TCP/SRL/6614
Field Document 1

TECHNICAL COOPERATION PROGRAMME

DISEASE PREVENTION AND HEALTH MANAGEMENT IN COASTAL SHRIMP CULTURE

SRI LANKA

BASED ON THE WORK OF

DR. SIMON J. FUNGE-SMITH
FAO CONSULTANT SHRIMP HEALTH MANAGEMENT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Bangkok, May 1997

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The Food and Agriculture Organization is greatly indebted to the organizations and individuals who assisted in the implementation of the project by providing information, advice and facilities.

TABLE OF CONTENTS

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The enthusiasm of all those involved in the implementation of this project is commendable, and gives great hope for its future potential.

As always, FAO/RAP have been helpful in numerous ways

1.STATE OF SHRIMP FARMING IN SRI LANKA (NORTHWEST COAST)

The shrimp culture sector in Sri Lanka is a relatively new industry, and is currently facing many of the problems encountered previously in other countries. The technical knowledge base of the majority of the shrimp fanners is very low and becoming increasingly so, as more small scale farms are developed. Shrimp farming is still relatively small scale in Sri Lanka with a total area of approximately 2600 ha. These farms can be broken down as follows:

Area (ha)	% of total area
> 20	32
10 – 20	9
4.5 – 10	15
2 – 4.5	10
Below 2	6
Unregistered farms	28

The majority of the unregistered farms have encroached into reserved areas and are small farm operations - their size generally being below 2 -3 ha. Farms over 4 ha are required to fulfill Initial Environmental Examination (IEE) or Environmental Impact Assessment; small farms are exempted from this and this has contributed to the proliferation of small illegal operations.

Small farms are usually owner operated and do not have a high level of technical input. There appears to be some form of technical service available whereby farmer groups are visited by local consultants. Large farms have well trained managers - often with overseas experience. There is currently no governmental extension capacity to train farmers - it is the development of this, that is one of the goals of this TCP project. ***It is the lack of accurate information available to the farmers that results in inappropriate farming techniques, disease and production losses***

Plans are currently underway to develop shrimp farms in other parts of the country - utilizing seawater abstracted from the sea (full salinity) and not the brackishwater usually found in the Northwest Province lagoon systems. Culture in full strength seawater is possible providing a regular water exchange regime is practiced. Alternatively culture should only take place during the monsoon or rains seasons, to prevent excessive salinity in the ponds. Before these developments proceed further, it is important to establish the principal factors underlying the disease problems in the Sri Lankan shrimp industry. ***There is also the consideration that this area may provide*** *much* ***of the countries broodstock - and the development of shrimp farms in this area would certainly increase the risk of contamination of the broodstock supply***

Hatcheries

Prior to 1995 there were few hatcheries in Sri Lanka and postlarvae had been imported from Thailand and India. These postlarval imports are the most likely source of the Systemic Ectodermal and Mesodermal Baculovirus (SEMBV), the white spot virus disease infection to the farms. After it became known that this practice was occurring, the Ministry of Fisheries and Aquatic Resources (MOFARD) banned the import of postlarvae (1994), but illegal imports are thought to have continued on a small scale . This action might have been too late since SEMBV struck the farms in the northern part

of the lagoon system in 1996 (Puttlam district). SEMBV has subsequently spread southwards through this lagoon and canal system. The high price for Sri Lankan postlarvae (125 cents, May 1996) made it profitable to smuggle or import postlarvae, but subsequent to the farms developing SEMBV related problems the price dropped to 50 cents (June, 1996) and is currently 40 cents (May, 1997).

There are now between 40 - 60 small hatcheries located in the Chilaw district of the northwest Province and these supply postlarvae to local farms. Many have closed due to the low profitability of the operation and lack of demand from farms. Large farms usually have their own hatcheries and are self sufficient for postlarvae. Broodstock for the hatcheries are collected from the south of Sri Lanka and transported to the hatchery areas for spawning and larval production.

Due to the high hatchery production capacity, prices have fallen considerably. This has a positive and negative angle - farmers are no longer inclined to smuggle postlarvae from India (a country with widespread SEMBV problems), but the low price has resulted in farmers doubling stocking densities.

A potential outcome of this project is the increased understanding by farmers, that to pay more for postlarvae that are good quality is actually saving money in the long term. If screening of postlarvae becomes routine and poor quality postlarvae are discarded, then prices for postlarvae will increase. The farmers must first appreciate that this is a positive health management action that will benefit their operation.

It has now been demonstrated that SEMBV can be present in postlarvae and that this can be a significant route of infection of the disease to shrimp grow-out ponds. The health status of the broodstock shrimp used in hatcheries is currently unknown.

There is a possibility that the broodstock shrimp in Sri Lanka are not infected with SEMBV, but this needs to be established. If this is not the case then the the principal route of infection must be occurring at a different stage of the culture cycle. Obvious candidates are : hatcheries (these are located in the midst of the shrimp culture area) or carrier crustaceans (white shrimp that are found in the culture ponds and in the waters outside the farms).

If the routes of infection for SEMBV can be closed by appropriate management techniques, then the threat of this viral disease can be minimised. It must be stressed that SEMBV is only one cause of production problems and stock loss in Sri Lankan shrimp farming; prevention of this disease still leaves many other conditions that need to be dealt with *(e.g.* black gill, fouling, vibriosis, slow growth).

Grow-out

It is apparent that many management based problems are occurring in Sri Lankan shrimp ponds. Many farmers complain of stock losses and attribute these to SEMBV, since it is an easy targe:. Actually, many of the problems in the farms are caused by farmers' response to the perceivei threat of SEMBV. This is paradoxical since it is the management strategies adopted to avoid SEMBV that predispose the shrimp to other disease conditions.

Sri Lankan shrimp farms typical characteristics are :

- Low number of Taiwanese style (2 vane, 1 hp) paddlewheels per pond (typically 2-4 per acre)
- Water depth 1.1 -1.2 metres

- Acid soils
- Submersible pumps (low flow capacity)
- Stocking density 17-30.m^{-2}
- Fast growth rate (35 grams in 120 days, except where salinity is high)
- Reported FCR approximately 1.2 - 1.3 (although higher was encountered at several farms >1.8)
- Low water exchange
- Poorly cleaned pond bottom
- Tendency towards acid soils
- Poor inlet water quality (almost all farms are on the lagoon/ Dutch canal system)

In response to increasing production problems in the Sri Lankan shrimp culture sector, farmers have modified their culture practices, principally by reducing water exchange. In the case of small farmers this has taken the form of zero water exchange when nearby ponds have a disease problem. In larger farms production ponds have been converted to reservoirs, and water treatment and recirculation may be performed.

When farms do not clean the pond bottoms effectively their subsequent crop already starts with a higher organic loading on the system. This increases oxygen demand by the pond and my cause overblooming due to excessive soil fertility. If this is coupled with low aerator effectiveness and lack of water exchange, the conditions at the bottom of the pond become extremely deteriorated. This deterioration may take the form of low oxygen condition, high bacterial loadings, ammonia and hydrogen sulphide production.

Hydrogen sulphidde is most toxic when present in acidic conditions - this is another condition found in many shrimp ponds - particularly those in intertidal areas built on mangrove soils and intertidal mud flats.

Many farmers complain of 'black gill' or 'pink gill' in their shrimp. These two conditions are typical of deteriorated pond bottoms. Pink gill is associated with hydrogen sulphide toxicity in the presence of acid soils. Black gill is caused by a number of agents - bacterial infections, high organic fouling, acidic pond soils are the most common.

Traditional methods of remediating deteriorated acidic pond environments such as these are:

- High water exchange
- Increasing water circulation
- Lime/dolomite applications

Water exchange

Water exchange is the most effective method for improving fouled water, flushing out waste products and providing oxygenated water. The problem faced by farmers is that they suspect that the influent water is the source of disease at their ponds. It is a potential threat - although less so than infected postlarvae or carrier shrimp.

Many farmers associate water exchange with shrimp mortality. This is unfortunate since the problem usually existed prior to the exchange - it is the water exchange that stimulates shrimp moulting and this stress then causes the disease to

become acute. If water were exchanged regularly this problem would not occur. Farmers that are afraid to change water usually leave it too late - this causes shrimp to delay moulting and go off their feed due to stress or beginning of some infection (SEMBV, vibriosis). The exchange of water speeds this process up and the shrimp then appear to have suffered from the water exchange.

It is an important goal of this project to demonstrate the high risk routes of virus infection so that farmers can return to water exchange methods of maintaining environmental quality.

Some farmers are converting production ponds to storage reservoirs. This is to be encouraged since it allows some settlement of influent water prior to introduction to ponds. Farmers are also chlorinating this water in the belief that it will kill virus diseases. This is incorrect, since the dosages of chlorine applied are too low. To chlorinate the water against disease would be prohibitively expensive. If water were aerated and stored for one week prior to use, the quality would be significantly improved and the threat of virus transmission would be considerably reduced - the virus only appears to be viable for 3 days when free in the water. Deeper ponds would increase water retention capacity and prevent overblooming/lab lab formation of the stored water. If deep reservoirs are to be used then great care must be taken if the ponds are constructed on potentially acidic soils. Disturbance of new soil can result in the formation of extremely low pH conditions at the pond bottom.

Lime and dolomite applications may improve water quality by neutralizing soil acidity. The raising of pond bottom pH may alleviate some of the problems caused by acidity and hydrogen sulphide.

Water circulation

Improved water circulation would provide cleaner feeding areas for the shrimp. In all ponds observed so far, the pond bottoms are covered in settled sediments and there are no clean areas for shrimp to reside. This is not a problem if organic inputs (feed) to the ponds are low (i.e. low stocking density and high water exchange). However, if water exchange is reduced and feeding increased for higher stocking densities, the pond bottom will quickly foul and present the problems currently observed in Sri Lankan ponds.

High salinity

As an initiative to remove the impact of large farms from the Dutch Canal lagoon system, finance has been provided to large farms to re-construct the farm systems. These farms now operate on a partial or full recirculation system. The expectation is that removal of these farms effluents from the system will relieve pressure on water quality. Small farms cannot be restructured due to lack of land availability.

Large farms employing water recirculation are currently facing a serious problem with high water salinities. The farms did not use low salinity water when the farm was filled expecting rains to dilute the system. These rains have not arrived, and the farms have had to endure up to 4 months of high salinity water. In some farms the salinities have reached 45, 49 and 60 ppt (salinity of normal seawater, full strength = 34 ppt). This is extremely stressful to the shrimp, causing very slow growth, lack of feeding and low oxygen capacity in the pond. The result has been that many of these ponds have suffered from very low growth rates and thus the shrimp cultured have become un-economic. Low feeding rates may have resulted in over application of feed to the ponds

which has subsequently fouled the pond bottom. In conjunction with low water exchange this has resulted in bacterial infections and fouled gill conditions.

Recirculation can be used effectively, but only if low salinity water can be used to fill the farm. Since the rains have failed for two consecutive years reliance on rainwater appears to be a high risk in Sri Lanka. Some farms are attempting to remediate the high salinity by using borehole water. ***This is to be discouraged since it salinates aquifers that have other resource user particularly in coastal areas where freshwater may be in limited supply***

The amount of freshwater required to dilute a 1 acre pond from 35 to 34 ppt is 121,000 litres. If this is coupled to the evaporation rate, the daily amount of freshwater required far exceeds the capacity of most bore wells and therefore has no significant effect on the pond salinity.

Farms in the Puttlam lagoon area frequently encounter high salinity since the lagoon water itself becomes hypersaline at some periods of the year. The best strategy is to avoid culturing shrimp during this period.

Water quality in Dutch Canal and lagoon system

Increasing numbers of shrimp farms have inevitably increased stress on this system. There are other resource users that have contributed to the derioration of water quality. There has been a proliferation of small mangrove crab fattening operations in some areas; these small cage operations in the lagoon feed fresh wastes (animal offals etc.) to the crabs and all wastes from these systems enter the lagoon directly.

The principal cause of water quality deterioration in the lagoon is possibly the lack of rainfall the past two years. This has prevented any significant flushing of the lagoon and thus loadings the lagoon have accumulated.

Chlorination

Chlorination of pond water is being increasingly practiced by farmers in Sri Lanka. The problem is that many farmers do not understand the underlying principle. Chlorination is not intended to sterilize the water and is not effective at killing SEMBV at the concentrations used. Chlorination is intended to kill pest species in the pond prior to stocking with postlarvae. Included in these species are those crustaceans that are potential carriers of SEMBV. If this process is not performed properly - there is a good chance that pest species will develop in the pond and potentially transmit viral disease to the shrimp. ***It is a goal of this project to evaluate the potential risks associated with carrier crustaceans.***

Under-chlorination allows pest/carrier species to remain, and over-chlorination causes problems with bloom development during pond preparation. ***The correct usage of calcium hypochlorite is to be encouraged and should be investigated with respect to the Sri Lanka culture system.***

Feeding

Shrimp feed is imported to Sri Lanka and has therefore been subject to import tax and several other tariffs. Due to the losses incurred by the shrimp industry these tariffs have been removed and feed has been made cheaper to the farmers. It has been suggested that this removal of tariff does not apply to small scale encroachment farmers because they lack a farm registration certificate. The result of this is that such farmers are paying considerably more for their feed (average >$1.50, 85-90 rupees). This high cost of feed is encouraging the small farmers to overstock their ponds in the mistaken belief that this

will increase profitability. This is never the case and could actually cost the fanners more. Awareness of the benefits of low stocking density and good food conversion ratios is low. It will be important to educate the small farmers in the best possible method of culture for their small ponds. Due to lack of aerator action, organic soils and low water exchange the carrying capacity of these ponds is naturally lower than other areas.

Farmers are currently asking the government for preferential rates on electricity prices to further reduce their production costs.

2. SELECTION OF SITES FOR THE EXPERIMENTAL DEMONSTRATION UNITS (EDU)

The proposed farm sites for the EDU are satisfactory and likely to achieve the desired results. Four locations have been selected - 3 are large scale farms and 5 ponds on each farm will be monitored. All three farms have their own hatcheries, and this will facilitate health monitoring and sampling.

The fourth location for the research project will be identified as the purchasers of screened larvae from a small hatchery (in Chilaw). The fourth location will be small scale farmers ponds to provide comparative information regarding sources of infection and to demonstrate the importance of good quality postlarvae.

The farm systems types employed are diverse (recirculation, brackish well water, open system) and will present a variable range of culture environments for the study. Daily management of the ponds will be left to the owners of the farms, and the research group will merely collect samples and management information. Advice may be given if required (especially to the small farmers).

3. RESEARCH PROGRAMME

The research programme carried out by the National Aquatic Resources Agency (NARA) is intended to establish the principle sources of disease (particularly viral) affecting shrimp farm production in Sri Lanka. It is this knowledge that allows effective protocols for health management to be formulated and implemented. The programme is targetted at SEMBV (Systemic Ectodermal and Mesodermal Baculovirus, white spot virus disease) because it appears that infection can occur at all stages of the culture cycle (from broodstock to growout).

It is important to appreciate that the NARA research programme intends to follow SEMBV as a model for shrimp health management. However, many of the shrimp health problems occurring in Sri Lanka may be caused by other agents *(e.g.* bacteria, fouling organisms) or environmental factors *(e.g.* deteriorated pond bottoms, hydrogen sulphide etc.). These other diseases will be monitored concurrently with SEMBV screening. ***The scope of the NARA programme must*** *be* ***broad enough to incorporate these other disease agents to truly qualify as shrimp health management.***

To achieve this health monitoring programme the capacity of the NARA facilities require development in the fields of histology, basic microbiology, microscopy and Polymerose *Chain* ***Reaction (PCR).***

In order to understand how SEMBV and other diseases are affecting shrimp culture in Sri Lanka a programme of screening and monitoring has been devised to establish the principal routes of infection in shrimp culture. This programme will investigate shrimp health in the following areas:

- Wild populations (broodstock and potential carrier species outside farms)

- Hatcheries (broodstock and larvae)
- Growout (cultured shrimp and carrier species in ponds)

3.1 SEMBV incidence in wild populations (Appendix II)

Since all postlarvae stocked into shrimp ponds are produced from wild broodstock, it is important that the incidence of SEMBV be determined in the wild population. This part of the research programme will require the collection of wild caught *Penaeus monodon* from around the island. Screening of these animals (size range approximately 30+ grams) will indicate whether there are potentially clean stocks of shrimp available for use as broodstock animals.

In order for the data obtained from this screening programme to be analysed effectively it is recommended that an epidemiologist is consulted. This is to ensure that the correct** conclusions **are drawn from the limited number of samples it is possible to collect during this programme.

The visit of Dr. Siriwardena (NARA) and Dr. Subasinghe (FIRI) to Bangkok coincides with an epidemiology workshop at AAHRI, and this issue could be discussed with the organiser (Dr. J. F. Turnbull, Institute of Aquaculture, University of Stirling).

Wild caught shrimp are not usually infected with other diseases, however during the capture and transport process other infections may occur. These also need to be checked (damage, external fouling organisms, bacterial infection, Monodon Baculovirus).

It is not intended to use broodstock sized animals for this survey in the interest of minimizing costs.

Another potential route of SEMBV infection to the shrimp ponds is via carrier species. These species may be symptomatic or non-symptomatic. If these carrier species are infected and enter the production ponds (particularly at pond filling time) they may be predated by *Penaeus monodon.* The route of infection by ingestion of infected tissue is proven and is potentially a significant risk - especially in culture ponds where no efforts are made to eliminate pest/carrier species during pond preparation. Screening of these potential carriers should be performed both outside the farms and within the ponds in the EDUs.

3.2 Hatchery monitoring of larval and postlarval health (Appendix III)

SEMBV infection may occur during the hatchery phase of production, especially if the hatcheries are located close to production areas. Alternatively, low level infection transmitted from broodstock may be horizontally transmitted during the hatchery phase.

Samples of larvae and postlarvae will be taken from the hatcheries that supply the EDUs and screened for SEMBV infection. This will demonstrate whether infections are occurring during the hatchery process and allow appropriate measures to be be taken. A final screening of postlarvae prior to stocking the experimental ponds will also be performed to establish the incidence of SEMBV in the postlarvae. It is intended that some clean stocks of postlarvae will be identified and stocked, such that the potential of infection within the pond can be evaluated.

Concurrent with screening for SEMBV, infection samples of postlarvae will be monitored for other indicators of health and quality, *e.g:*

- Damage (setae, appendages)

- Fouling (bacterial, fungal and protozoan)
- Colour (chromatophore dispersion)
- Activity
- Development stage vs. day of culture
- Indications of malnutrition - gut to muscle ratio, hepatopancreas size and colour

Four hatcheries will be monitored - three are part of large farms intended as Experimental Demonstration Units and the fourth is a small hatchery selling to small farmers in the Chilaw district.

As part of this programme, the incidence of SEMBV in Chilaw hatcheries will also be established. There are between 40-60 small hatcheries in Chilaw district close to the project Extension Centre. This area also contains shrimp farms and it is possible that this proximity might allow infection during the hatchery phase.

3.3 Shrimp health screening during grow-out at Experimental Demonstration Units (Appendix IV)

Four EDUs are to be used containing five ponds in each unit (total 20 ponds). Three of the EDUs are large farms with their own hatcheries supplying postlarvae, which greatly facilitates the monitoirng programme of postlarvae and grow-out ponds. The large EDUs also have good management practices that will facilitate the collection of daily management information such as water quality, water exchange, liming and feed applications.

The fourth EDU will be 5 small farmer ponds, and have not yet been identified. These ponds will be identified among the purchasers of postlarvae from the small hatchery monitored. (section 3.2 above refers).

Shrimp will be routinely screened for general health status (every two weeks). In the course of the shrimp health monitoring programme for the experimental ponds, supporting water quality and environmental information will also be collected. Routine monitoring of water and sediment quality in the experimental ponds is intended. This is because shrimp health is often closely linked to the quality of the culture environment - the explanation as to the cause of disease can often be found in the deterioration of the culture environment.

Dr. Jayasinghe's current research programme (NARA) has studied some water quality parameters and attempted to relate these to shrimp health. His group have studied several farms employing different water management systems. Lack of water monitoring facilities has limited some of the data obtained from this research, particularly where monitoring has been performed by research students.

The manual produced by Dr. Jayasinghe concerning low water exchange and water re-use systems is based on a study tour to Thailand and not on the situation in Sri Lanka. The transfer of Thai water management systems may not be appropriate for Sri Lanka, due to the lower aerator capacity and poor pond preparation techniques employed here. Low water exchange systems may actually increase problems in culture ponds. This is because pond cleaning may be inadequate and the acidic conditions found in many ponds causes stressful conditions alleviated only by water exchange. When used successfully, low water exchange culture methods rely on meticulous cleaning and preparation of the ponds prior to stocking

Dr. Jayasinghe is anxious to be involved with the Shrimp Health Management Project - citing the ongoing water quality monitoring programmes performed by his group. Dr. Jayasinghe's group have access to water quality measuring equipment and thus no contribution would be necessary from FAO. It must be stressed that the involvement of Dr. Jayasinghe's in a monitoring programme is only worthwhile if the data obtained is relevant and accurate. *To this end, a strict sampling programme has been devised and must be adhered to. The regular preparation and presentation of results to the project group will also be necessary (Appendix V).*

Reporting times should be quarterly to ensure regular synthesis of the research results. This is to allow the timely inclusion of water and environmental quality information in the evaluation of the effect of the Shrimp Health Management.

4. LABORATORY CONSTRUCTION

A laboratory building is to be constructed at NARA to house the project offices and equipment, however it will not be completed for some time. The PCR equipment will be housed in an interim laboratory until completion of the new building. (government responsibility)

Principal requirements for the laboratory building are :

- A dust free containment area for the PCR equipment
- Laboratory space for the anciallary equipment for PCR (gel electrophoresis, tissue preparation etc.
- Relatively clean, pressurized water supply

The water supply to the laboratory (responsibility NARA) must be of sufficiently good quality to use in a distillation apparatus. This water must be relatively free of suspended solids, iron and organic matter. If water of this quality is not available, pre-filtration units will be required (responsibility NARA). The flow rate of water required is minimum 65 litres per hour (to feed cooling water to the distillation apparatus).

After discussions with Dr. Siriwardena it has been recommended that the PCR equipment be housed inside a dust exclusion facility. This is a small glass and aluminium structure that is located inside a laboratory. The intention is to exclude dust and contamination from the sensitive PCR process. Dr. Siriwardena has the preliminary details for the structure, and Mrs. P.K.M. Wijegoonawardena (NARA) will furnish further details after her return from training in Thailand and Malaysia. The construction of these facilities is the responsibility of NARA and the PCR facility can be moved to the new building when it is ready.

5. *EXTENSION CENTRE - CHILAW*

The extension centre in Chilaw is located on the coast and close to 40 small scale hatcheries. Chilaw district also has a great number of large, medium and small scale farms. This location is central in the shrimp farming area of northwest Province and is an ideal location for an extension centre. The extension centre will be modified by the Ministry of Fisheries to provide a small wet laboratory, office space for the 3 personnel and storage for equipment.

The proposed changes required were construction of new wall and doorway to form a wet laboratory, as well as installation of windows, sink, cupboards, shelving and workbenches.

The proposed equipment that will be used at the extension centre will assist the extension team in testing water at the farms that they visit. Samples for disease diagnosis can also be taken. The extension centre will be equipped with a microscope allowing the examination of wet mount material and could use the rapid staining technique for SEMBV. Samples that could not be identified can be preserved and taken to NARA for identification. ***The facilities at the centre are not sufficient to provide*** *a* ***large scale testing service for either water quality or shrimp health -this would require further development of the facilities.***

If the demand for a centre providing testing services is demonstrated, then the Chilaw extension centre would be a good model for its development. Both the Development Finance Corporation of Ceylon (DFCC) and the Northwest Provincial (NWP) Council have expressed intentions of financing such a centre in the future.

The availability of transport will determine the effectiveness of the extension service provided by the team. This matter should be resolved in the initial phase of the project

The two extension assistants assigned at the centre have been undergoing training in all aspects of farm management and operation at two of the farms proposed as EDUs (Indiwari, Aqua Garden). The management and technical knowledge present at these farms is excellent, providing a good learning environment for the assistants.

6. FARMERS TRAINING WORKSHOPS (Appendix VI)

The intention of the farmers training workshops is to provide a basic level of technical information to assist farmers in understanding shrimp health management. By identifying discrete geographical groups of farms it is hoped to encourage those farmers who share common land and water resources to organize into societies. These societies should then be represented in the Sri Lanka Shrimp Farmers Association (SLSFA).

The large number of farmers that have suffered crop/financial losses has created significant pressure on the Northwest Provincial (NWP) Council to take some form of action. To this end they have commenced some small farmer awareness programmes requesting inputs from NARA staff. This initiative of the NWP Council is complementary to the farmer training workshops proposed in this project, although their focus is more towards the smallest operations. The NWP Council has expressed a willingness to be involved in the workshop component of this project and will facilitiate the identification of farmer groups and the provision of facilities for the workshops.

The farmers groups identified by NWP Council have been used previously for the purposes of data collection on shrimp farming. However, further groups need to be identified in the course of the project to ensure a broad spectrum of farm sizes are involved.

The NWP Council suggested the best location for the workshops be in the villages of the small fanners to facilitate travel and encourage good participation. The consultant is entirely in agreement with this proposal; however, the possibility of visiting larger better managed farms should be encouraged.

Since part of the intention of the farmer workshops is to encourage organization into local societies the involvement of larger farms is crucial. Many of the larger farms do not have good technical knowledge and also require the extension support provided in the training workshops.

The number of participants proposed for each workshop (50-75) should be reduced to encourage more interaction during the training. Large groups are difficult to manage and discourage individual involvement. The ideal size for a workshop is approximately 20-25 persons.

The funding of these workshops is to be provided by the Export Development Board (EDB) of Sri Lanka and DFCC on a 50:50 share basis.

One training workshop was conducted during this consultancy mission, attended by 17 small and medium sized farmers. This was a pilot workshop in order that the trainers could prepare material and decide the manner of the presentation. The enthusiastic participation of the farmers involved was a strong indication of the interest in these small workhops. There is a lack of good quality; reliable information available to Sri Lankan shrimp farmers regarding good management practices, and these workshops will go some way towards rectifying this. The exposure of the Extension Centre at Chilaw is another positive aspect of the workshops, and fanners were interested in the facilities and services available at the centre.

7. *PROJECT PROGRESS REVIEW MEETING*

This first progress review meeting was intended primarily to introduce the scope of the TCP assistance to the review committee. This was duly done to general agreement that the project was timely and necessary for the Sri lankan shrimp culture sector.

Discussions regarding the funding of the farmer training workshops were held, and DFCC and EDB agreed to fund these on submission of budgets and time schedules. The funding of the small workshops was to be split between the two organizations.

The national seminar programme was also discussed with respect to financing by EDB and DFCC. Since the budget and resource personnel have yet to be finalized, a decision was not taken at this meeting and will be subject to further discussions later in the year.

The Northwest Provincial Council was not represented due to the non-availability of Mr. Fernando - he will attend the next progress review meeting.

8. INTERNATIONAL TRAINING

The two trainees to be sent for the Shrimp Health Management training course (AAHRI, Bangkok 19-25 May) and PCR training (AAHRI, June, 25 May -21 June) have been identified. These are Mrs. P.K.M. Wijegoonawardena (NARA) and Mr. Mahinda Kulathilake (MOFARD/AQD). The technician from NARA to be trained in PCR techniques at AAHRI, concurrently with the other two trainees, has been identified as Mr. Kumarasena Godagedara.

In section 3.18 of the Fish Health Officer's (FIRI) end of mission report there is a recommendation that Mrs. Shamila Corea (NARA) should be trained for three months at Mahidol University. This training would be a preliminary part of a PhD programme. The type of training offered at Mahidol University is specifically related to viral disease, bacterial disease and biochemical issues. The laboratory proposed (Dr. Timothy Flegel) does not specialize in shrimp health management, but rather in identification of diseases. Mrs. Corea's experience to this date has been concerned primarily with water quality monitoring in shrimp ponds and some basic health checks. It is the consultant's opinion that she would not be a suitable candidate for a disease/biochemistry programme of this sort. Mrs. Corea is also not expected to finish her MSc programme until the end of 1997, thus she would not be able to start a Phd programme until after

that date. Mrs. Corea expressed concern that since her background was not disease oriented the choice of subject was not suitable.

A more effective use of the training component would be to extend the visit of Mrs. P.K.M. Wijegoonawardena (NARA) to include training at Dr. Timothy Flegel laboratory, Mahidol University (Bangkok, Thailand) or in Dr. Mohammed Shariff's laboratory, Universiti Pertanian Malaysia (Selangor, Malaysia). The research group of Dr. Timothy Flegel at Mahidol specialize in viral disease detection techniques and a short stay at this laboratory (2 weeks) would complete the training in shrimp health management that Mrs.Wijegoonawardena will start at AAHRI. Dr. Shariff's laboratory use the PCR machine that is intended for the project (Rapid Cycler) and thus a short familiarization course with this machine is recommended (2 weeks). This training would be of direct application and benefit to the project.

There is a possibility of Mrs. Wijegoonawardena could use some of the data from the TCP for a disease/shrimp health management oriented PhD after the completion of the TCP. The consultant feels that PhD training is not compatible with the goals of this TCP, but in the long term would benefit the health management capacity of NARA.

9. EQUIPMENT REQUIREMENTS

A fully functioning shrimp health laboratory requires diagnostic capabilities in the fields of microbiology, histology, microscopy and PCR (Polymerase Chain Reaction) detection of viruses. The equipment list provided in Appendix VII specifies the items of equipment required in a laboratory for the proper functioning of a shrimp health laboratory.

This equipment list includes all of these features and where possible these are separated into sections. There is naturally some overlap in equipment requirements between the techniques. The exception to this is the PCR technique, which relies on scrupulous cleanliness and prohibits the sharing of equipment to prevent contamination of this sensitive technique.

The aquaculture division of NARA currently has no equipment that can be used for health management and diagnostic research. Bacteriology facilities are available at the Post Harvest division - this is available for aquaculture division use. NARA aquaculture division has water quality analysis facilities and therefore no equipment for these purposes has been included.

The distillation equipment needs to be regularly cleaned to prevent limescale and other contamination (accordig to manufacturers instructions). This is to ensure that the quality of the water produced is consistently good. The distilled water produced must be stored in clean (acid washed and rinsed) polythene tanks and stored out of direct sunlight. Distilled water should not be stored for more than one week.

The Chilaw Extension Centre is relying on NARA to provide distilled water for use in the laboratory, and NARA and Chilaw must make provisions for the production and collection of this water. This has been discussed with Dr. Siriwardene and Mr. Kulathilake.

Water for use in the PCR technique must be of a higher quality than that produced by distillation. Distillation is a preliminary procedure to remove most of the major contaminants. Further polishing of the distilled water is required for use in the PCR techique. Distilled water must be passed through an EASY pure cartridge filter system (incorporating activated carbon filters and ion-exchange resins).

If impure water is used in the EASY pure cartridge system the resins and filters will rapidly become exhausted and require replacement. The new cartridges are costly and this must be considered in the installation of these systems. It is expected that a system using distilled water should last for approximately 12 months or more - this is the expected duration of the research component.

10 CONCLUSIONS AND RECOMMENDATIONS

- Candidates have been identified for the following overseas training:
    - AAHRI Shrimp Health Management course , 19-24 May - Mr. Mahinde Kulathilake (MOFARD) and Mrs. Prianjulee Wijegoonawardena (NARA)
    - PCR training course 4 weeks at AARI Bangkok, 25 May - 21 June - Mr. Mahinde Kulathilake (MOFARD) and Mrs. Prianjulee Wijegoonawardena (NARA) and Mr.Kumarasena Godagedara (NARA)
    - PCR techniques training Dr. Flegel laboratory, Mahidol University, 2 weeks - Mrs.Prianjulee Wijegoonawardena (NARA)
    - PCR Rapid Cycler familarization training, Dr. Shariff laboratory, Universiti Pertanian Malaysia, 2 weeks- Mrs. Prianjulee Wijegoonawardena (NARA)
- NARA research programme has been planned and discussed. This will commence aftertraining is finished and equipment installed. This includes shrimp health screening frombroodstock through to grow-out and also wild crustacean carriers. Different water managementschemes are in place at the EDUs and these will be monitored for environmental qualityalongside with shrimp health. The information gathered during this programme should bereviewed regularly by the project progress review committee.
- The wild population and hatchery screening programme should be discussed with anepidemiologist to ensure the correct sampling and analysis protocol. This is due to the risk ofbias and innacurate information derived from the limited number of samples available.
- Chilaw Extension Centre is operational but awaiting equipment. The capacity of the centre toprovide a true testing service is limited. Extension and pondside assistance is possible andintended. If this component proves successful it will provide a good model for other centres inthe area.
- The farmer training workshop programme has been devised, the content and training materialhas been described. The first training workshop has been conducted successfully.
- The specifications for equipment and consumables required for the successful operation of theNARA and Chilaw Extension Centre components have been completed.
- Shrimp culture in Sri Lanka is constrained by low level of technical knowledge in the industry.Research capacity in health management is currently very low.
- Farm losses are attributed to a wide range of disease, however they can be broadly split into:
    - Virus infection of shrimp from sources currently unknown
    - Poor management causing environmental deterioration in pond

- Sri Lanka may have stocks of virusfree broodsrock available. If these are discovered shrimp farming development in the area should not proceed to avaoid contamination
- Low water exchange due to fear of virus introduction is creating serious disease problems in ponds (high salinities and deteriorated water and sediment quality)
- Frehwater abstraction form tube wells to dilute high salinity water isineffective due to low flow rates and limited water supply. Thisactivity should be strongly discouraged where other resource users rely on the water for drinking andwashing.
- Chlorination of ponds prior to stocking will minimize virus infection form carrier species. The ideal application rates for Sri Lankon farms should be determined and this information made available to farmers.

APPENDIX I

Consultant's Terms of Reference. Itinerary and Persons met

Under the overall responsibility of the Chief, Operations Group, RAPR, under the technical supervision of the Inland Fisheries Division of FAO, the consultant will:

1. review the status of shrimp health in the Western coastal areas of Sri Lanka and advise the NPD and the relevant project staff on designing and implementing experimental trials on alternate water management and farming systems to avoid major health problems, especially the SEMBV, in Sri Lanka;
2. conduct/participate in the training workshop/s as outlined in the project work plan;
3. advise on long-term needs for a sustainable shrimp industry in Sri Lanka with special reference to health management, with a view to developing a major proposal for possible donor funding;
4. assist in implementation for the pilot experiments and provide major inputs to develop extension material on shrimp health management in Sri Lanka;
5. assist in drawing specifications of equipment necessary to upgrade laboratory capabilities in shrimp health management;
6. present a report at the end of each mission, addressed to the project operations officer at RAPA (hard copy together with diskette in Word)

ITINERARY

DATE	PERSONS	SUBJECT
April		
	FAO/RAPA	Pre-mission briefing TCP/SRL/6614(A)
	Ms. D. Blessich Dr. Rohana Subasinghe	
15 April	**Depart Hatyai**	
16 April	**FAO/RAPA** **Depart Bangkok**	Collect TOR, tickets and make hotel reservations 21.45
17 April	**Arrive Colombo**	02.00
	FAO	
	Mr. Bernard (FAOR) Mr. Sugathapala (FAO Programme Assistant)	Discussion of TOR Request for revised CV, (Appendix I) for submission to NARA.
	NARA	
	Mr. Gunawardene (Chairman) Dr. Siriwardene (Division head) Dr. Jayasinghe Mr. Kulathilake Ms. Wijegoonawardena Ms. Corea	Discussion of CV, request for revised version Introduction to proposed nominees for training Discussion of mission objectives with NARA Informed of non-availability of Mr. Jayasekera (NPD)
18 April	**NARA**	
	Dr. Siriwardene Ms. Wijegoonawardena	Further discussions of proposed itinerary Submission of re-written CV to NARA Informed of Mr. Jayasekera's availability 21st April
	FAO/FIDI	
	Dr. Rana Dr. Siriwardene	Discussion of constraints to effective data and information collection in shrimp farming in Sri Lanka
	FAOR Mr. Sugathapala	Submission of re-written CV to FAOR
19 April	**No meetings**	Design itinerary for discussion with NPD Report
20 April	**NARA** Dr. Siriwardene	Further discussions of shrimp farm situation and coastal aquaculture development
21 April	**MOFARD**	

		Discussion of project
	Mr. Jayasekera (National Project Director) Mr. Tilak (NPD - FAO Inland Fisheries Project) Mr. Kulathilake (Project Station - Chilaw) Mr. Jayasena (Additional Secretary) Mr. Gunawardana (Minister)	Discussion and finalization of itinerary Discussion of training workshop Informed of lack of defined source of funding for training workshop Discussion of equipment list Informed Project Progress Review Committee not finalized Request for rapid action of ministry to TCP related issues Explanation of mission Discussion of shrimp farming issues in Sri Lanka
	DFCC	
	Mr. Senevirathna (Senior Project Officer Fisheries) Mr. Wickramasinghe (Manager, Agriculture Fisheries and Special Projects)	Description of farmer training workshops component Description of National seminars Request for advance funding for first training workshop
	FAOR	
	Mr. Sugathapala	Mission update Discussion of international training to be provided to NARA and MOFARD personnel Request for vehicle for farms visit
22 April	**National Holiday**	Report
23 April	**NARA**	
	Dr. Jayasinghe Ms. Corea	Discussion of current research programme and future developments Discussion of potential for collaboration with proposed FAO Shrimp Health Management Project Discussion of current farming system and potential for improvement Preliminary discussion of Ms. Corea's suitability for international training
24 April	**NARA**	Discuss equipment List
	Dr. Siriwardena	Discuss potential PhD candidate Laboratory construction - requirements for PCR and completion times
25 April	**NARA**	

	Dr. Siriwardena	Formulate screening programme for SEMBV, Broodstock screening, Hatchery screening, Carriers screening, Growout in EDU screening, Other monitoring requirements for EDU
	FAOR	
	Mr. Bernard (FAOR)	Mission update
26 April	**Chilaw**	
	Dr. Siriwardena Mr. Kulathilake Mr. Wannigama	Visit Chilaw Aquaculture Extension Centre Detail laboratory design Dicuss small farmer workshops
		Visit farms in Chilaw area, discuss culture and shrimp health problems with managers
27April	**Chilaw/Phutulam**	
	Mr. Kulathilake	Visit small hatchery identified for research programme. Discussion of health management techniques. Visit small farmers to discuss culture methods, problems and awareness of health management and disease Visit large recirculating farm
28 April	**Chilaw**	
	Mr. Wannigama (EDU owner and consultant) Mr. P. Salgado (EDU manager)	Discuss farmer training workshop inputs Discuss status of shrimp farms in Northwest Province Visit one of the proposed Experimental Demonstration Units
	C.P. Extension Service	
	Mr. Manoch Chuenkhachorn	Discuss C.P. centre's intention to provide PCR screening service for SEMBV Discuss price of service and potential for intercalibration of equipment with NARA
	Northwest Provincial (NWP)	
	Council	

	Mr. W.L.C. Lowe (Secretary) Mr. H.F.S. Fernando (Director Fisheries Division) Mr. K. Kanankage (NWP Development Authority) Mr. P. Ramanayake (Aquaculture Projects Officer)	Introduce Shrimp Health Management project goals. Describe proposed Extension Centre and NARA project. Discuss potential for NWP Council collaboration in small-farmer group identification and training workshops. Discuss status of farming in NWP - problems concerning farm registration and control of development
29 April	**MOFARD**	
	Mr. Jayasekera (NPD) Dr. Siriwardena (NARA) Mr. Kulathilake	Discussion of farms visit with NPD. Arrange content of training workshop. Discuss collaboration with NWP Council in in identifying small famer groups and assistance in training workshops. Arrange agenda for first meeting of Progress Review Committee.
30 April	**FAOR**	Contact Dr. Subasinghe FIRI to discuss equipment budget Contact AAHRI request details of PCR costs
	NARA/MOFARD	
	Dr. Siriwardena Dr. Jayasinghe Ms. Wijegoonawardena	Organize material and resource personnel for first training workshop Present experimental protocols for EDU and shrimp health monitoring Discuss contributions to NARA research programme
1 May	**National Holiday**	Report writing
2 May	**EDB**	
	Dr. Weerakoon Mr. Jayasekera (NPD) Dr. Siriwardena	Discuss previous EDB financial support to shrimp sector Discuss EDB contribution to fanner training workshop Potential for video presentation of shrimp farming
	Analytical Instruments PVT.	
	Mr. Jayasundara	Source and pricing of project equipment
	MOFARD	

	Mr. (Secretary) Mr. Hettiarachchi (Director Export Development) Mr. Jayasekera (NPD)	Introduce project objectives, describe role of MOFARD/NARA Discuss future development and requirements of shrimp farming in Sri Lanka
3 May	**Phutulam**	
	Dr. Siriwardena (NARA) Mrs. Wijegoonawardena (NARA)	Visit farms with production problems Collect samples and advise managers
4 May	**Analytical Instruments PVT.**	
	Mr. Jayasundara	Source and pricing of project equipment
5 May	**Project Progress Review**	
	Meeting	
	Mr. Jayasena (Additional Secretary, MOFARD) Mr. Jayasekera (NPD) Dr. Siriwardene (NARA) Mr. Senevirathne (DFCC) Dr. Weerakoon (EDB) Mr. Lalith De Mel (President, SLSFA) Mr. Hettiarachchi (Director, Export Development, MOFARD) Mr. Kulathilake (MOFARD/Chilaw)	Funding of workshops Inputs of DFCC/EDB/NWP EDU inputs and FAO assistance Expected outputs NARA research programme Extension programme
6 May	**Analytical Instruments PVT.**	
	Mr. Jayasundara	Source and pricing of project equipment
	FAOR	Equipment sourcing Contact AAHRI regarding training
	Chilaw - Training workshop	Preparation Travel to Chilaw
7 May	**Chilaw - Training workshop**	

	Mr. Jayasekera (NPD) Dr. Siriwardene (NARA) Mr. Wannigama Mr. Kulathilake (MOFARD) Mrs. Wijegoonawardena (NARA) Mrs. Corea (NARA) Extension assistants (Chilaw extension centre)	One day farmers training workshop
8 May	**FAOR-11.00 am**	
	Mr. Bernard	Briefing on mission
	MOFARD- 2.00 pm	
	Mr. Gunawardana (Minister) Mr. Jayasena (Additional Secretary) Mr. Jayasekera (National Project Director) Mr. Bernard (FAOR)	Mission progress report
9May	**FAOR**	
	Mr. Bernard Mr. Sugathapala	Submission of draft mission report
10 May	**Depart Colombo**	01.40
	Arrive Bangkok	06.00
May	**FAO/RAPA**	
	Ms. D. Blessich (Project Co-ordinator)	End of mission debriefing Submission of report

APPENDIX II

Experimental Protocol for Wild Population and Carriers Sampling

Research programme for NARA - Screening wild populations for SEMBV incidence around the coastline

Wild shrimp taken from around the island should be screened for SEMBV using the PCR technique. It is important that the location the shrimp were obtained is recorded accurately. If possible transects should be taken to establish whether the shrimp further from the shore have a different incidence of the disease to those closer to the coastline. The intention of this is to establish whether there are any stocks of broodstock shrimp which are SEMBV free, or have low incidence of the virus.

The shrimp will be screened for other disease symptoms also.

Wild shrimp survey survey protocol:

- More than 20 animals should be checked from each location.
- An even sex ratio should be attempted, and sex recorded of samples
- The locations should be well separated around the island (but where broodstock are to be found).
- Within a location nearshore and offshore samples should be taken seperately.
- The sampling programme should be performed over the monsoon and dry season for one particular area where broodstock are collected, to compare whether the climate/season has an effect on the incidence of the disease.
- Shrimp 30-40 grams
- Gill and ovarian tissue to be collected from each individual
- 10 locations, 20 samples = 200 samples (400 if two types of tissue screened). Cost of shrimp free or less than $80
- For one site take transects and sample every 2 months = 20 animals x 2 stations (inshore, offshore) x 6 = 240 samples (no reps), Cost of shrimp $96
- Total samples = 440 samples

If clean broodstock are discovered it is important that these stocks be maintained as such. The development of shrimp farming in these area should be prohibited to maintain the status of such stocks

Research programme for NARA - Screening crustacean carriers of SEMBV- NWP

The incidence of SEMBV in wild crustacean populations should also be monitored. Ideally, the incidence in the whole lagoon and Dutch Canal system would be established, a more reasonable approach is the screening of crustaceans around the EDU farms. If crustaeans (white shrimp, *Acetes* etc) are found in the EDU ponds during production, then these should be screened as a possible source of virus contamination. This is particularly important if the postlarvae screened do not present evidence of virus infection.

- Within farms = 20 ponds, 1 species, 3 reps = 60 samples

- Outside farms =10 sites, 2 species, 3 reps = 60 samples *{Metapenaeus spp., Acetes spp.Penaeus indicus,* whichever species is most abundant in area or grow-out ponds.)

APPENDIX III

Experimental Protocol for Hatchery Screening

Research programme for NARA - Screening larvae/postlarvae for stocking into EDU's

It is important that individual spawnings are held seperately to allow the screening of the broodstock and the resulting postlarvae to be evaluated. Mixed spawning will reduce the effectiveness of separating infected and non infected animals.

- Screen broodstock after spawning (gill and ovarian tissue)
- Screen 4 hatcheries and 6 tanks per hatchery.
- Screen PL5 and PL 15 (prior to stocking)
- 5 00-1000 postlarvae collected from each tank
- Macerate tissue and take one gram for PCR, 3 replicates

N.B. it is important to use the same weight of tissue each time to allow a semi-quantitative evaluation to be performed.

- Total number of samples = 24 tanks, 3 replicates, 2 stages =144 samples
- Broodstock samples = 24 tanks, 2 tissues, 2 replicates = 96 samples
- Total samples = 240 samples

If SEMBV is not detected in postlarvae these can be stocked as such. If SEMBV is detectd in many samples then the decision to stock infected animals may be taken. This decision should be based on whether the postlarvae exhibit high levels of infection (dark band after PCR) or low levels (light band). If the postlarvae are light band they can be stocked with caution since the infection is already present in the population. It must be stressed that te intention of this programme is to attempt to provide clean postlarvae for stocking in the EDU's

Research programme for NARA - Screening larvae/postlarvae from small hatcheries in Chilaw

The postlarvae (PL15) from the hatcheries in Chilaw should be monitored for SEMBV incidence. This programme could take place through the year and hatcheries should be sampled at least twice during the year. The hatchery location, time of year that the samples were taken and the source of the broodstock should be recorded if possible.

- 40 hatcheries, 3 replicates, 2 times
- Total = 240 samples

APPENDIX IV

Experimental Protocol for Grow-out Farms

Research programme for NARA - Monitoring shrimp health in growout ponds of EDU's

There are 20 ponds that will be monitored for shrimp health. The problem of monitoring shrimp health in grow-out ponds is the large number of individuals required to give a representative sample. For the purposes of this project it is proposed that shrimp are only sampled for SEMBV infection at the first month stage.

- 100 animals should be sampled from each pond (100/60,000 = 0.16% of population) and the gill tissue should be screened for SEMBV.
- Pooled samples could be used to minimize costs.
- Faecal samples could be screened for SEMBV during later stages of production - these should be collected from feed trays in the ponds. It may be necessary to pool samples from several days to obtain a sufficiently large sample. This is an effective non-destructive technique for SEMBV screening.
- The samples should also be used to perform general health checks and histology using standard techniques.

Screening of shrimp health should be perfromed every two weeks, concurrent woth the water quality samplng programme

- 20 ponds pooled samples 3 replicates
- Total = 60 samples

Research programme for NARA - Screening diseased shrimp for SEMBV infection

If sickened or moribund animals are found at any stage of the culture cycle these shouldbe screened for SEMBV infection and other diseases. These animals are not representative of the population but are often a first indication that there is something wrong in a pond - it is therefore important to screen these samples.

- Other samples , 20 ponds 10 animals
- Total = 200 samples

APPENDIX V

Pond Environmental Monitoring Protocol for EDU

Research programme for NARA -Proposed monitoring programme for EDU ponds used for Shrimp Health Management Project

- responsibility (EDU Farm managers where equipment is available), NARA

1) Daily monitoring - to be performed and recorded by the experimental unit management if facilities are available. If no facilities *(i.e.* small farmers) are available the FHO or NARA groups will collect information weekly

- pH *
- Dissolved oxygen concentration *
- Temperature
- Salinity*
- Secchi depth
- Feed applied *
- Water exchange *
- Semi-quantitative, total ammonia and hydrogen sulphide tests are to be provided by NARA as an additional check.

N.B. Ideally, pH and dissolved oxygen should be monitored twice daily at 06.00 and 15.00

Other management information should be gathered if possible - this includes:

- Stocking date *
- Pond preparation method *
- Stocking density *
- Chlorination (amount, method) *
- Lime and dolomite applications (amount, when) *
- Any drug/chemical applications (amount, when)
- Other notable incidences (i.e. bloom crash, bad weather, aerator failure etc.) *

2) Fortnightly water quality monitoring - to be performed by NARA staff

- Total ammonia-nitrogen (indophenol method)*
- Nitrite-nitrogen (NED/sulphanilamide method)*
- Nitrate-nitrogen (Cadmium reduction to nitrite method)
- Dissolved reactive phosphorus*
- Alkalinity (phenolpthalein method)*
- Hydrogen sulphide*
- Chemical oxygen demand (dichromate oxidation method)

- Total suspended solids (Collection onto weighed filter paper, drying 24 hrs 110 °C)*

3) Monthly accumulated sediment monitoring - responsibility NARA

Accumulated sediment in pond - should be checked monthly for :

- Water content (drying 24 hrs 110 °C)
- Organic content (loss on ignition, 450°C, 18 hrs) *
- Hydrogen sulphide (qualitative method) *
- pH *

4) Pond soil monitoring

- Pond soil cores should be checked at beginning and end of culture cycle for:
- Organic content *
- Water content
- pH*

* ***Items marked with an asterisk are priority parameters that should be monitored through the culture cycle***

APPENDIX VI

First Training Worshop

FARMERS TRAINING COURSE

These workshops are intended to provide farm-based practical training for local shrimp farmers. The identification of local problems is important and these will be dealt with specifically by the workshop trainers. Farmers attending the courses will be encouraged to form local societies to represent their interests in a national body.

The resource personnel for the first workshop were: Mr Wannigama (SLSFA), Mr. Jayasekera (NPD), Dr. Siriwardena (NARA), Mrs.Wijegoonawardena (NARA), Mr. Kulathilake (FHO), Mrs. Corea (NARA), AEA (Aquaculture Extension Assistants, Chilaw). The consultant provided training inputs to the course and assisted in development of course material.

1. ***Overview of management in Sri Lanka***
2. ***Question and answer to panel- establishment of specific local problems***
3. ***Ponsdside demonstration of shrimp health checks***

Overview of good management techniques in Sri Lanka - Mr. Wannigama

Pond Preparation -Dr. Siriwardena

- Cleaning
- Chlorination techniques
- Liming to correct pH
- Screening of inlet water
- Fertilization techniques

Post-larval selection/quality - Mrs. Wijegoonawardene, Dr. Siriwardena

- Identification of good quality PL
- Problems associated with poor quality PL
- Disease introduction via PL
- Potential screening methods - PCR and formalin stress method
- Low stress stocking methods

Water management -Mrs. Corea

- Low water exchange system (no exchange first month)
- Water colour, secchi depth, aeration management.
- Water deterioration - effects and control
- Water quality checks and implications

Feed management - Dr. Funge-Smith

- Avoid overfeeding - signs - feed trays empty too slowly, increasing survival
- Avoid underfeeding - signs, cannibalsim, feed trays empty too quickly

- Feed distribution, feed trays
- Check growth regularly (cast net)
- Calculate survival regularly

Sediment management - Dr. Siriwardena, Dr. Funge-Smith

- Pond circulation and cleaning, provide clean feeding areas
- Available methods
- Potential problems associated with deteriorated pond bottoms
- Soil acidity problems - checks and remediation

Pondside shrimp health management - Dr. Funge-Smith, Dr. Siriwardene

Visual checking health of shrimp:

- Gut fullness - check after feeding (large animals 1–1.5 hour, small animals 1.5–2 hours)
- Zoothamnium - poor water quality
- Gill associated problems
- Black gill - fouled pond bottom long term, anaerobic mud
- Yellow/brown gill - bloom crash
- Pink gill - hydrogen sulphide, low pH, fouled pond bottom
- Carapace fouling, abdominal fouling - pond water, pond bottom, water exchange
- Damage - tail rot, acidity, cannibalization, underfeeding
- Melanization - acidity, vibriosis, damage
- Soft shell - high acidity, low alkalinity, chronic vibriosis
- Hepatopancreas damage - small or abnormal colour - vibriosis, lab-lab
- Black splint - vibrio
- Unusual colouration - stress
- White patches/spots- SEMBV virus, chronic vibriosis, excessive liming
- Dorsal pigmentation - slow growth, fouling
- Slow growth - high salinity, chronic vibriosis, underfeeding

Behaviour changes:

- Coming to edge - low oxygen, high hydrogen sulphide, pH, gill fouling, fouling, vibriosis, white spot
- Swimming at surface - fouling, gill problems,vibrio
- Too manyanimals in feed tray - fouled pond bottom, underfeeding

APPENDIX VII

Equipment and Consumables Recommended for Procurement by the Project

		Make/source	Model/cat no.	Recommended Source
PCR Equipment				
PCR (Rapid Cycler), specify block, accessories	7,000	Rapid Cycler		**?**
Gel Electrophoresis cell (mini, 1 off)	775	NBS UK		Analytical Instruments, Colombo
Gel Electrophoresis cell (midi, 1 off)	600	NBS UK		Analytical Instruments, Colombo
Accessories for electrophoresis - gel moulds etc.	200	NBS UK		Analytical Instruments, Colombo
Power pack for electrophoresis cells (2 cells)	500	-		Analytical Instruments, Colombo
UV light transilluminator for viewing gels	700	-		Analytical Instruments, Colombo
Microcentrifuge 2 – 3,000 rpm, 1.5 ml vials	725	Microcentaur	CEK-111-010E	Fisons Scientific
Finnpipette digital pipettes (0–10,10–100,100–500\mgr\l)	657	Finnpipette		Analytical Instruments, Colombo
Aerosol barrier tips for Finnpipettes	800	Finnpipette		Analytical Instruments, Colombo
Deep freeze (upright, -20oC) for PCR reagent storage	700	-		Local
Horizontal platform shaker for gel staining	403	-		Analytical Instruments, Colombo
Polaroid camera plus filters to photograph gels	800		LCG-190-010A	Fisher Scientific
Staining bath for mini and midi gels	200	-		Fisons Scientific
Magnetic stirrer hotplate	175	Remi	1 MLH	Analytical Instruments, Colombo

SUB -TOTAL		**$ 14,235**			
Consumables for PCR					
Samples = 1,360, Controls = 272,	Total samples =	**1,632**			**NOTE: Details of consumables to be confirmed by NARA trainee Ms. Wijegoonawardene after training**
TRIS		nominal			Local
EDTA		nominal			Local
Boric acid		nominal			Local
DNA stain (ETBR) ($0.50)		816			Perkin Elmer
PCR Primer kit plus dye, positive control etc. ($ 3.20 / sample)		5,222	Mahidol University	Bangkok	Dr. Tim Flegel, Thailand
PCR DNA poiymerase ($ 1.60 / sample)		1,958			Perkin Elmer
PCR DNTP ($ 1.60 / sample)		2,611			Perkin Elmer
Agarose for gel electrophoresis ($ 0.56)		914			Analytical Instruments
Polaroid film ($ 0.50 / sample)		816			Local
SUB-TOTAL		$ **12,337**			
General Pathology					
EASY pure ultrapure water unit, reservoir feed		2,200	EASY pure	WDK-200.RFl.7	Fisons Scientific
Pre-treatment cartridge for EASY pure		70	EASY pure	WDK-710-PRJ.9	Fisons Scientific
Ultrapure de-ionising cartridge for EASY pure		75	EASY pure	WDK-720-UCJ.9	Fisons Scientific
0.2 micron final filter for EASY pure		75	EASY pure	WDK-?	Fisons Scientific
Stereo compound microscope + photographic equpt.		4,011	Leica photoautomat	MIB-210-A	Fisons Scientific
Vortex mixer		230	-	P7-70-1074	Carolina equt. catalogue
SUB-TOTAL		$ **12,961**			
Histology					

Microtome with accessories	1,560	-	P7-62-8166	Carolina catalogue
Tissue float bath	430	LABLINE	P7-62-8450	Carolina catalogue
Embedding table	170	-	P7-62-8092	Carolina catalogue
Slide drying plate	450	-	P7-62-8475	Carolina catalogue
Wax dispenser	1,000	-	MNK-900-030Q	NARA catalogue
Variable volume dispenser	450	-	DHT-355-090H	NARA catalogue
SUB-TOTAL	$ **4,060**			
Chilaw Extension Centre				
Desktop computer for AEC, 8 mB RAM, 486 – 100mHz CPU	1,754	-		Local
Printer - bubblejet	438	-		Local
Power stabilizer for computer etc.	123	-		Local
Whiteboard	87	-		Local
Refridgerator	500	-		Local
Field pH meter plus pH electrode, waterproof	526	Hanna or Jenway		Local
Field oxygen meter plus electrode, waterproof	526	YSI 85		Local
Refractometer (salinity 0–100ppt)	230	Atago	S/Mill-E	Analytical Instruments, Colombo
Dissection kit (scalpels,forceps-large/fine,scissors)	200	-		Analytical Instruments, Colombo
Microscope (stereo, oil immersion x l00)	1,754	Indian Leica		Analytical Instruments, Colombo
Top pan electronic balance (0–200 g)	1,026	A+D	EK 200	Analytical Instruments, Colombo
Room air-conditioner	877	-		Local
Hach kit (DRL 2010)	Free	Provided by EDB for project use		

Hach powder pillows - ammonia, 2500 tests	400	Hach	Hach
Hach powder pillows - nitrite, 1000 tests	200	Hach	Hach
Hach powder pillows - alkalinity, 3000 tests	108	Hach	Hach
Hach powder pillows - hydrogen sulphide, 2500 tests	450	Hach	Hach
Chemicals and consumables	1,000	-	-
Glass slides,cover slips (see consumables)	-		-
Alcohol,preservatives, stains, buffers for ph meter	-		-
Glassware (NARA will assist, see consumables)	-	NARA to provide glassware to Chilaw	
TOTAL	$ **10,199**		

N. B Costs are purily indicative.