200,000.00		200,000.00	
Bungalow Furniture	400,000.00		400,000.00		400,000.00	
		970,000.00		970,000.00		970,000.00
Vehicles						
Land Rover	600,000.00		600,000.00		600,000.00	
Diesel Van	400,000.00	1,000,000.00	400,000.00	1,000,000.00	400,000.00	1,000,000.00
Contingency Provision (10%)	721,000.00	355,000.00	721,000.00	355,000.00	721,000.00	355,000.00
Total		3,905,000.00		3,905,000.00		3,905,000.00

OUTFLOW	Year 1		Year 2		Year 3		Year 4		Year 5	
Capital expenditure										
Buildings										
Snake pits	100,000.00		100,000.00		100,000.00		100,000.00		100,000.00	
Office	640,000.00		640,000.00		640,000.00		640,000.00		640,000.00	
Laboratory	320,000.00		320,000.00		320,000.00		320,000.00		320,000.00	
Snakes house	200,000.00		200,000.00		200,000.00		200,000.00		200,000.00	
Stores	160,000.00		160,000.00		160,000.00		160,000.00		160,000.00	
Small animal House	160,000.00		160,000.00		160,000.00		160,000.00		160,000.00	
		1,580,000.00		1,580,000.00		1,580,000.00		1,580,000.00		1,580,000.00
Residential Quarters										
Bungalow (big) 1200 sq ft.	580,000.00		580,000.00		580,000.00		580,000.00		580,000.00	
Bungalow (small)	400,000.00		400,000.00		400,000.00		400,000.00		400,000.00	
Two roomed Bungalow	400,000.00		400,000.00		400,000.00		400,000.00		400,000.00	
Labour quarters	400,000.00		400,000.00		400,000.00		400,000.00		400,000.00	
Restaurant	400,000.00		400,000.00		400,000.00		400,000.00		400,000.00	
		2,180,000.00		2,180,000.00		2,180,000.00		2,180,000.00		2,180,000.00
Equipment										
Lab. equipment										
Deep Freezer	50,000.00		50,000.00		50,000.00		50,000.00		50,000.00	
Refrigerator	30,000.00		30,000.00		30,000.00		30,000.00		30,000.00	
Freeze Drier	375,000.00		375,000.00		375,000.00		375,000.00		375,000.00	
Electronic Chemical Balance	65,000.00		65,000.00		65,000.00		65,000.00		65,000.00	
Mincer	10,000.00		10,000.00		10,000.00		10,000.00		10,000.00	

Glass Ware	50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		
Ampules	900,000.00		900,000.00		900,000.00		900,000.00		900,000.00		
		1,480,000.00		1,480,000.00		1,480,000.00		1,480,000.00		1,480,000.00	
Office Equipment											
Typewriter	20,000.00		20,000.00		20,000.00		20,000.00		20,000.00		
Photocopier	125,000.00		125,000.00		125,000.00		125,000.00		125,000.00		
Telephone	100,000.00		100,000.00		100,000.00		100,000.00		100,000.00	100,000.00	
Fax Machine	125,000.00		125,000.00		125,000.00		125,000.00		125,000.00		
Office Furniture	200,000.00		200,000.00		200,000.00		200,000.00		200,000.00		
Bungalow Furniture	400,000.00		400,000.00		400,000.00		400,000.00		400,000.00		
		970,000.00		970,000.00		970,000.00		970,000.00		970,000.00	
Vehicles											
Land Rover	600,000.00		600,000.00		600,000.00		600,000.00		600,000.00		
Diesel Van	400,000.00	1,000,000.00	400,000.00	1,000,000.00	400,000.00	1,000,000.00		1,000,000.00		1,000,000.00	
Contingency Provision (10%)	721,000.00	721,000.00	721,000.00	721,000.00	721,000.00	721,000.00	721,000.00	721,000.00	721,000.00	721,000.00	
Total		7,931,000.00		7,931,000.00		7,931,000.00		7,931,000.00		7,931,000.00	

Rate of Inc.	1st year		2nd year		3rd year		4th Year		5th year	
Re-current expenditure										
Consumables 10%										
Chemicals	50,000.00		55,000.00		60,500.00		66,500.00		73,200.00	
Snake food	100,000.00		110,000.00		121,000.00		133,100.00		146,400.00	
Stationery	100,000.00		110,000.00		121,000.00		133,100.00		146,400.00	
Packing and Transport	100,000.00	350,000.00	110,000.00	385,000.00	121,000.00	423,500.00	133,100.000	465,800.00	146,400.00	512,400.00
Personnel-wages and salaries 10%										
Managing Director	120,000.00		132,000.00		145,200.00		159,700.00		175,700.00	
Manager/Administration	96,000.00		105,600.00		116,200.00		127,800.00		140,600.00	
Manager/Farm	96,000.00		105,600.00		116,200.00		127,800.00		140,600.00	
Technicians (2)	96,000.00		105,600.00		116,200.00		127,800.00		140,600.00	
Clerks (2)	72,000.00		79,200.00		87,100.00		95,800.00		105,400.00	
Security guards (3)	72,000.00		79,200.00		87,100.00		95,800.00		105,400.00	
Drivers (2)	48,000.00		52,800.00		58,100.00		63,680.00		70,000.00	
Provident Fund	100,000.00		110,000.00		121,000.00		133,100.00		146,400.00	
ETP - (3%)	20,200.00		22,220.00		24,400.00		26,900.00		29,600.00	
		720,200.00		792,200.00		871,500.00		958,400.00		1,054,300.0
Snake collection 10%										
Training of Youth	62,500.00									
Snake sticks	50,000.00									
Snake boxes	50,000.00	162,500.00								
Cost of tickets (printing)	54,600.00		60,000.00		66,000.00		72,600.00		79,900.00	
Souvenirs (cost)	300,000.00		330,000.00		363,000.00		399,300.00		439,200.00	
Books(printing cost)	1,641,600.00		1,805,000.00		1,986,400.00		2,185,000.00		2,403,500.00	
Tomid & Tomins					2,069,500.00		2,276,500.00		2,504,200.00	
Vegetables (cop)	150,000.00		165,000.00		181,500.00		199,700.00		219,700.00	
		2,146,200.00		2,360,000.00		4,666,400.00		5,133,100.00		5,646,500.00
Total		3,378,900.00		3,537,200.00		5,961,400.00		6,557,300.00		7,213,200.00

	1st year		2nd year		3rd year		4th Year		5th Year	
BF		3,378,900.00		3,537,200.00		5,961,400.00		6,557,300.00		7,213,200.00
Miscellaneous										
10% Fuel	62,000.00		68,200.00		75,000.00		82,500.00		90,750.00	
05% Insurance	60,060.00		66,000.00		72,600.00		79,900.00		87,900.00	
10% Directors-Honorarium	168,000.00		184,800.00		203,300.00		223,600.00		246,000.00	
10% Communications	120,000.00		132,000.00		145,200.00		159,700.00		175,700.00	
10% Snakes	186,500.00		205,150.00		225,700.00		248,300.00		273,100.00	
10% Electricity, Water	120,000.00		132,000.00		145,200.00		159,700.00		175,700.00	
10% Maintenance Buildings(05%)	20,400.00		22,400.00		24,600.00		27,100.00		29,800.00	
10% Maintenance Equipment (05%)	122,500.00		134,750.00		148,200.00		163,000.00		179,300.00	
Turnover Tax (at 15% per year)	3,379,500.00	4,238,900.00	3,568,300.00	4,513,600.00	4,089,000.00	5,128,800.00	5,355,900.00	6,499,700.00	5,891,500.00	7,149,750.00
Total expenditure before Depreciation		7,617,800.00		8,050,800.00		11,090,200.00		13,057,000.00		14,362,950.00
Depreciation - Buildings 50 years		81,600.00		81,600.00		81,600.00		81,600.00		81,600
Depreciation - Equipment 15 years		163,300.00		163,300.00		163,300.00		163,300.00		163,30
Depreciation - Vehicles 10 years		100,000.00		100,000.00		100,000.00		100,000.00		100,000.
Total expenditure after depreciation		7,962,700.00		8,395,700.00		11,435,100.00		13,401,900.00		14,707,850.00
Profit/Loss for the year (after depreciation)		14,567,300.00		15,392,900.00		21,024,900.00		22,304,300.00		24,568,950.00
Rate of return on capital		183.7%		194.1%		265.1%		281.2%		309.
Rate of return on Equity		373.0%		394.2%		538.4%		571.1%		629

Table 1

Option 1 (in Rs.)

	Year 1	Year 2	Year 3	Year 4	Year 5
Income					
Snake venom only	1,928,000	2,011,500	2,212,500	2,433,700	2,667,000
Expenditure					
Exp. after dep.	2,784,100	2,848,800	3,099,500	3,376,500	3,671,500
Net cash flow	(956,100)	(837,300)	(887,000)	(942,800)	(1,004,500)
Rate of return on investment	(12.1)	(10.6)	(11.1)	(11.8)	(12.6)
Rate of return on Equity	(24.5)	(21.4)	(22.7)	(24.1)	(25.7)
Discounted Cash Flow					
(i) D.C.R. .08 NPV (3,644,216)	(885,349)	(717,566)	(704,278)	(652,958)	(684,065)
(ii) D.C.R. 0.10 NPV (3,494,569)	(869,095)	(691,610)	(666,137)	(643,932)	(623,795)
(iii) D.C.R. 0.15 NPV (3,086,971)	(831,807)	(632,999)	(583,646)	(539,282)	(499,237)
(iv) D.C.R. 0.20 NPV (2,749,329)	(796,431)	(581,086)	(513,573)	(454,430)	(403,809)

D.C.R. Discount Rate; NPV - Net Present Value

Table 2

Option 2 (in Rs.)

	Year 1	Year 2	Year 3	Year 4	Year 5
Income					
Snake venom & other venoms	1,933,000	2,126,500	2,339,000	2,572,900	2,830,200
Expenditure					
Exp. after depreciation	2,799,800	2,866,100	3,086,600	3,396,300	3,608,000
Net cash flow	(866,800)	(739,600)	(747,600)	(823,400)	(777,800)
Rate of return on investment	(10.9)	(9.3)	(9.4)	(10.4)	(9.8)
Rate of return on Equity	(22.2)	(16.9)	(19.1)	(21.1)	(19.9)
Discounted Cash Flow					
(i) D.C.R. .08 NPV (3,165,000)	(802,657)	(633,837)	(593,594)	(605,199)	(529,682)
(ii) D.C.R. 0.10 NPV (3,005,700)	(787,921)	(610,910)	(561,448)	(562,382)	(483,014)
(iii) D.C.R. 0.15 NPV (2,662,700)	(754,116)	(559,137)	(491,921)	(470,985)	(386,567)
(iv) D.C.R. 0.20 NPV (2,377,800)	(722,044)	(513,282)	(432,860)	(396,879)	(312,676)

Table 3

Option 3 (in Rs.)

	Year 1	Year 2	Year 3	Year 4	Year 5
Income					
Snake venom, other venoms and Tourism	21,619,000	22,786,500	26,157,000	28,772,700	31,650,000
Expenditure					
Exp. after depreciation	5,752,700	5,965,100	6,691,200	6,934,000	7,542,300
Net cash flow	15,866,300	16,821,400	19,465,800	21,838,700	24,107,700
Rate of return on investment	199.4	212.1	245.4	275.4	304.0
Rate of return on equity	406.3	430.8	498.5	559.2	617.4
Discounted Cash Flow					
(i) D.C.R. .08 NPV 77,032,000	14,692,193	14,415,939	15,455,845	16,051,444	16,417,343
(ii) D.C.R. .10 NPV 70,835,600	14,422,466	11,907,565	14,618,815	14,915,832	14,970,881
(iii) D.C.R. .15 NPV 63,802,400	13,803,681	12,716,978	12,808,496	12,491,736	11,981,526
(iv) D.C.R. .20 NPV 56,379,300	13,216,627	11,674,405	11,270,698	10,526,253	9,691,295

Option 4 (in Rs.)

	Year 1	Year 2	Year 3	Year 4	Year 5
Income					
Income from all sources	22,530,000	23,788,600	32,460,200	35,706,200	39,276,800
Expenditure					
Exp. after dep.	7,962,700	8,395,700	11,435,100	13,401,900	14,707,850
Net cash flow	14,567,300	15,392,900	21,024,200	22,304,300	24,568,950
Rate of return on investment	183.7%	194.1%	265.1%	281.2%	309.7%
Rate of return on Equity	373.0%	394.2%	538.4%	571.1%	629.2%
Discounted Cash Flow					
(i) D.C.R. .08 NPV 76,631,000	13,620,425	13,191,715	16,693,770	16,393,660	16,731,024
(ii) D.C.R. .10 NPV 72,237,100	13,241,675	12,714,535	15,789,699	15,233,836	15,257,317
(iii) D.C.R. .15 NPV 63,113,800	12,673,551	11,637,032	13,834,384	12,758,059	12,210,768
(iv) D.C.R. .20 NPV 55,508,500	12,134,560	10,682,672	12,173,417	10,750,672	9,767,179

ANNEXURE 5

ALLOTMENT DATA OF THE TWO PROPOSED LOCATIONS

	Illukegama Stores Complex	**Handungama Circuit Bungalow Complex**
Block/Zone	Block 104-Madatugama H7 Area (plan 2042)	Block 302-Handungama H 1 Area
Extent	Approx. 10 acres	Approx. 10 acres
Access	Gravel road	Tarred road
From Kekirawa main road	3 Km	24 Km
Electricity	Available	Available
Water: Tap Well Stream	Available No Yes	Available No Yes
Infrastructure	All available	All availalbe
Landscape	Scrub - poor	Good
Topography	Flat	Undulating (part)
Drainage	Good	Good
Soil	Reddish brown earth	Reddish brown
Rainfall	1500-2000 mm October/January heavy rains	1500-2000 mm October/Janaury heavy rains
Temperature	25°C - 36°C	25°C - 36°C
Closest town	Kekirawa (3 Km)	Galnewa (2 Km)
Schools	Kekirawa	Galnewa
Security	Kekirawa Police	Galnewa Police
Tourist route	3 Km	24 Km

LIST OF TABLES

Table 1

Distribution of Snakebite Patients Admitted to Hospitals Sri Lanka, 1980 to 1990

	YEAR									
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NA	966	1562	2225	2452	3690	4737	5431	6687	7199	7621

NA = Number of snakebite patients admitted
Source: Medical Statistician.

Table 4

Three Countries with High Snakebite Mortality

	Burma	India	Sri Lanka
Rate/100,000 population	3.3	4.9	5.7
Period	1969-78	1974-75	1970-79

Source :

M Aung-Khin(1980) The problem of snakebite in Burma. Proc. Intern. Sem. Epidemiology and Med. Treatment of snakebites, Japan; 125-127.

B B Gaitonde & S Bhattacharya (1980) An epidemiological survey of snakebite cases in India. Proc. International Sem. Epidemiology and Med. treatment of snakebites, Japan; 129-133.

Anslem de Silva & L Ranasinghe (1983) Epidemiology of snake-bite in Sri Lanka; a review. Ceylon Medical Journal, 28 : 144-154.

Fig. 3

Bungarus caeruleus (English-Common Krait; Sinhala- Thel [illegible],
Tamil- [illegible])

Fig. 4

[illegible]

Fig. 1

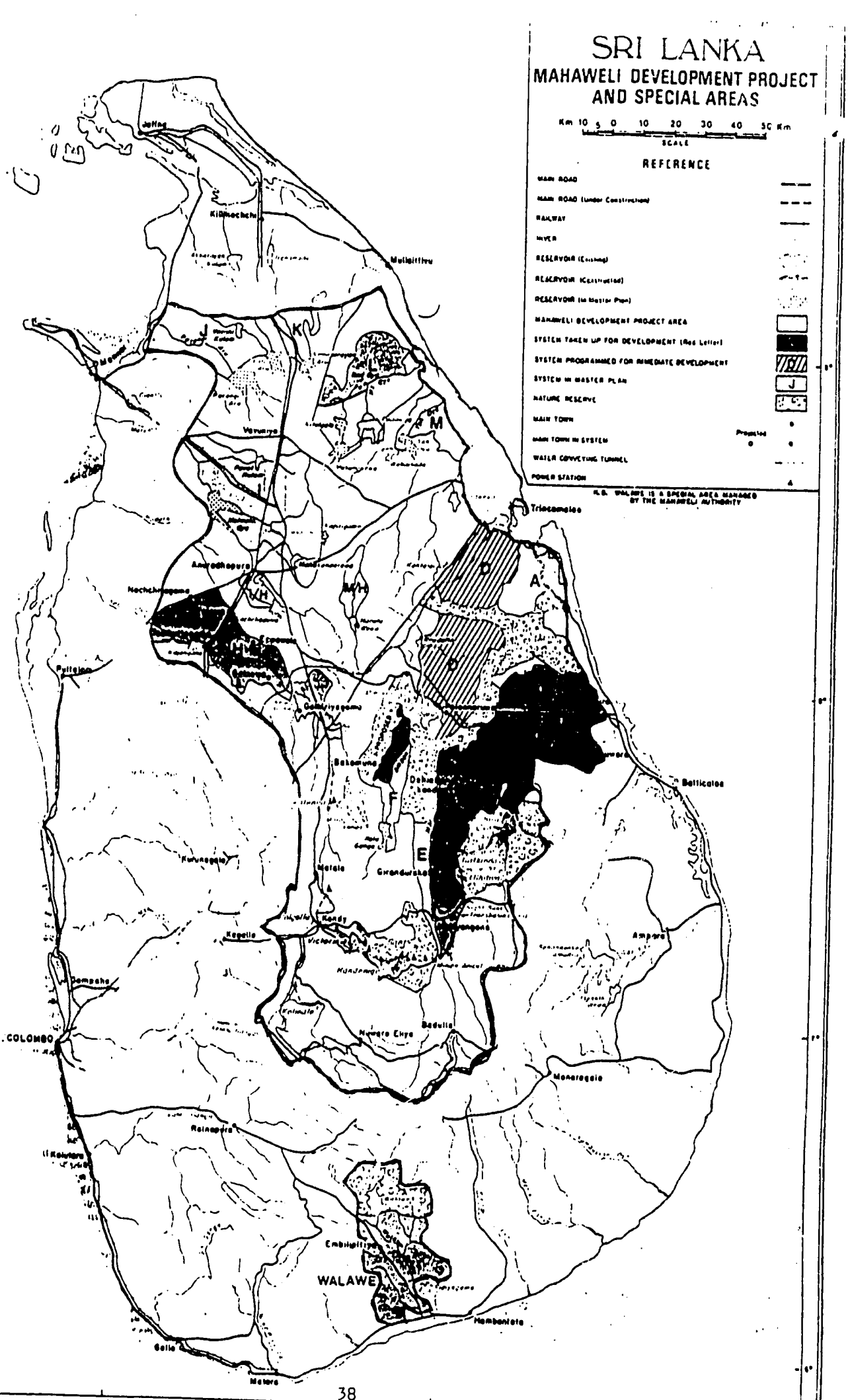
(English-The Cobra; Sinnala-

Tamil-

Fig. 2

Fig. 5

Echis carinatus (English-Saw scaled viper; Sinhala - *Vali polonga*; Tamil - *Surattai parbu*)



Planning & Monitoring Unit, Mahaweli Authority of Sri Lanka, September 1988

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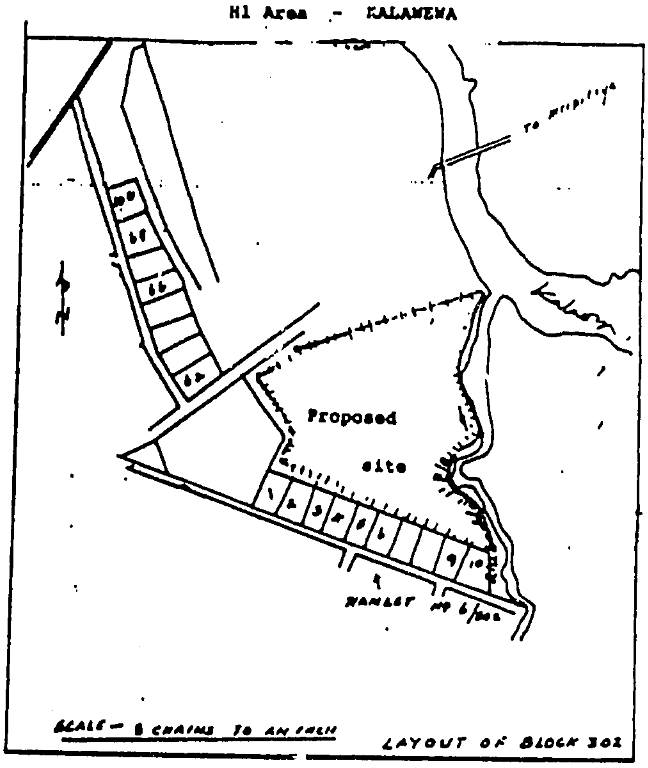
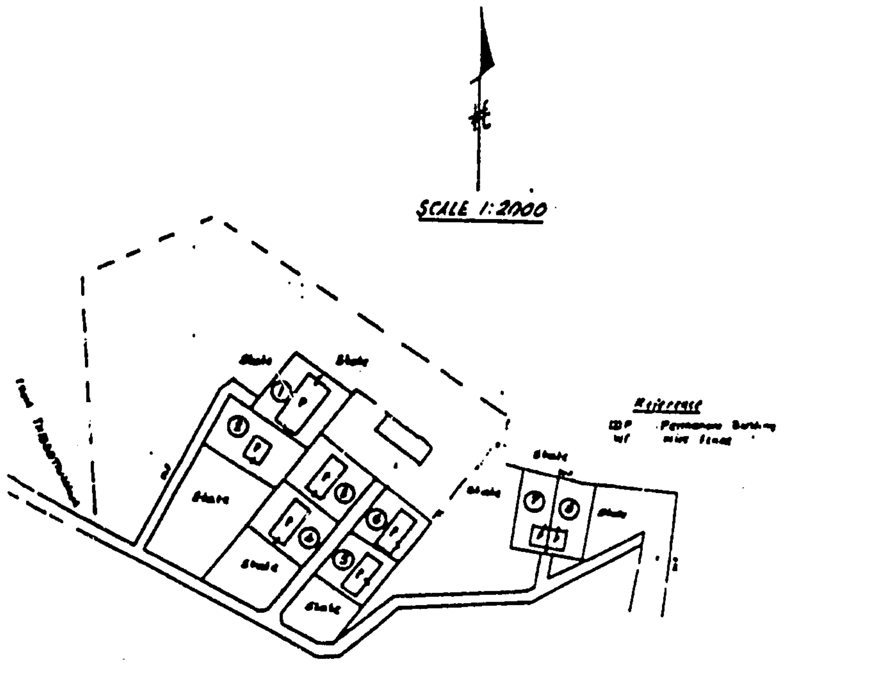
H1 Area - KALAWEWA



PLAN No 2042

BLOCKING OUT PLAN TO INCLUDE VACANT BUILDINGS IN H-AREA, MEA

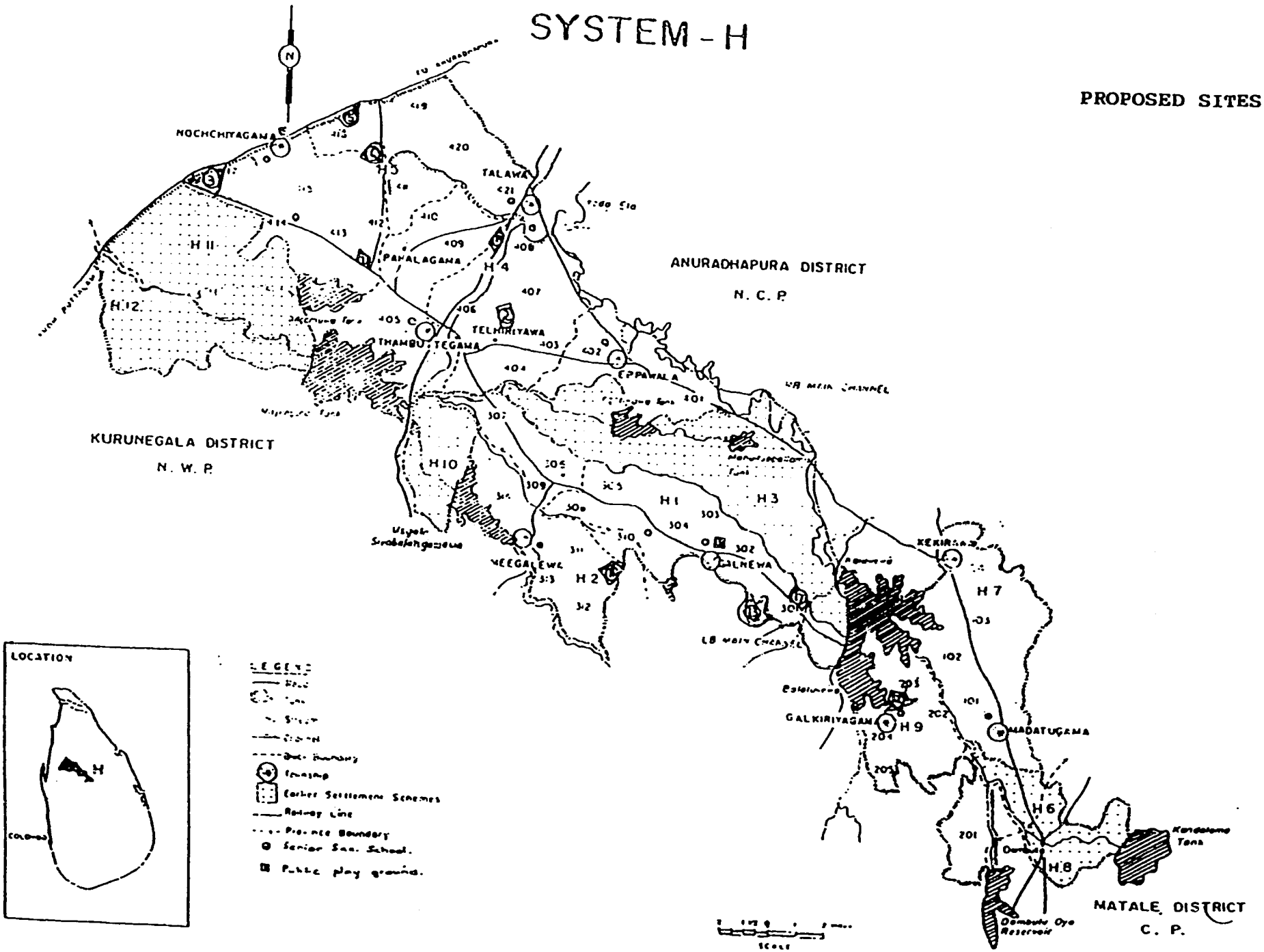


SHEDULE

LOT No	EXTENT HECTARE	TYPE OF BUILDING	BUILDING NO
1	0.0998	State	
2	0.0868	State	
3	0.0832	State	
4	0.0838	State	

LOT No	EXTENT HECTARE	TYPE OF BUILDING	BUILDING NO
5	0.0658	State	
6	0.0625	State	
7	0.0516	[illegible]	11
8	0.0560	[illegible]	12

SYSTEM - H



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