

## Aquaculture Research Needs, Priorities and Capacities in Sri Lanka

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### Abstract

Aquaculture is one of the most rapidly expanding activities which has become a major non-traditional foreign exchange earner in Sri Lanka. It is important as a cheap source of protein in the diet of rural communities. Lack of a clear national research policy and long term planning have resulted in *ad hoc* changes in aquaculture research priorities and programmes.

Most of the priority areas identified fall within the development of shrimp culture, capture based culture fisheries development in inland water bodies and ornamental fish culture. There is a need to diversify aquaculture species and culture systems and to evaluate their economic feasibility. Research capacities in the areas of aquaculture, socio-economics, legal aspects, sea farming and improvement of breeding techniques are inadequate. Still there is no efficient mechanism to transfer research findings to the end users. National aquaculture research policy is mainly based on the national aquaculture development plan. Improvement of research capacities, co-ordination and linkage between researchers, farmers, and extension workers will promote the sustainable development of the aquaculture industry in Sri Lanka.

### Introduction

Aquaculture in Sri Lanka is a rapidly expanding industry of recent origin. Government of Sri Lanka has taken initial steps to develop reservoir fisheries and inland fish production in early 1950's by introducing *Oreochromis mossambicus* (De Silva 1985). Several species of Chinese carps and Indian carps were introduced to Sri Lanka at a later stage. Contribution of inland fish production to the total fish production increased up to about 20% in the late 1980's. Shrimp culture commenced in mid 1980's and it has become a main non-traditional foreign exchange earner (Jayasinghe 1991). The total national farm population has increased to over 925 with an estimated area of about 3500 ha allocated for shrimp farming (Jayasinghe 1997).

In view of the limited production potential in coastal fisheries and high production cost in deep sea fisheries, high priority has been given in the fisheries development plan for aquaculture development (Anon. 1995). It provides fish as a cheap source of protein for the rural communities, generates income and employment opportunities and much needed foreign exchange for the country. The present aquaculture systems in Sri Lanka are pond

culture of shrimps, ornamental fish culture and culture-based capture fishery in inland reservoirs and fattening of crabs. Pond fish culture, freshwater prawn culture, cage culture, pen culture, sea weed culture, sea farming and farming of molluscs are at experimental stage. Still there is a need to increase the contribution of research to improve or refine culture technologies, culture systems, health management, and management of aquaculture environment to develop environmentally sound, socially responsible aquaculture. The present study was conducted in Sri Lanka, as a part of a regional study initiated to identify aquaculture development oriented research needs, research priorities, research capacities and development constraints by FAO and the Network of Aquaculture Centres in Asia-Pacific (NACA).

### **Materials and Methods**

The present paper is based on the Sri Lankan component of a regional study organized by the Network of Aquaculture Centers in Asia-Pacific. A questionnaire survey was conducted to gather information on the research priorities, on-going research and research needs, in aquaculture development. National Aquatic Resources Research and Development Agency (NARA), Aquaculture Farmer Associations, Universities and Aquaculture Development Division of the Ministry of Fisheries and Aquatic Resources Development participated in this study. On the basis of the survey responses, common issues, and constraints in aquaculture development, research needs and priorities were identified.

### **Results and Discussion**

With the realisation of the importance of the aquaculture sector in supplementing the gap between the demand and supply in fish and shellfish in the domestic market and the foreign exchange earnings, Sri Lanka has established the National Aquaculture Development Authority under the Ministry of Fisheries and Aquatic Resources Development and a research division under NARA. The National Aquaculture Development Authority of the Ministry is responsible for the development, management, production and extension in aquaculture and inland fisheries. Priorities of the fisheries development plan include increase of inland fish production as a cheap protein for the rural communities, employment generation, and earning of foreign exchange through export of high valued species. Priorities of the aquaculture development plan include fish seed production, integrated fish farming and pond fish culture, fish production in seasonal and perennial irrigation tanks, cage culture, coastal aquaculture and sea farming. It must be noted that aquaculture development activities in Sri Lanka are carried out under the provision of the National Environmental Act (Anon. 1988) which requires environmental impact assessment.

The national institution responsible for aquaculture research in Sri Lanka is NARA (Sivasubramaniam 1995). The role of the aquaculture research sector is the planing and execution of research and development activities in relation to biological resources of inland waters and brackish waters and development of aquaculture systems for selected exotic and indigenous species, including environmental assessment and management of aquaculture. Aquaculture development priorities are identified considering the availability of aquaculture resources, potential for increased production, potential for income generation and the potential for foreign exchange earnings. Planners, researchers and the representatives from

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the farmer community, and sometimes representatives from NGOs participate in identifying priorities.

Farmer organisations participate in identifying research needs and co-operate with the Universities and government organisations. However, their own research contribution is very minimal. Except for isolated activities, there are no established private sector research programmes.

The goals and objectives of the aquaculture research are:

- to ensure the application and utilisation of scientific and technological expertise for the implementation of national development programmes in aquaculture;
- to promote and conduct research directed towards the identification, assessment, management and development of aquatic resources;
- to co-ordinate research activities, collate and disseminate information and training.

Aquaculture research priorities in the area of shrimp culture include health and environmental management of shrimp farming with special reference to development of treatment systems, identification and prevention of disease, water quality management, soil management and coastal zone planning. Programmes on diversification of culture species and systems and sea farming are in the pipeline. The potential groups of species considered include seaweed, sea cucumber, artemia, milk fish, sea bass and grouper. The concept of community-based management of reservoir fisheries has gained more importance in the recent past in order to develop a socially responsible culture-based capture fisheries systems in Sri Lanka. Formulation of suitable feeds for brood stocks of carps, increasing the efficiency of the fry and fingerling production of major carps, development of a scientific data base on culture-based capture fisheries, determination of the production capacities are needed to increase the inland fisheries production. Assessment of freshwater ornamental fish resources and breeding of indigenous fish species are the main programmes concerned with ornamental fishery development. An effort is being made to develop community oriented shell fish culture. Mangrove and wetland management programme includes the continuous assessment of these resources, investigations on their contribution towards the production in brackish water areas and collecting information for their conservation and sustainable utilisation of the resources.

Expected output of the research programmes are technology development, improvement of existing technologies, formulation of policies, and conservation and management of aquatic resources. Target beneficiaries are the farmers, planners, policy makers, coastal communities and exporters. Table 1 summarises the processes and criteria used in formulating aquaculture research plans and priorities. NARA and the universities are the key institutions involved in the aquaculture research at present. Recent trend is to undertake collaborative research programmes participating government sector organisations, universities and farming communities.

NARA, universities and Rice Research Institute are presently involved in aquaculture research. Their affiliations are given in Table 2. Ministry of Fisheries and Aquatic Resources Development, Ministry of Education and Higher Education and the Ministry of the Agriculture are the Ministries involved in aquaculture research. These organisations are capable of addressing a fair proportion of the Sri Lanka's aquaculture research needs.

The adequacy of research capacity is very minimal in the areas of sea farming, improvement of breeding techniques, legal and economic aspects in aquaculture (Table 3).

Although there are several research programmes in environmental management, health management, brood stock development, breeding of indigenous ornamental fish, and improvement of breeding and culture techniques, the research capacities appear to be inadequate. There is an urgent need to improve the research capacities in those areas.

Table 1. Processes and criteria used in formulating aquaculture research plan and priorities

| Type of organisation   | Process  | Criteria  | Participants  |
|--|--|---|---|
| National Aquatic Resources Research and Development Agency   | <ul style="list-style-type: none"> <li>• Consultation among farmers, researchers, managers and government officers</li> <li>• Formulation of projects</li> <li>• Discussions with senior staff</li> <li>• Recommendation of the scientific and technical committee</li> <li>• Approval of the governing board</li> </ul> | <ul style="list-style-type: none"> <li>• Industry needs</li> <li>• Request from:               <ul style="list-style-type: none"> <li>• Farmers and farm managers</li> <li>• Government Aquaculture Development Division</li> </ul> </li> <li>• National development plan and needs</li> <li>• Interest of researchers</li> </ul>   | <ul style="list-style-type: none"> <li>• Shrimp farmer associations</li> <li>• Government research agency (NARA) - officials and technical staff</li> <li>• University researchers</li> </ul> |
| Other research organisations including national universities | <ul style="list-style-type: none"> <li>• Individual initiative (researchers): proposal prepared for submission for funding through institute</li> <li>• Consultative approach: discussions with government agencies and private sector</li> <li>• Peer consultation</li> </ul>   | <ul style="list-style-type: none"> <li>• Interest of researchers</li> <li>• Local needs</li> <li>• National development needs</li> <li>• Staff capability</li> <li>• Contribution to scientific knowledge</li> <li>• Interest and requirement of funding organisation</li> <li>• Supply of inexpensive protein (food security)</li> <li>• Private sector needs</li> </ul> | <ul style="list-style-type: none"> <li>• Researchers</li> <li>• University faculty members</li> <li>• Government sector</li> </ul>  |

Table 2. Research organisations, their affiliation and areas of competence.

| Research organisation                                    | Affiliation   | Area of competence   |
|--|---|--|
| National Aquatic Resources Research & Development Agency | Ministry of Fisheries and Aquatic Resources Development | <ul style="list-style-type: none"> <li>• Shrimp culture</li> <li>• Welland management</li> <li>• Environmental management of aquaculture</li> <li>• Utilisation of problem soils for shrimp culture</li> <li>• Inland fisheries management</li> <li>• Ornamental fish culture/food fish culture</li> <li>• Bivalve culture</li> <li>• Artemia culture</li> </ul> |
| University of Colombo                                    | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Bivalve culture</li> <li>• Artemia culture</li> <li>• Shrimp culture (ranching in lagoons)</li> </ul>   |
| University of Peradeniya                                 | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Integrated fish culture</li> <li>• Ornamental fish culture</li> <li>• Shrimp culture</li> <li>• Reservoir fisheries</li> <li>• Rice-fish culture</li> <li>• Fish breeding</li> </ul>  |
| University of Sri Jayawardenapura                        | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Freshwater fisheries management</li> <li>• Environmental management in shrimp culture</li> <li>• Feed development</li> <li>• Water management</li> </ul>  |
| University of Kelaniya                                   | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Inland Fisheries and aquaculture</li> <li>• Conservation of endemic freshwater fish</li> <li>• Fish diseases</li> <li>• Shrimp culture</li> <li>• Ornamental fish culture</li> <li>• Food fish culture</li> <li>• Environmental aspects</li> <li>• Mangrove and wetland management</li> </ul>                           |
| University of Ruhuna                                     | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Ornamental fish culture</li> <li>• Riverine fisheries</li> <li>• Marine fisheries</li> <li>• Environmental aspects</li> <li>• Mangrove management</li> </ul>  |
| Eastern University                                       | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Fish disease</li> <li>• Fish/shrimp farming</li> </ul>  |
| Jaffna University  | Ministry of Education and Higher Education              | <ul style="list-style-type: none"> <li>• Fish farming</li> </ul>   |

Table 2. Continued

| Research organisation            | Affiliation              | Area of competence  |
|----------------------------------|--------------------------|---|
| Institute of Fundamental Studies | Presidential Secretariat | <ul style="list-style-type: none"> <li>• Limnology</li> <li>• Reservoir fisheries</li> <li>• River ecology</li> </ul> |
| Rice Research Institute          | Ministry of Agriculture  | <ul style="list-style-type: none"> <li>• Rice-fish farming</li> </ul>   |

The existing manpower resources include more than 250 personnel trained in areas related to biological sciences, attached to universities and NARA. Nevertheless very few have specialised in aquaculture. There are no legal specialists, social scientists, economists and engineers trained at Ph.D. level for aquaculture. Long-term planning and development programmes should consider the development of manpower in these areas. There are more than 100 scientists attached to institutions participated in this survey. Some of them are able to undertake aquaculture research with minimal exposure.

NARA has the highest number (18) of researchers in aquaculture and related disciplines. Recent interest developed among universities has increased the number of researchers in national universities and there are around 20 researchers qualified at post graduate level involved in research activities directly and indirectly related to aquaculture.

The highest total annual financial contribution to aquaculture research from the national budget comes from NARA and at present is around Sri Lankan Rupees 7.5 million. Approximately Sri Lankan Rs. 0.5 million is allocated per researcher to direct research activities and for infrastructure development. In the national universities, several major fisheries and aquaculture research programmes with substantial financial allocations have been carried out during the last decade. They include the following research projects.

- Strategies for partitioning the productivity of Asian reservoirs and lakes between capture fisheries and aquaculture for social benefit and local market without negative environmental impacts  
Total budget - Sri Lankan Rs. 48.7 million  
Funding agency - European Commission (INCO-DC Programme)  
Executing institution - University of Kelaniya, Sri Lanka
- Management strategies for enhanced fisheries production in Sri Lankan Australian lakes and reservoirs  
Total budget - Sri Lankan Rs. 17 million  
Funding agency - Australian Centre for International Agricultural Research (ACIAR)  
Executing institutions - University of Kelaniya, Sri Lanka
- Biology and distribution of *Anguilla bicolor bicolor* and *Anguilla nebulosa nebulosa* in the river systems of southern Sri Lanka  
Total budget - Sri Lankan Rs. 8.7 million  
Funding agency - Swedish Agency for Research Cooperation with Developing Countries (SAREC)  
Executing Agency - University of Ruhuna, Sri Lanka

Table 3. Adequacy of research capacity in meeting the aquaculture development needs.

| National aquaculture development priority                        | Priority research needs                                   | Adequacy |   |   |   |   |
|--|---|----------|---|---|---|---|
|  |   | 1        | 2 | 3 | 4 | 5 |
| Shrimp/prawn culture   | Environment management                                    |          | X |   |   |   |
|  | Disease/health management                                 |          | X |   |   |   |
|  | Soil management   |          |   | X |   |   |
| Inland aquaculture-based capture fisheries                       | Reservoir fisheries management                            |          |   |   | X |   |
|  | Development and improvement of brood stock                |          | X |   |   |   |
|  | Formulation of low-cost feeds                             |          | X |   |   |   |
|  | Determination of stocking densities in reservoirs         |          | X |   |   |   |
|  | Integrated fish culture                                   |          | X |   |   |   |
| Sea farming  | Verification of technology                                |          | X |   |   |   |
|  | Improvement of breeding techniques                        | X        |   |   |   |   |
|  | Economics of sea farming                                  | X        |   |   |   |   |
| Ornamental fish culture  | Breeding of indigenous species                            |          | X |   |   |   |
|  | Environmental aspects - population dynamics               |          |   | X |   |   |
| Seaweed and mollusc culture                                      | Improvement of breeding and culture techniques            |          | X |   |   |   |
|  | Assessment of natural resources                           |          |   | X |   |   |
| Mangrove and wetland management and conservation                 | Ecosystem management                                      |          | X |   |   |   |
|  | Productivity  |          | X |   |   |   |
|  | Environmental impact of destruction of sensitive habitats |          |   | X |   |   |
| Legal requirements/legislation related to aquaculture            | Legal framework   | X        |   |   |   |   |
| Socio-economics and environmental impacts related to aquaculture | Environmental auditing and evaluation                     |          | X |   |   |   |
|  | Studies on social impacts                                 |          | X |   |   |   |

Key: 1 = No capacity; 2 = Inadequate; 3 = Fairly adequate; 4 = Good; 5 = Excellent capacity

Table 4. Dissemination and utilization of research outputs

| Target users  | Methods used   |
|---|--|
| Policy planners, political level                                    | Reports<br>Seminars<br>Newspaper articles  |
| Administrators and managers of government agencies                  | Reports<br>Seminars<br>Meetings  |
| Fish farming community, small and medium scale and community level  | Workshops<br>Leaflets<br>Books<br>Meetings and conferences   |
| Private sector and supporting industries including investment banks | Meetings<br>Seminars   |
| Research community  | Research communications<br>Conferences<br>Annual seminars<br>Research papers and abstracts<br>Electronic media |
| Extension community   | Leaflets<br>Seminars   |
| Public in general   | Newspaper articles   |

Table 5. Issues and needs in planning and implementing national aquaculture research

| Category                                 | Issues   | Causes and Constraints   | Required Action   |
|--|--|--|---|
| Administration and institutional aspects | <ul style="list-style-type: none"> <li>• Incorrect administrative decisions on research priorities</li> <li>• Lack of sound aquaculture research plan or action plans</li> <li>• Low priority given to research</li> </ul> | <ul style="list-style-type: none"> <li>• <i>Ad hoc</i> changes in priorities</li> <li>• Inadequacy of funds</li> <li>• Need for trained staff</li> </ul> | <ul style="list-style-type: none"> <li>• Make research organisation an independent body</li> <li>• Develop action plan 5-10 years in advance</li> <li>• Improve staffing pattern at Department level</li> </ul> |



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Table 5. Continued.

| Category                                | Issues  | Causes and Constraints  | Required Action  |
|---|---|---|--|
| Legal aspects                           | <ul style="list-style-type: none"> <li>Weakness in legal framework</li> </ul>   | <ul style="list-style-type: none"> <li>Conflicts and problems in implementing plans</li> </ul>  | <ul style="list-style-type: none"> <li>Revise legal framework</li> </ul>   |
| Information                             | <ul style="list-style-type: none"> <li>Lack of availability of information on research developments</li> <li>Lack of information exchange/co-ordination</li> <li>Duplication of projects</li> </ul> | <ul style="list-style-type: none"> <li>Lack of required information</li> <li>Lack of project information</li> </ul>   | <ul style="list-style-type: none"> <li>Prepare information plan and framework</li> <li>Improve information exchange and co-ordination</li> <li>Develop advance information facilities</li> <li>Acquire current journals</li> <li>Increased extension and field services</li> </ul> |
| Human resources and research competence | <ul style="list-style-type: none"> <li>Lack of trained and experienced personnel</li> </ul>   | <ul style="list-style-type: none"> <li>Difficulty in implementing research programmes</li> </ul>  | <ul style="list-style-type: none"> <li>Promote collaborative programmes</li> <li>Provide regional co-ordination programme</li> <li>Develop regional lead centre for each specific area</li> </ul>  |
| Research facilities                     | <ul style="list-style-type: none"> <li>Inadequate facilities (including equipment and laboratory)</li> <li>Lack of funds and facilities</li> </ul>  | <ul style="list-style-type: none"> <li>Lack of government and external funding</li> <li>Inability to conduct experiments due to lack of facilities and inaccessibility of field sites</li> </ul>                    | <ul style="list-style-type: none"> <li>Provide or develop facilities</li> <li>Promote collaborative projects</li> <li>Identify funding sources</li> <li>Construct field research laboratories</li> </ul>   |
| Research environment                    | <ul style="list-style-type: none"> <li>Lack of appropriate training and exposure</li> <li>Low level of farmer participation in research</li> <li>Lack of co-ordination</li> </ul>                   | <ul style="list-style-type: none"> <li>Inefficient implementation and formulation of research programmes</li> <li>Low level of education of farmers</li> <li>Need to delineate research responsibilities</li> </ul> | <ul style="list-style-type: none"> <li>Provide appropriate training and exposure for staff</li> <li>Proper delineation of responsibilities</li> <li>Improved linkage and Cupertino between research and extension and farming communities</li> </ul>                               |
| Others                                  | <ul style="list-style-type: none"> <li>Duplication of research</li> </ul>   | <ul style="list-style-type: none"> <li>Lack of funds</li> <li>Inadequate co-ordination among research centres</li> </ul>  | <ul style="list-style-type: none"> <li>Develop collaborative research, identify main areas of research &amp; share sub-areas among research centres</li> <li>Recognise importance of research organisation</li> </ul>  |

- Pelagic productivity, plankton, fish population dynamics of small pelagic fish in the coastal lagoons of southern Sri Lanka  
Total budget - Sri Lankan Rs. 1.9 million  
Funding agency - Swedish Agency for Research Cooperation with Developing Countries (SAREC-SIDA)  
Executing Agency - University of Ruhuna, Sri Lanka
- Enhancing the capacity of the Department of Fisheries Biology of University of Ruhuna to carry out marine environmental research  
Total budget - Sri Lankan Rs. 7.1 million  
Funding agency - Swedish Agency for Research Cooperation with Developing Countries (SAREC-SIDA)  
Executing Agency - University of Ruhuna, Sri Lanka
- Livestock, fish and prawn integrated culture  
Funding agency - International Foundation of Science (IFS), Sweden  
Total budget - Rs. 0.66 million  
Executing Agency - University of Peradeniya, Sri Lanka
- Breeding of indigenous and endangered fish species  
Funding agency - Council for Agricultural Research Policy (CARP), Sri Lanka  
Total budget - Rs. 1.1 million  
Executing Agency - University of Peradeniya, Sri Lanka
- Fisheries management in Victoria reservoir, Sri Lanka  
Funding agency - Council for Agricultural Research Policy (CARP), Sri Lanka  
Total budget - Rs. 0.4 million  
Executing Agency - University of Peradeniya, Sri Lanka

Several projects on health management in coastal shrimp culture, and aquaculture development are supported by FAO and the total budget of these projects is Sri Lankan Rs. 3.9 million.

The main target users of the aquaculture research in Sri Lanka are the farmers, planners, policy makers, and extension workers. Dissemination of knowledge is mainly through reports, seminars, meetings, farm level workshops, leaflets, annual seminars and research communications (Table 4). However there is a considerable amount of criticism in the effectiveness in dissemination of the research finding to the end users. The extension arm of the Ministry of Fisheries and Aquatic Resources Development has to be strengthened for this purpose.

The most important needs and issues in planning and implementation of national aquaculture research are summarised under the categories of administrative and institutional aspects, legal aspects, information, human resources, research facilities and research environment in Table 5. Lack of long-term National aquaculture research policy and plan, and incorrect decisions lead to *ad hoc* changes in research programmes and in priorities. Development of a national long-term action plan will help more co-ordinated continuous research activities.

Lack of information, delays in information exchange and inaccessibility to modern information systems are main disadvantages faced by the aquaculture researchers in Sri Lanka. Inability to retain qualified staff and lack of required exposure affect the standard of research programmes implemented. Advanced facilities for aquaculture research are yet to be developed. Lack of field stations in the area of development restricts close monitoring.

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Proper delineation of responsibilities and improvement of co-ordination and linkage between researchers, farmers and extension workers will benefit each other in promoting the flow of research information to the end users.

**References**

- Anonymous 1988.  
National Environmental-Act (Act No. 47 of 1980, Amended Act No. 56 of 1988)  
Central Environment Authority, Colombo, Sri Lanka.
- Anonymous 1995.  
Fisheries Development Plan, Ministry of Fisheries and Aquatic Resources  
Development, Colombo, Sri Lanka.
- De Silva S.S. 1985.  
Status of the introduced cichlid *Sarotherodon mossambicus* in the reservoir fishery  
of Sri Lanka. A management strategy and ecological implications. *Aquaculture and  
Fisheries Management* 16: 91-102.
- Jayasinghe J.M.P.K. 1991.  
Utilisation of acid sulphate soils for shrimp culture in Sri Lanka. Ph.D. thesis,  
University of Stirling, UK, 207 pp.
- Jayasinghe J.M.P.K. 1997.  
Investigations on the disease out-breaks in shrimp culture systems developed on  
problem soils. Final Report of Research grant ARP/12/153/163. National Aquatic  
Resources Research & Development Agency, Colombo. 157pp.
- Sivasubramaniam, K. (1995)  
Fisheries Research in Sri Lanka. ADB/SRI LANKA Fisheries Sector Development  
Project, Consultancy Report. Colombo Sri Lanka. 165 pp.