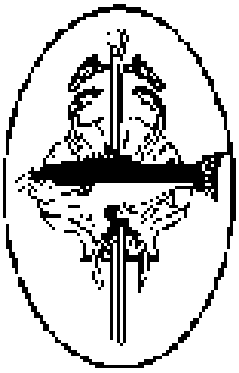
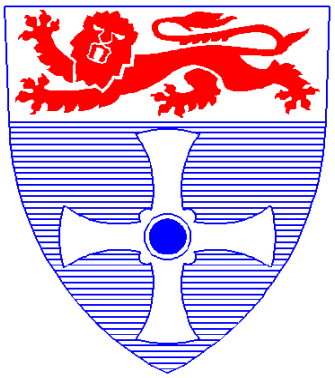
UNIVERSITY OF STIRLING



INSTITUTE OF AQUACULTURE

UNIVERSITY OF NEWCASTLE



CENTRE FOR LAND USE AND WATER RESOURCES RESEARCH

INTEGRATION OF AQUACULTURE WITHIN IRRIGATION SYSTEMS

PROCEEDINGS OF STAKEHOLDER WORKSHOP HELD AT HOTEL TOPAZ, KANDY,

26-27th of November 1998

Working Paper 2.3

With
Agribusiness Centre,
Peradeniya University

A UK-Sri Lanka Collaborative Research Project funded by the UK Department for International Development (DFID)

Preface & Acknowledgements

This stakeholder workshop, is an interim component of a UK Department for International Development (DFID) funded natural resources research program, incorporating two linked projects: R7064 and R7123. The project aims to investigate the potential for integrated aquaculture options within large and small-scale irrigation systems to bring benefits to marginal groups within diverse, risk-prone semi-arid and water-stressed regions of the world. Benefits are expected to be increased opportunities for livelihood diversification and more efficient and sustainable use of dwindling per capita water supplies.

The workshop was hosted by the Agribusiness Centre, Faculty of Agricultiure, University of Peradeniya (Sri Lanka). Other principle collaborators are the Institute of Aquaculture, Stirling University (UK) the Centre for Land-use and Water Resource Research, Newcastle University (UK) and CARE International (Sri Lanka).

All statements of fact or opinion in this document should be taken as interim statements, The work is continuing and matters covered in this report may be revised in the light of future information received. The document has been prepared to provide information exchange within the research team and with counterparts elsewhere. Comments are invited and should be sent to project leaders in UK or Sri Lanka.

Executive Summary

The purpose of the workshop was to elicit the opinion of a broad range of stakeholders on poverty focussed aquaculture options in both large and small-scale irrigation systems and to develop a framework for an in-depth study of aquaculture potential. Researchable constraints and development opportunities were identified through stakeholder analysis.

Attending the 2-day workshop were over 30 participants from local and central government, NGO's, donors, banks and research organisations. Language constraints precluded the participation of primary stakeholders (i.e. the farmers themselves) whose needs and priorities are instead being elicited using similar workshops and a variety of other participatory techniques in the field.

The conceptual basis behind the 'stakeholder analysis' methodology is presented, highlighting the need for such participatory methods in planning research designed to support sustainable development interventions. Using this approach we seek to understand the potential benefits and losses which may accrue to different groups and come up with a shared idea of work based on stakeholders expectations, priorities and their potential to contribute.

The workshop commenced with a series of presentations based on available secondary data. These included: the nature of inland water resources including large (institutionally managed) and small-scale (farmer-managed) systems, aquaculture options learned from other areas of the world and the current socio-economic and gender context of communities associated with irrigation development in Sri Lanka. Open discussion forums in which the opinions of participants were canvassed followed these sessions.

Three different stakeholder sessions followed. In the first, participants were grouped according to their institutional background and asked to comment on their potential to gain from the project and their ability and constraints to participation. Lack of time and other resources were identified as a major constraint. In the second session stakeholders were placed into mixed groups and asked a series of questions designed to elicit their reactions to the project objectives. All participants agreed broadly with the need to address sustainability issues pertaining to inland fish production and the need for bottom up approaches to improve the potential of marginal groups to benefit. Finally in the third session stakeholders were invited to participate in the formulation of a research agenda based on identification of technical, institutional, socio-economic and biological constraints to aquaculture within large and small-scale irrigation systems.

In summary, all the stakeholders present endorsed the need for such a project enthusiastically. The unique withdrawal of state patronage to the sector from 1989 to 1994 was identified the principle cause of weak institutional support for the inland fisheries sector. This along with poor co-ordination between other developmental and line agencies were identified as important constraints to the uptake of sustainable aquaculture options within irrigation systems, particularly in the context of no existing indigenous tradition of aquaculture. The institutional situation also impacts on the reliability of data used to establish the current status of the inland fisheries sector, highlighting the need for further field based situational research prior to any intervention. Despite a widespread appreciation of the participatory paradigm, many institutions (and in particular those involved in research) emphasise the development of intensive, high input fixed technological packages which are likely to have limited to relevance to the marginal groups targeted by the project.

Glossary of terms

AbC	Agribusiness Centre (University of Peradeniya)
DFID	Department For International Development (formally ODA)
FIrST	Fish in Irrigation Systems Technology
IIMI	International Irrigation Management Institute
IoA	Institute of Aquaculture (Stirling University)
CLWRR	Centre for Land Use and Water Resource Research (Newcastle University)
NGO	Non Governmental Organisation

Table of contents.

Preface & Acknowledgements ..... **ii**
Executive Summary ..... **iii**
Glossary of terms ..... **iv**
Table of contents. ..... **v**
List of Tables. ..... **vi**
1. Introduction and purpose of the workshop **1**
2. Summary of workshop proceedings **1**
3. What is a stakeholder analysis? **2**
4. Results of stakeholder analysis session 1 ..... **3**
4.1 Results of stakeholder session 1. Part A **3**
4.2 Results of stakeholder session 1. Part B **5**
5. Results of stakeholder analysis session 2 ..... **5**
6. Results of stakeholder analysis session 3 - Formulation of a research agenda **8**
Appendix 1a: Position paper 1a - What we hope to achieve; aims and project goals **10**
Appendix 1b: Position paper 1b - Key issues in developing aquaculture as part of integrated water resource management within irrigation systems **11**
Appendix 2: Position Paper 2 – The nature and distribution of irrigation systems in Sri Lanka and their potential for Aquaculture. **12**
Executive Summary **12**
Part I - Introduction **13**
Part II - Water resources in Sri Lanka **13**
2.1 Introduction 13
2.2 Reservoirs 14
2.2.1 Multipurpose reservoirs 14
2.2.2 Hydroelectric reservoirs 15
2.2.3 Other Reservoirs 15
2.3 Classification of Irrigation Resources 15
2.4 System Tanks and Non System Tanks 18
2.5 Irrigation Canals 18
2.6 Water availability in tanks 19
Part III - Water Uses in Sri Lanka **20**
3.1 Irrigation Development in Sri Lanka: the Rationale 20
3.2 Rice Cultivation: the Main Use of Irrigation Water 20
3.3 The Drive for Diversification 21
3.4 Livestock in Irrigation Systems 22
3.5 People Use Irrigation Water 22
3.6 Fish in Irrigation Systems 22
Part IV – Socio-economic Conditions in Irrigation Systems **23**
4.1 General Socio-economic Conditions in Irrigation Schemes **Error! Bookmark not defined.**
4.2 Fishermen amongst Farmers. **25**
Part V - Management of Irrigation Schemes **27**
5.1 Institutional involvement in irrigation management 27
5.2 Farmer Participation in Irrigation Management 27

Part VI -Potentials & constraints to promotion of aquaculture in irrigation systems..... 29
6.1 Water Adequacy.....29
6.2 Potential & constraints to aquaculture and fisheries within irrigation systems. 29
References..... 31
Annex 1: Changes in command area of major and minor irrigation schemes in Sri Lanka 1975-1994 "000"ha. 33
Annex 2: Gross sown area under paddy by season, by type of irrigation scheme and zone 1977-1997 (‘000s ha) 34
Annex 3: Irrigation schemes with fisheries of major importance to the inland fisheries sector. 35
Annex 6: Map of Sri Lanka showing major anicut schemes 39
Annex 7: Water levels of Kaudulla tank 41
Appendix 3: Position paper 3. The nature and distribution of small-scale farmer managed
irrigation systems in Sri Lanka and their potential for aquaculture..... 42
References..... 56
Appendix 4: Position Paper 4a: Current Status of Inland aquaculture in Sri Lanka..... 62
Appendix 4b: Position Paper 4b. Socio-economic and gender issues with relevance to
aquaculture development in Sri Lanka..... 83
References..... 90
Annex 1: Summary of key points arising from open discussion of Position Paper 4. 91
Appendix 5a: Position paper 5: Production of aquatic organisms in large and small-scale
irrigation systems - Lessons learnt from elsewhere..... 92
References:..... 98
Annex 1: Summary of key points arising from open discussion of Position Paper 5 99
Appendix 6: Workshop timetable and agenda..... 100
Appendix 7: List of participants attending workshop and affiliation..... 101
Appendix 8. Composition of groups participating in stakeholder session 1. : ... 102
Appendix 9: Composition of groups participating in stakeholder sessions 2 & 3. 103

List of Tables.

Table 1: Results stakeholder session 3: Identification of researchable constraints to aquaculture in small and large-scale irrigation systems……..8

1. Introduction and purpose of the workshop

A workshop was held in Kandy on the 26th - 27th November 1998. Attending were 30 participants, representing a variety of institutions, including local and central government, NGOs, donors, banks and research organisations. The workshop was hosted by the Agribusiness Centre, Department of Agriculture, University of Peradeniya. Primary aims were to canvass opinion on aquaculture options in both large and small-scale irrigation systems, to contribute to the establishment of the geographic and socio-economic context of irrigation systems and to develop a framework for an in-depth study of aquaculture potential. Researchable constraints and development opportunities were identified through stakeholder analysis. Sites suitable for in-depth investigation will be identified. Outputs will contribute to a wider DFID funded collaborative program being undertaken in semi-arid regions of Sri Lanka, India and Pakistan. Details of project goals in Sri Lanka are outlined in Appendix 1. A report of the proceedings of the workshop is presented in the following sections.

2. Summary of workshop proceedings

The workshop began with a series of presentations based on available secondary data to provide context for the following discussions. Commissioned by the Agribusiness Centre and IIMI, the presentations considered the following areas: the nature of the inland water resource including large and small-scale irrigation systems, aquaculture options learned from elsewhere and socio-economic and gender issues.

These outputs clearly demonstrated the variation in reporting of agencies involved in irrigation and fisheries. Inconsistent definitions for large and small-scale, perennial and seasonal systems made interpretation difficult. The source and quality of fish production data was also impaired by the weak institutional situation that persists following withdrawal of all government support to the inland fisheries sector between 1989-1994 (see section 3.4). The primacy of crop production, particularly paddy, both historically and in modern times for the design and management of irrigation structures and water became evident from presentations on both large and small-scale systems. During discussion after the presentations, participants with a fisheries background raised the negative impacts of irrigation development. The lack of an aquaculture tradition contrasted with the recent boom in coastal shrimp culture and a traditional dependence on inland and marine fisheries (Working Papers 3 and 4). The socio-economic and gender issue paper stimulated lively discussion especially regarding the need for greater consideration of gender impacts in research planning. Key points arising from these open discussion forums are detailed after each of the respective working papers presented in Appendices 1 to 5. The subsequent stakeholder analysis was based on three sessions, the results of which are presented in sections 4 to 6. A summary of methods and outputs of these sessions follows.

Session 1: Participants were grouped into seven stakeholder groups; donors, government development organisations, NGOs, government research organisations, university irrigation research, university agricultural/fisheries, and one group of women. Most participants were from research and university backgrounds. The workshop was held in English, and some of the field-based NGO participants may have been prevented from fully active participation because of language difficulties. Individual and consensus opinion was canvassed on 3 questions relating to the stakeholders view on (1) their individual gain from the project (2) their potential inputs to the project and (3) constraints to participation in the project (the results are presented in Appendix 8). The main benefit was seen by the dominantly research-orientated group as an opportunity to collect data and gain knowledge in a new area of study. The main constraints to their participation in the project were the shortage of time and other resources.

Session 2: This session focused on reactions to the project objectives and developmental impact, particularly on the poor. Participants were divided into four mixed groups. There was wide agreement between different groups. The need for research that improves the knowledge base for integration of irrigation and fish production was agreed. The current lack of suitable management approaches and technology was raised. The role of the project in improving dissemination of information, improving co-ordination and collaboration was suggested. There was broad agreement that the project objectives did meet Sri Lanka's needs and that a participatory, grass roots approach was vital to develop appropriate solutions. Co-ordination of the various stakeholders was raised as vital to improving dissemination of results to the target groups. Improved awareness among decision-makers, exchange of published data between scientists and field workers, and farmer participation in field schools and village meetings were recommended.

Session 3: Formulation of research agenda. Four categories were used to summarise the research priorities for small-scale and large-scale irrigation systems (see Appendix 10). Technical, socio-economic, institutional and biological foci revealed both common and specific issues. A variety of knowledge gaps were identified. The technical issues of fish seed availability, species choice, and management strategies were raised. The matrix does little justice to the complexity of constraints identified. For instance, predation pressure on stocked fish and encroachment of aquatic weeds in small-scale systems were identified as biological issues but clearly also have institutional, social and economic bases. Similarly the technical problem of siltation can be linked to socio-economic factors such as land use practices around the tanks and population pressure. The constraints to fish production of seasonality of water availability and primacy of water for crops were raised as technical rather than institutional or socio-economic issues. Technology options based on fish culture in canals, in cages in water bodies and in rice fields were identified as priority knowledge gaps to overcome. The current lack of extension and research services towards improving fish production in irrigation systems was linked to conflicts of interest between agencies, or at least communication gaps. Very limited capacity to implement change, especially for the numerous small-scale tanks, and enforce laws was identified as a major constraint.

During the course of formulating a research agenda, the stakeholders identified many of their own weaknesses in facilitating communities to improve fish production in irrigation systems. Even field-based NGOs mainly concentrate on tank rehabilitation and the improvement of fish production through stocking with hatchery produced seed is constrained by the scarcity of government fish seed supplies, and lack of technologies for local fish seed production. Two major questions are, if fish seed were available at the right size and time, would they lead to measurable impacts on production, given the importance of self-breeding and recruiting of exotic tilapias? In turn would these benefits accrue to poorer people within communities?

In both large and small group sessions, academics were challenged by field researchers and development workers as to the relevance of their research foci and knowledge of real issues facing poor communities.

3. What is a stakeholder analysis?

Development activities can bring both benefits and losses, intended and unintended to the various individuals, groups, communities and institutions involved in a project. These 'stakeholders' are present at various levels. *Primary stakeholders* tend to live in close proximity to the project location and are likely to be directly affected by the project impacts. Further removed are *secondary stakeholders* who have an interest in the resources affected by the project, or are involved in the delivery or decision-making processes associated with project activities. Within this second group are those who affect and those who are affected by change. Losses are likely to impact most seriously on the poorest primary stakeholders.

When researching any new development initiative it is necessary to understand how people involved in it are likely to be affected. This can be achieved in a *stakeholder analysis*, in which the potential interactions, conflicts and trade-offs associated with a particular course of action can be recognised. Stakeholder analysis is also an important first step in developing a shared idea of the work to be done and how to go about it, to improve the way work is designed and carried out. In the present context stakeholder analysis was carried out to determine participants' priorities for the formulation of a research agenda, to clarify differences in contribution, expectations and priorities, and to negotiate acceptance of these.

As it proved difficult to bring primary and secondary stakeholders together within a single forum, these workshops focused mainly on the institutions working in development. Workshops were followed up by village-level consultations using a variety of participatory techniques. In India this has taken the form of a village level stakeholder workshop.

4. Results of stakeholder analysis session 1

Participants were divided into eight stakeholder groups according to their primary institutional function or gender (see Box 1) and asked three questions. In part A individual responses were collected from all participants within groups, whilst responses in part B are a result of group consensus. The participant composition of the different groups is shown in Appendix 8. Results of the session are presented below. Responses are highlighted in bold text, where participants apparently misinterpreted particular questions. Numbers in brackets indicate the repetition frequency of a particular response.

Box 1: Different Stakeholder groupings for session 1.
A: Donors
B: Development
C: Fisheries NGO's
D: Non Fisheries NGO's
E: Government Research
F: University Irrigation Research
G: University Research Male
H University Research Female

4.1 Results of stakeholder session 1. Part A

Question 1. What will you gain from the project?

Responses (from individuals within groups)
Group A: *improve knowledge of rural aquaculture development options, *learn how to optimise use of limited resources, *to learn of alternative farming opportunities in irrigated areas, *to be able to exchange ideas and experiences related to the integration of fish production and irrigation, *to learn about proper implementation of reservoir hatcheries.
Group B: *to collect data on perennial irrigation systems (2) *opportunity to learn something new, *will learn potential and constraints for developing inland fisheries, *myself and others will be able to get sufficient animal protein
Group C/D: *I will learn about local food security and aquaculture, *the project may generate self-employment opportunities in the future, *I will learn about the project.
Group E: *will help me to collect and better understand relevant information regarding aquaculture, *will gain financial and technical help to conduct research on fish in rice and aquaculture in irrigation systems (2)*
Group F: *opportunity to do research leading to publications that will ultimately benefit the poor, *I would like to see how the development of inland fisheries production could contribute to formulation of watershed based management policy, *will get more understanding and experience of a problem of national importance, *will learn about new technologies.
Group G: *will learn about research that could contribute to development, *will be able to establish useful contacts, *will learn about the capacity and perceptions of participants, *will

learn about stakeholder methodology, *will do research to gain my PhD, *will be able to identify potential areas of collaboration
Group H: *will be able to increase fish production through research outputs, *will gain knowledge of new technology, *will allow me to disseminate information to those who are trained in fisheries and aquaculture, *will improve my own research activities and gain practical experience in development issues to improve my employment prospects (2)

Question 2 - How will you benefit the project?

Responses (from individuals within groups)
Group A: *I can assist projects in North Western Province, *could help in disease diagnosis, *could possibly help in larval feeding technology, *offer financial aid for new programs implemented by NGOs, *could offer research and advice on social and financial aspects, *could help to develop inland fisheries models, *I could provide cost benefit analysis.
Group B: *can participate in training programs to disseminate knowledge and enhance development of inland fisheries (2).
Group C/D: *could share knowledge and experience in the fisheries sector especially about integrated fish farming, *my experience in rural development could be shared
*could facilitate farmers to adopt rice fish integration,
Group E: *do research and transfer the technical know how to the community, *train farmers groups, *help with technical improvements (e.g. mini hatcheries), *collect relevant information from my institute and share with project, *could help in identifying researchable issues, *Lobby administrators to implement any favourable project outcome.
Group F: *can gather information from various stakeholders, *knowledge and experience research techniques, * knowledge of irrigation systems managing multidisciplinary research, *Experience in hydrology and water resources
Group G: *Economic analysis of fish production in irrigation systems of the dry zone of Sri Lanka, *Will present position a paper, *will facilitate participation
Group H: *could assist in collecting literature, *could work with farmers, * could assist collecting marketing information, *could participate in research, *help in economic analyses, gender analysis and assisting surveys, *could offer my theoretical knowledge on a number of disciplines including ecology and gender in an interdisciplinary fashion, can contribute my experience to research programmes conducted in irrigation systems.

Question 3 What would constrain your ability to participate in the project?

Responses (from individuals within groups)
Group A: *there would be no constraints as I am presently involved in reservoir based fisheries development in NW province, *financial constraints, *time constraints (2)
Group B: *official engagements, *financial constraints
Group C/D: *others take too long to recognise my vision, *time constraints (3), family obligations
Group E: *logistical constraints, *lack of transport (2), *difficult to stay away from home for a long time, *lack of relevant training, *conflicts with current work, *may conflict with current work in the shrimp industry,
Group F: *time commitments to other academic programs (2), *contract to expire shortly
Group D: ***collaboration with ecologists engineers for appropriate solutions/ applications**
Group H: *time constraints and personal commitments(3) *lack of experience in the field, *how to complete my PhD in six months, *if the project appears to have adverse environmental and ecological effects.

4.2 Results of stakeholder session 1. Part B

Question 1. What will you gain from the project?

Responses (group consensus)
Group A: *gain more knowledge of sustainable fisheries development in irrigation systems
Group B: *new aquaculture technology to improve the nutritional status of the nation,
Group C/D: *increased awareness of integrated approaches to aquaculture development
Group E: *support to conduct research and a forum to exchange and improve knowledge base
Group F: *Increase knowledge of design and management of irrigation systems compatible with increase opportunities for fish production, *how to tackle poverty alleviation
Group G: *improve institutional capacity and personal status through knowledge of technology, *to appreciate others view-points, *improve co-ordination through contacts and formation of networks, *identify researchable opportunities and constraints for the poor to benefit from integration of fisheries in integrated farming systems
Group H: *it will improve individual knowledge and increase research opportunities

Question 2: How could you contribute to the project?

Responses (group consensus)
Group A *participation to share expertise of group members (technical, social, economic)
Group B: *develop cost effective implementable models & monitor usefulness to the farmer.
Group C/D: *share experiences to facilitate and initiate a process.
Group E: *identify researchable issues, *develop technologies and transfer to the target group, *persuade relevant decision-makers to implement any feasible outcome
Group F: *policies and practices about irrigation systems and water resources, *knowledge of technical limitations to performance of irrigation systems
Group G: *offer multidisciplinary research methodologies, *sharing knowledge and experience with respect to project objectives, *facilitate mobilisation of tangible and intangible resources with respect to achieving project objectives.
Group H: *can offer knowledge and experience in various disciplines (agriculture, aquaculture), *we can offer a female perspective on the analysis

Question 3: What constrains your participation?

Responses (group consensus)
Group A: *we are only able to participate on a part-time basis
Group B: *time and money, *conflicting institutional objectives and financial constraints
Group C/D: ***Poor communication between farmers and researchers**,
Group E: *lack of mobility - research stations are far from research sites, *Research only overlaps slightly with our focus, *financial constraints.
Group G: *potential lack of multidisciplinary holistic approach, *logistical (time) constraints *institutional barriers (conflict of interest and institutional politics).
Group H: *may conflict with personal and professional responsibilities, *may conflict with personal value systems e.g. through adverse effects on natural ecosystems.

5. Results of stakeholder analysis session 2

Participants were divided into four new heterogeneous stakeholder groups (see Appendix 9) and were asked to respond to four questions. Responses are recorded below.

Question 1: Why is there a need for this project?

Group Responses

Group A

- Irrigation systems are an under-utilised resource
- To improve and enforce management systems
- To increase income generating opportunities and nutrition
- To benefit unemployed youth, poor men and women and landless people.

Group B

- To optimise use of irrigation systems to alleviate poverty
- Facilitate development of appropriate technology
- Expand demand for aquaculture and related research
- Could help establish strong linkages and co-ordination amongst stakeholders

Group C

- Optimising efficient use of resources
- Improving the livelihood security of poor groups
- To provide a cheap source of protein

Group D

- Knowledge of technology is lacking
- **Financial problems**
- Lack of co-ordination and collaboration among institutes
- A multi-disciplinary research focus is currently lacking
- Poor dissemination of research findings and inconsistent policies

Question 2: Do these objectives meet Sri Lanka's needs?

Group responses

Group A. Yes but there is also a need for the following:

- There is a need for sustainable integrated water management and development of institutional capacity at different levels.
- There is a need to Empower villagers by bridging the gap between government policies, international donors, NGOs and peoples needs.

Group B

- Yes, through strengthening of seed production programmes

Group C

- Addresses problem of malnutrition in mothers and children
- Offers increased employment opportunities
- Increases earning potential of women
- Increase fingerling production for stocking

Group D

- Yes!

Question 3: How can the project best target the poor?

Group responses:

Group A

- *investigate problems at grass roots level using a multidisciplinary and participatory approach to identify needs, *consider intensive systems leading to poverty infiltration (this will result in indirect benefits for the poor in the context of decreasing interest in agricultural livelihoods)

Group B

- *identify areas of high poverty and use participatory techniques to target relevant needs, *efficient networking of various stakeholders to share knowledge experience and other resources, *be low input integrated subsistence or commercial production depending on results of preliminary research, *should not be driven by donors or politicians.

Group D

- * communities should participate in research, *credit should be available, *bottom up and top down development of technologies adoptable by the poor, *identification of tank specific aquaculture techniques, *stimulate legislation with respect to multi -use of water resources in irrigation systems, *identify and find solutions to overcome social constraints, improve harvesting marketing and post harvesting technologies.

Question 4: How can you ensure that dissemination will reach target groups?

Group responses:

Group A

- *dissemination of results through participatory research, village meetings should be gender and age balanced to identify needs of isolated groups, *effective and targeted documentation of outputs for planners, policy makers, engineers and extension workers, *training of extension workers rather than establishment of demonstration sites, *strengthening of existing networks, *stakeholder workshops max. duration 1 day.

Group B

- improved co-ordination of various stakeholder institutions, *Ensure direct participation of CBOs, *participatory monitoring and evaluation using farmer derived indicators for impact assessment, *use of electronic and print media to disseminate information.

Group C

- *publications and seminars for scientists, *awareness programmes and workshops for communities, *farm field schools organised by NGOs, CBOs and FOs (farmers are result driven), *use of extension workers and pilot projects

Group D

- *farmer participation in all phases of research, *establish model farm villages, *extension should be involved in every aspect of project, *improve awareness amongst decision-makers and establish multidisciplinary committees amongst extension officers, agricultural officers etc.

6. Results of stakeholder analysis session 3 - Formulation of a research agenda

Participants were divided into the same four heterogeneous stakeholder groups as session 2 (see Appendix 9) and asked to identify constraints to aquaculture in large and small-scale irrigation systems and gaps in the existing knowledge base. Results are presented in Table 1.

Table 1: Results stakeholder session 3: Identification of researchable constraints to aquaculture in small and large-scale irrigation systems.

	Constraints			**Gaps**
	Small irrigation systems	**Large irrigation systems**	**All irrigation systems**	**All irrigation systems**
Technical	*Seasonality and uncertainty of water availability *Identification of suitable species.* *Fish seed timing and variety. *Primacy of crops over fish.* *Overuse/misuse of agro-chemicals.*	*Impacts of chemical residues unknown.* Impact of hydraulic conditions in canals on performance of fish. *Artificial barriers for fish migration.* Uncertainty of water availability.	Lack of basin level hydrological planning. ***Poor seed availability.* *Siltation *Lack of integrated watershed management* *Primacy of irrigation for arable crops. **Fluctuations in water levels.* *Poor access to nursery* *pond management and harvest technologies	How to enhance and sustain natural fish breeding systems during the design and management of irrigation systems. **Appropriate technologies for the spawning and nursing at the local levels.* Knowledge of feeding technologies (cages) **Knowledge of management of fish stocks (large)* Lack of knowledge of pen and cage systems in canals. *Appropriate methods for poor people to produce ornamental fish production.* Technology for rice fish culture. *Potentials for use of drainage water* Polyculture of ornamental and food fish.
Socio-economic	Traditional management of resources and set up of village. **Poor maintenance.* *De-forestation in Catchment area.* Access to water resources.	Poor seasonal labour availability. **Lack of sense of ownership/ government dependency attitude* *Illegal fishing and methods	Poverty. *Human population pressure.* Management and inputs of farming systems around tanks. ***Poaching*	Poor understanding of cast, ethnicity, gender , religion ***Consumer preferences.* Comparison of food and ornamental combinations. *Compatibility of different aquaculture options with existing portfolio of income generating activities at community and household level.* Better understanding of seed and food fish marketing and production networks.

Table 1 continued.

	Constraints			Gaps
	Small irrigation systems	**Large irrigation systems**	**All irrigation systems**	**All irrigation systems**
Institutional	Lack of technical assistance and poor extension capacity.	Conflicts due to complexity and size. *Little experience in resettlement management.* *Poor technical extension linkages.* *Communication gap between irrigation engineers, biologists and greens (multidisciplinary approaches) *Management of sluices for agriculture rather than fisheries*	Property rights and access. *Poor capacity to implement change or enforce laws.* **Institutional conflict of interest. ***Poor co-ordination / management between water users (poor definition of responsibilities amongst Govt. departments).*	Poor catch statistics **Lack of data on quantity and quality of small scale irrigation systems* *Poor understanding of participatory mechanisms to involve communities.
Biology	**Encroachment by aquatic plants.	Predation pressure	High predation pressure. *Available species for local niches i.e. deep water, macrophagous.*	*Suitability of indigenous fish species for different water bodies *Potential for communicable disease in new systems (diagnostic, prophylaxis and treatment).*

* The No. of asterisks refers to the frequency with which constraints were cited by different stake holder groups. (* = 2 citations, ** = 3 citations etc.).

Appendices

Appendix 1a: Position paper 1a- 'What we hope to achieve: Aims and goals of the project.

Presented by: John Gowing Centre for Land Use & Water Resources University of Newcastle upon Tyne.

1. Introduction to UK-Sri Lanka collaborative research project

As demands from industry and municipalities increase, irrigated agriculture faces increasing competition for water. This situation has refocused attention on efficiency in irrigation systems and has led to a recent paradigm shift in the concept of irrigation management. The new focus is on irrigation systems as components of the whole water basin within which productivity of water use must take into account its multiple uses which may include industry, domestic supply, livestock and fish production as well as irrigation. At the same time, there is widespread concern over the environmental impact of large-scale irrigation development. In particular, it is apparent that extensive development of water resources for irrigation has often disrupted natural fisheries. Yet there has been little consideration given to replacement of the lost fishery potential through multiple-use management of the irrigation systems.

This research project aims to establish the scope for increasing productivity of water-use through integration of aquaculture within the extensive irrigation systems of Sri Lanka. The project will evaluate technical and institutional constraints to integrated management of canal systems for aquaculture and irrigation and provide guidance to planners and engineers. The project will involve case studies and action-research based upon collaboration between UK research institutions and collaborating institutions in Sri Lanka. A participatory approach will be adopted in order to promote maximum involvement of all stakeholders.

The project is funded by the UK Department for International Development and will adopt a poverty-focus. Direct beneficiaries will be small-scale fish producers (both existing and newly recruited) likely to be drawn from marginal and/or land less groups. Indirect beneficiaries will include fish processors (including women). Outputs will include three main elements:

- technical guidance to engineers and managers on how to integrate aquaculture into irrigation systems;
- policy guidance to planners and donors on when/where to intervene in order to promote integrated aquaculture in irrigation systems;
- research guidance to scientists and extensionists on ways to assist small-scale producers to benefit from such initiatives.

The project in Sri Lanka is part of a wider research programme involving collaborative fieldwork also in India and Pakistan.

UK collaborators are:
Centre for Land Use & Water Resources Research
University of Newcastle upon Tyne

Institute of Aquaculture
University of Stirling

Sri Lankan collaborators are:
Agribusiness Centre
University of Peradeniya

International Irrigation Management
Institute, Colombo

CARE International
Colombo

Appendix 1b: Position paper 1b - Key issues in developing aquaculture as part of integrated water resource management within irrigation systems

Presented by Dr David Little, Institute of Aquaculture, University of Stirling

1. Summary of key issues relating to integrated water resource management

- Water – quantity, quality, time – is there enough, of the right quality at the right time in the right place to meet peoples needs? Trends suggest that water will become a major source of conflict on international, national and local levels.
- Major use of water is for irrigating crops. Can the use of water for crop production be better balanced with its use for other purposes- multiple purpose use
- On balance irrigation has often had negative impacts on supplies of wild aquatic food. Gains in rice may have not been offset by losses to fish, snails and vegetables etc formerly abundant in flooded systems.
- These pressures will be stronger under semi-arid conditions with strong seasonality of water availability. These include areas with the poorest people, and the fastest growing populations.
- Can management of irrigation systems be integrated with the production of fish and other aquatic products? This project sets out to answer this question, in drier parts of Sri Lanka and India. We aim to identify promising approaches and begin the process of developing suitable methods with institutions, communities and individuals.
- A major issue is whether irrigation systems are managed by farmers' themselves- or water is supplied by some outside agency via a piped or channelled supply.
- Is the system small–scale, involving individuals or small communities, or large scale involving a much greater range of people?
- Does the system maintain water year-round predictably or is water availability seasonal and/or unpredictable?
- In what way can irrigation systems be integrated with aquaculture to involve and impact on poorer stakeholders?
- What could be the relationship between centrally irrigated areas with perennial water and those systems holding water seasonally? (seed supply?)

2. Issues in developing aquaculture as part of integrated water resource management

- What are irrigation users already doing in terms of managing aquatic products? Can these approaches be improved or disseminated further afield?
- What role does integration with aquaculture have in improved use of 'redundant' water resources?
- What 'conventional' aquaculture, and fishery, technologies are useful for this situation and how can new ones be developed involving the poorest people.
- How can poor people will no access to water resources benefit from integrated aquaculture ?(trading, employment etc)

Appendix 2: Position Paper 2 – The nature and distribution of irrigation systems in Sri Lanka and their potential for aquaculture.

Presented by: Mr Parakrama Weligamage, International Irrigation Management Institute.

Executive summary

The history of Sri Lanka's famous hydraulic civilization runs back to 3rd century BC. The country employed a variety of techniques to irrigate its rice fields in order to make maximum use of water. Today this remains the primary use of irrigation water, with some 500,000 ha under paddy cultivation. This massive resource scattered throughout the country gives the nation access to a yet under-utilised resource; a system of water bodies with potential to assist country's drive to increase its food production.

Water resources in the country are broadly divided into natural and man-made systems. Natural inland water resources include rivers, a coastal lake system and coastal lagoons. Man made systems include reservoirs, which store water for irrigation, hydropower generation, domestic consumption and diversion weirs or 'anicuts' that divert water from a river or a stream to be conveyed to use for irrigation. Some of the modern systems are multi - purpose, fulfilling several of these functions simultaneously. A system of irrigation canals helps to distribute water to fields, whilst surplus water is removed by a system of drainage canals.

Several indicators are used to classify irrigation systems. The most commonly used is the extent of the command area of the system. This distinction is also the basis for management of the system. Systems with command areas greater than 80 ha systems are classified as medium and those over 400 ha as major. Major and medium systems are managed by the Irrigation Department except for those systems, which are under the purview of the Mahaweli Development Programme.

Irrigation development in the country in the 20th century were planned to address two major problems, firstly to abate land pressure in the Wet Zone areas of the country (irrigation developments were typically combined with resettlement programs) and secondly to increase food production. Socio-economic conditions in different irrigation and settlement schemes in the country have shown notable differences in the process of development. Limited supply of land, increasing population and lack of diversified activities have created a recurring set of social problems commonly known as second-generation problems. To address these problems, attempts have been made to create suitable alternative employment opportunities. The potential of aquaculture as a means of diversifying farmer livelihoods is the subject of this research program.

Both farmers and irrigation agencies are stakeholders in a single operating entity that utilises irrigation resources along with other inputs for agricultural production. The institutional history of irrigation management farmer participation in collective irrigation management is closely associated with their institutional history. Cultivation committees, agricultural productivity committees and farmer organisations were some of the institutions established to allow farmer participation in decision making. Until late 1970's these two stakeholder groups were poorly co-ordinated, resulting in poor exchange of each other's ideas. The concept of participatory irrigation management emerged as policy makers came to understand the vital need for integrating the ideas of different stakeholders in planning, operations and maintenance of irrigation systems. Farmer organisations and joint management committees are two key components of this approach.

Efficient utilisation of water resources has become an increasingly critical need of the country. However progress is impeded by conflicts which arise amongst various uses and users of water. Allocation of water for power generation for instance is considered vital to the industrial

development of the country, yet spatial and temporal water requirements for irrigation and power purposes are rarely complementary. All perennial rivers in the country originate from central upland regions yet most water is consumed in downstream areas. The competing demands of different provinces have also been a source of conflict. The potential for creation of additional conflicts through use of water for aquaculture must also be considered.

Part I – General introduction

This paper was prepared as background material for an activity-planning seminar to be held in November 1998, hosted by the University of Peradeniya as a part of Fish in Irrigation System Technology (FIrST) research project. This is a collaborative research program involving the Centre for Land and Water Resources Research (University of New Castle upon Tyne), the Institute of Aquaculture (University of Stirling) and the Agribusiness Centre (University of Peradeniya).

The history of Sri Lanka's famous hydraulic civilization dates back to 3rd century BC. The country employed a variety of techniques to irrigate its rice fields in order to make maximum use of its limited water resources. The country is fortunate to be endowed with an extensive system of ancient irrigation works that was capable of reassuming its design task after modest rehabilitation investment in recent times. The inventory of irrigation resources was reinforced in the modern era and today, the area under irrigated paddy cultivation is approximately 500,000 ha. This massive water resource scattered throughout the country represents an as yet under-utilised resource; with a potential assist country's drive to increase its food production.

This paper consists of five parts. Part II provides a comprehensive description of water resources in the country including irrigation systems and other fresh water resources. Part III discusses the nature of water uses within the agricultural sector. Available literature on the socio-economic conditions of communities relying on irrigation systems will be reviewed with a comparison of the livelihoods of inland fishermen. Part IV discusses the management of irrigation within the country followed by an analysis of potentials and constraints to develop aquaculture within irrigation systems.

Part II - Water resources in Sri Lanka

2.1 Introduction

Located in the Indian Ocean Sri Lanka is an island of some 65,000 km^2, which depends solely on rainfall for it’s fresh water requirements. The country experiences four types of rainfall: monsoonal, conventional, cyclonic and orographic. The Southwest monsoon occurs from May to September resulting in heaviest precipitation in the highland massif in the Southwest of the island. The Northeast monsoon collects moisture from Bay of Bengal bringing less rain than the Southwest monsoon, but covering all parts of the island. Inter-monsoon rains occur during March to April and relatively heavy inter-monsoonal rains during October to November.

Mean annual rainfall, which is the major determinant of the country's agro-climatic variability, varies from 2500mm to 5000 mm in the south-west sector of the island and less than 1250mm over much of the rest of the country. Areas receiving a mean annual rainfall over 1500mm are considered as wet zone areas. Rainfall in the wet zone is evenly distributed throughout the year. The dry zone receives most of its rain from the Northeast monsoon.

Agricultural activities in the country are based on two major cultivation seasons, namely *maha* and *yala*. These seasons are a result of the rainfall distribution pattern in the country. Exact demarcation of the cultivation seasons also depends on geographical location. Maha season is the major cultivation season. This generally starts in October immediately before the onset of the

North Eastern monsoon continuing up to March when dry spells favour harvesting of the main rice crop. Yala cultivation usually starts towards the end of April, with harvest during August to September. Yala Cultivation in the dry zone areas depends almost entirely on water stored for irrigation. Agricultural activities in the country show a temporally staggered pattern, thus in a single area one can observe some farmers performing land preparation as the first practice in the new season while others are harvesting the last season's crop. Figure 1 shows average monthly precipitation (1961-1991) in two towns; Colombo and Anuradhapura, representing wet zone and dry zone respectively, to illustrate the major rainfall seasons and their coincidence with the maha and yala agricultural seasons.

Precipitation received in the land is collected in 103 river basins. Development of water resources in the country has from the earliest times revolved around management of the river basin watersheds. Trans-basin diversions (anicuts) permitted the movement of water from surplus to deficit basins.

Water resources within the country can broadly be divided into natural and man-made systems. Natural inland water resources include rivers, coastal lake systems and coastal lagoons. No natural lakes are found within Sri Lanka, instead the extensive system of reservoirs and canals is entirely the result of human intervention. A clear distinction between tanks and reservoirs is not made, though larger man-made water bodies are often referred to as reservoirs whilst their smaller counterparts known as tanks.

Water resource development activities in ancient times were focused on irrigation. Use of water for other purposes such as hydropower and domestic uses gained importance in the 20th century. This resulted in the recent construction of a number of additional major reservoirs to augment the existing base resource. In the following section the nature of non-irrigation or multipurpose reservoirs is discussed, followed by a typology of the islands broad range of irrigation resources.

2.2 Reservoirs

Reservoirs in the country can be divided in to three categories according to the major purpose for which they were built.

a) Multipurpose reservoirs
b) Hydroelectric reservoirs
c) Others

2.2.1 Multipurpose reservoirs

These reservoirs provide water for both irrigation and power generation. Some of them are also designed to facilitate conveyance of water to other reservoirs. The Mahaweli, Udawalawe and Senanayaka Samudraya systems are such examples. The most important multipurpose reservoirs in the country are listed in Table 1.

Table: 1. Major multipurpose reservoirs in Sri Lanka.

Name	Water area (ha)	Capacity Mm^3	Location (District)	Purpose
Senanayaka Samudraya	7872	947.7	Moneragala	Multi
Victoria	2270	721.2	Kandy	Multi
Randenigala	2750	861.4	Kandy	Multi
Rantembe	-	7.0	Kandy	Multi
Kotmale	1500	127.9	Nuwara Eliya	Multi
Udawalawe	3444	268.1	Ratnapura	Multi
Labugama	84	8.9	Colombo	Domestic
Kalatuwawa	186	17.7	Colombo	Domestic

[1]Millions of cubic metres.

2.2.2 Hydroelectric reservoirs

Reservoirs included in this category are used mainly for the generation of hydroelectric power. Located mostly in the wet zone, they are typically large, deep reservoirs which retain water for longer periods than irrigation reservoirs. Some characteristics of the principle hydroelectric reservoirs in the country are shown in Table 2.

Table: 2. Major hydroelectric reservoirs in Sri Lanka.

Name	Water area (ha)	Capacity[1]	Location
Moussakeke	718	114.5	Nuwara Eliya
Castlereagh	373	53.9	Nuwara Eliya
Norton	15	0.9	Nuwara Eliya
Smanalawewa	1123	326.2	Ratnapura

[1]Millions of cubic metres.

2.2.3 Other reservoirs

The reservoirs described in Table 3 assist the conveyance of irrigation water but do not directly discharge water for cultivation.

Table 3: Other reservoirs in Sri Lanka

Name	Water area (ha)	Capacity[1]	Location (district)	Purpose
Aligalge	111	2.6	Ampara	Conveyance
Himidurawa	113	4.3	Ampara	Conveyance
Kondavattan	361	11.2	Ampara	Conveyance
Ampara	369	8.9	Ampara	Conveyance
Valathipiddy	156	2.5	Ampara	Conveyance
Alahena	103	2.2	Ampara	Conveyance
Malayadi	238	9.0	Ampara	Conveyance
Polgolla			Kandy	Conveyance
Loggal Oya			Badulla	Conveyance
Heppola Oya			Badulla	Conveyance
Diyabana Oya			Badulla	Conveyance

[1]Millions of cubic metres.

2.3 Classification of irrigation resources

Irrigation resources are those canals and tanks developed by man to store and convey water to be used for the production of crops. Some of the reservoirs already described above can be classified as irrigation tanks in addition to their other functions. A variety of indicators are used to classify irrigation resources within the country, including; structure function, mode of irrigation, size of command area, period of construction and system of management.

The irrigation Department (1975) used a classification based on the structure function, mode of irrigation and size of command area. Based on the 'structure function' classification, there are two types of scheme; tank base irrigation schemes used to store water, while 'anicuts' are diversion weirs used to divert water flow from a river or a stream. A system is considered purely as a diversion scheme only when there are no tanks associated with the scheme, however most systems are a combination of the two.

Anicuts (diversion weirs) are most commonly used in the wet zone where rainfall distribution is uniformly high throughout the year and consequently perennial water supplies are available. Elehera, Angamedilla and Minipe left bank are examples of diversion weirs used in the dry zone by ancient Sinhalese irrigators. However reservoir based irrigation systems are more common in dry zone as storage of water is essential for use in the dry season.

Irrigation systems are also classified according to their mode of operation. There are gravity schemes and lift irrigation schemes. Gravity schemes occur most commonly as they harness the free head of water. Several lift irrigation systems were developed during the 1960s under the Rajangana and Nagadeepa systems and also in the Jaffna peninsula. However, the extent under lift irrigation has remained virtually static due to the rising cost of fuel and maintenance. Lift irrigation is also practised under agro-wells at the individual farmer level. However, the most common classification of irrigation systems is according to the extent of irrigable area (command area). However different agencies disagree on the demarcation points under this classification. The Irrigation Department classifies irrigation systems into three; major, medium and minor groups. Schemes with command areas over 400 ha are major, below 80ha minor schemes, and intermediate schemes (lager than 80ha and smaller than 400 ha) are considered as medium. By contrast, the Department of Census and Statistics uses only two broad major and minor categories whereby the medium schemes discussed above are included in the major category. Several workers researching settlement schemes in the country rely on this latter classification.

Table 4. Distribution of irrigation tanks by category and district.

District	Major	Medium	Minor
Ampara	11	21	10
Anuradhapura	11	11	1047
Badulla	3	9	12
Baticaloa	5	16	82
Colombo			11
Galle			01
Gampaha			
Hambantota	7	11	100
Jaffna			
Kalutara			3
Kandy			31
Kegalle			4
Kilinochchi	3	10	36
Kurunegala	7	7	1298
Mannar	2	8	80
Matale	3	3	63
Matara	2	4	4
Moneragala	2	11	25
Mullaitivu			
Nuwara Eliya			22
Polonnaruwa	5	12	29
Puttalam	1	8	86
Ratnapura	2	5	9
Trincomalee	4	10	158
Vauniya	6	21	168

Source: Irrigation Department

Table 4 shows the district-wise distribution of schemes according to the latter classification. In addition there are 36 major and 1706 minor anicut schemes covering total command areas of 41,500 ha and 51,000 ha respectively. District-wise water and command areas for major and

medium irrigation tanks are shown in Table 5. Table 6 details characteristics of major anicut schemes. Figure 1 and 2 show the geographical distribution of major tank and anicut schemes respectively. The irrigable area of anicut schemes supplying water through storage tanks were included under tanks to avoid double counting.

Table 5. District-wise cumulative water spread and irrigable area under major and medium tanks.

District	Water area (ha)	Command Area (ha)	No of tanks
Ampara	17922	60318	32
Anuradhapura	17274	28370	22
Badula	1551	4191	12
Baticaloa	4724	14728	21
Hamabantota	4039	10009	18
Kurunegala	3084	9049	14
Mannar	4090	9575	10
Matale	1930	2029	6
Matara	383	1803	6
Moneragala	926	1691	13
Polonnaruwa	8756	20854	17
Puttalam	1366	2117	9
Ratnapura	3856	7824	7
Trincomalee	5150	15237	14
Vauniya	6090	9005	27
Kilinochchi	5544	10865	13
Total	**86685**	**207665**	**241**

Source: Sri Lanka Department of Irrigation 1975 updated using other relevant publications

Table 6: Distribution of major anicut schemes in Sri Lanka

District	No of schemes	Command area (ha)
Ampara	6	2692
Badulla	5	2650
Baticaloa	2	964
Gampaha	1	3340
Hamabantota	2	8009
Kalutara	2	3280
Kandy	1	5297
Kurunegala	3	3467
Mannar	1	1845
Matale	1	492
Matara	1	769
Moneragala	2	1242
Nuwara Eliya	2	1476
Polonnaruwa	2	3385
Puttalam	1	564
Ratnapura	1	656
Trincomalee	2	984
Vauniya	1	349
Total	**36**	**41461**

Source: Sri Lnaka Department of Irrigation 1975 Arumugam

2.4 System tanks and non system tanks

Irrigation tanks can be broadly classified as system or non-system tanks. System tanks are interconnected within a system such that a common authority can manage water allocations amongst all tanks. Such inter-connected tanks were not rare in ancient Sri Lanka. Water was conveyed from Kalawewa in the Kalaoya basin to Nuwarawewa in the Malwatuoya basin, whilst Elehera anicut diverted water to Minneriya, Kaudulla and Kantale system. Recent large scale development programs as the Gal Oya, Udawalawe, Kirindi Oya and Mahaweli programs have created extensive systems of inter-linked tanks covering several river basins in the country (see Table 7). Non system tanks include tank cascades and isolated tanks. Most tank cascade systems are found in the North Central province. Madduma Bandara (1994) defined a cascade as a connected series of tanks organised within a catchment of the dry zone landscape storing, conveying and utilising water from an ephemeral rivulet ".

Table 7: System tanks connected to major trans-basin development programmes.

Mahaweli system areas	Number of tanks	Other major systems	Number of tanks
H	76	Galoya	23
B	85	Udawalawe	7
C	56	Kirindi Oya	7
L	17		

Source: Irrigation Department (1975), De Alwis (1998).

2.5 Irrigation canals

Irrigation canals in the country can be categorised as

a) Trans-basin canals that convey water from one river basin to another.
b) Main canals that convey water from a storage reservoir or a diversion weir to a distant end or to other sub-systems of an irrigation scheme.
c) Distributory canals that provide a link between main canals and
d) Field canals which deliver water to the farm plot in a gravity irrigation system

The total length of 'main' irrigation canals in the country is 2400 Km (Water News, 1998). Water flow in these canals varies according to predetermined water rotations planned by the irrigation authorities. According to Samaraweera (1998) water issues in the Mahaweli H system for the 1996/97-maha season commenced on October 15th continuing until March 15th. The potential for rearing fish in irrigation canals in the country is a researchable issue.

Canals are designed according to the volume of water flow required for a 100% paddy based system. Commonly adopted design criteria for irrigation canals are summarised in Table 8. Table 9 and table 10 show typical design flow rates of main canals and lengths of different types of irrigation canals respectively in the Mahaweli System.

Table 8: Capacity considerations adopted in design of irrigation canals.

Type of canal	Area of paddy at planned supply with flow rate of $1m^3s^{-1}$ (ha)
Main canals	715
Distributory canal	572
Field canals	429

Source: Mendis (1990)

Table 9: Flow-rates of main canals in the Mahaweli system.

Canal name	Flow rate (m^3s^{-1})
Minipe-LB	15
Minipe-RB	64
Bowatenna-Dambuluoya	28.3
Dambulooya-Mirisgonioya	8.5
Huruluwewa feeder	4.3
Kalawewa-RB	35.4
Tissawewa feeder	5.6
Nachchaduwa-Nuwarawewa	3.1
Elahera Minneriya Yoda Ela	56.6
Giritale feeder	12.7
Minneriya Kantale Yoda Ela	34
Angamedilla-Parakrama Samudra	14.2

Source: Water Management Secretariat/Mahaweli Authority of Sri Lanka.

Table 10: Canal lengths in the Mahaweli system.

Mahaweli System area	Canal length (Km)				
	Main	Branch	Distributory	Field	Drainage
H	152	100	660	1505	2250
G	32	5	89	281	420
C	92	98	552	1275	1920
B	53	72	602	1536	2300
L			12	10	36
Total	329	275	1915	4607	6926

Source: De Alwis (1998)

2.6 Water availability in tanks

The historic water management patterns and cultivation outputs of Kaudulla tank, a major irrigation reservoir in Polonnaruwa district with an augmented supply from Mahaweli system is shown in table 11. The table shows the wide variation in water availability and consequent effects on cultivation success, which occurs even under a system tank. Kaudulla can be considered as a representative tank of the dry zone. Jogaratnam (1974) included Kaudulla as one of the schemes covered in his comprehensive economic investigation of colonies associated with major irrigation schemes in Sri Lanka. This tank has a command area of about 4600 ha including encroachments. A rotational distribution system was practised during 1980 and 1982 yala seasons, which experienced serious droughts so that selected sectors of the system, were supplied only with issues sufficient for domestic purposes. Historic fluctuations in the water level of Kaudulla tank are shown in Annex 7.

Table 11: Water issues of Kaudulla tank in Polonnaruwa District.

Year	Season	Area cultivated ha	Cropping Intensity %	Water issues Mm^3
1978	Yala	4157	92	5.84
1979	Yala	4345	97	6.14
1980	Yala	2542	56	2.55
1981	Yala	4202	93	5.80
1982	Yala	1843	41	2.58
1978	Maha	4434	99	5.72
1979	Maha	4476	99	5.59
1980	Maha	4260	95	4.10
1981	Maha	4396	98	5.01
1982	Maha	4211	94	3.99

Source: Weller, Holmes and Gunston, 1985.

Part III - Water uses in Sri Lanka

3.1 Irrigation development in Sri Lanka: the rationale

Land development activities in the country since the early twentieth century focussed mainly on increasing paddy production. Land development ordinance of 1935 was enacted to develop peasant settlement schemes in the dry zone to alleviate the growing problem of landlessness in the densely populated wet zone. The resource base for this resettlement was large relatively unused landmasses irrigated by the rehabilitation of ancient tanks.

After this first wave of colonisation subsequent dry lands were opened through the construction of new irrigation schemes. Most were constructed solely for the purpose of irrigation though there also exist a number of multipurpose schemes such as Galoya in the East and Udawalawe in the South of the country. The Mahaweli Development Program initiated in late sixties and upgraded to an accelerated status in 1977 was designed to harness the potential of the Mahaweli (the largest river in the land) for the purposes of electricity generation, increased paddy production and increased provision of employment opportunities.

3.2 Rice cultivation: the main use of irrigation water

Rice cultivation is the main use of irrigation water in Sri Lanka and successive governments have supported a relentless drive to further increase production. All irrigated areas in the country are designated as ‘asweddumized’ paddy land. In 1994 sixty percent of the country's paddy lands in 1994 were through major, medium or minor irrigation schemes. Asweddumized land is defined as land converted to paddy cultivation through a combination of land levelling and preparation of earthen bunds, facilitating either irrigation or alternatively increased retention of water under rain-fed conditions.

Annex 2 shows lands use patterns for paddy cultivation during 1988-1997. It will be noted that land utilisation for paddy during the yala is considerably lower than the maha season, reflecting a widespread lack of water sufficient for cultivation of two crops per year. The difference in mean paddy yields between major and minor irrigation schemes are shown in Annex 2. Summary statistics for key variables affecting rice production are shown in Table 12.

Table 12: A summary of key statistics on rice cultivation (1995).

Variable	Cultivation regime	Maha season	Yala season
Cultivable(Asweddumized)Area (ha)	Major irrigation	322,629	-
	Minor irrigation	174,779	-
	Rainfed farming	237,047	-
Gross sown area (ha)	Major irrigation	267,167	206,357
	Minor irrigation	133,607	66,365
	Rainfed farming	165.875	75,649
Gross harvested area (ha)	Major irrigation	261,930	204,259
	Minor irrigation	127,946	63,067
	Rainfed farming	159,462	72,925
Yield (Kg/ha)	Major irrigation	4028	3717
	Minor irrigation	3331	2965
	Rainfed farming	3135	2850

Source: Sri Lanka Department of Census and Statistics.

Paddy is either consumed by the farm household or sold to one of the following market intermediaries: government purchasing agents (though the Paddy Marketing Board, the main state organ for this purpose, was inactivated early in 1998), co-operative wholesale organisations, multipurpose co-operative societies, local millers agents or local millers.

3.3 The drive for diversification

The drive to become self-sufficient in rice production as a national objective faced several constraints, principally lack of water to cultivate both seasons, and decreasing farmer profits levels reducing the sustainability of this farming practice. Irrigation and agricultural planners therefore focused their attention on crop diversification in order to increase farm household income by using available water more effectively. A promotion drive to popularise a group of crops, commonly known as Other Field Crops (OFCs) was initiated. OFCs including both food crops and non- food cash crops have subsequently become major users of irrigation water during the yala season. Food crops include maize, Soya and other pulses such as mung bean and cowpea whilst chilli is the most common cash crop grown by farmers. Table 13 shows yields of commonly grown OFCs during the yala season.

Table 13: Irrigated production of OFCs during the Yala season (1995)

Crop	Yield MT /ha
Chilli	1.02
Big onion	12.86
red onion	8.59
green gram	0.65
Soya bean	1.54
Maize	2.5

Source: Cost of cultivation of Agricultural Crops, Department of Agriculture.

OFCs require less water allowing cultivation of large areas compared to paddy, potentially providing farmers with a higher income. However, despite inducements, farmers have demonstrated considerable reluctance to adopt field crops as an alternative to paddy. Dimantha (1988) reports that many farmers avoid chilli cultivation because of its high labour requirement throughout the cropping season.

Sanmugam and Senanayake (1982) describe the traditional markets for OFCs in Sri Lanka. These include village traders and visiting traders, whilst the Major agricultural traders for OFCs are concentrated in 4th Cross street of the Pettah Market area in Colombo. Marketing channels for

OFCs are not as well established, as those for rice and the costs and risks as well as the complexity associated with marketing of OFCs are often higher. In addition free trade has made cheaper imported produce available to industries and consumers (including rice, vegetables and dried fish), as a consequence of lower labour costs in neighbouring states.

There are several technical and water management constraints to promotion of OFC cultivation under irrigation schemes. Water issues that frequently occur only once in 7 to 10 days are inadequate for most popular field crops. In addition OFCs need well-drained soils and are therefore not suitable for land types (Wijayaratne *et al.*, 1996) particularly poorly drained lower command areas.

3.4 Livestock in irrigation systems

Livestock is also a user of irrigation water. Cattle use irrigation tanks for water consumption and buffaloes in particular use them as wallowing sites. However cattle and buffaloes damage canal banks and increase conveyancing losses of water, creating conflict between livestock and crop farmers (IIMI 1994).

3.5 Domestic uses of irrigation water

Water stored in irrigation systems is also used for a variety of secondary purposes in addition to the primary use for rice cultivation. According to central Bank of Sri Lanka, some 49 percent of households in major irrigation districts (Ampara, Moneragala, Hambantota, Anuradhapura, Polonnaruwa and Puttalam) used tanks, rivers or canals as their source of water for bathing purposes. Other domestic uses include clothes washing and toilet functions.

Irrigation reservoirs also support many urban water supply schemes in the dry Zone. Settlers of the Kirindi oya project benefit from a pipe-borne water supply system with its source in the irrigation reservoir. Nuwarawewa tank is also the water source for the Anuradhapura city urban water supply scheme. Similarly water from the Mahaweli River diverted by the barrage at Polgolla helps several townships in the north central province to meet their domestic water requirement. (Samaraweera, 1998; De Alwis, 1998).

3.6 Fish in irrigation systems

The increased area of water storage arising from the rehabilitation and construction of new reservoirs, has also provided a cheap source of fish protein to meet the demand of the steadily rising dry zone population. Growth of the hitherto neglected capture fishery has been supported by a variety of government initiatives since the 1950's, breeding and stocking exotic carps and tilapias. Demand for inland fish has been further stimulated by transportation and cold chain constraints, which increase the cost of supplying marine fish to new settlements. These factors have contributed to increased production of fish from inland reservoirs.

Wimaladharma reported that in 1982 inland fisheries provided employment for 93 persons or 0.69 percent of total employment in the Minneriya settlement scheme (with a tank area of 2500.ha). Since several factors including tank water level fluctuation and fingerling availability affect the breakeven level of economic production a detailed study is necessary to evaluate the potential of tanks for generating sustainable employment within the fisheries sector.

Several studies have demonstrated the importance of inland fisheries to rural livelihoods. Wanasinghe (1982) observed itinerary traders selling fresh water fish in periodic rural markets in North Central Province. By contrast a comprehensive survey conducted by Senanayake (1980) provides no evidence of the existence of fresh water fish traders in periodic rural markets of Kurunegala district which is strategically located closer to marine fish producing areas.

Chandrasiri (1986) provides statistics on production of fresh water fish from five tanks in Hambantota district in southern Province (see Table 14 and 15). Four of these tanks receive water from the Kirindi Oya irrigation system and the author reports fish yields before implementation of the new scheme However some doubts are expressed as to the validity of the data due to the method of data collection employed by state officers.

Table: 14:Average monthly fresh fish production of selected tanks of Hambantota District, Southern Province 1981-1984 (MT).

Tank Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg
Tissa	8.8	19.1	12.1	17.2	21.5	24.9	23.1	25.3	15.9	11.5	13.5	11.8	17.0
Yodawewa	8.2	6.7	7.9	7.3	8.3	8.4	9.5	15.0	9.3	9.3	6.8	7.3	8.7
Weerawila	2.8	2.9	5.0	4.0	7.0	2.4	1.9	4.3	5.1	5.1	4.3	4.4	4.1
Bandagiriya	19.5	26.2	89.9	186.9	115.5	85.8	54.3	33.0	34.1	34.1	33.9	28.9	61.8
Ridiyagama	8.6	12.5	14.2	8.2	6.5	19.2	23.3	14.3	17.9	17.9	22.1	25.8	15.9

Source: Chandrasiri (1986)

Table: 15: Total annual production of fresh fish in selected tanks in Southern Sri Lanka 1981-1984 and 1994 (MT)

Tank Name	Annual Production (MT)	
Year	1981-84	1994
Tissa	204.6	120
Yodawewa	104.0	140
Weerawila	49.2	158
Lunugamvehera	new tank	132

Source: Chandrasiri (1986) and IIMI (1994)

Part IV – Socio-economic conditions in irrigation systems

4.1 Introduction

Using a variety of common indicators of well being, this section considers the socio-economic conditions of communities whose livelihoods are associated with irrigated agriculture in Sri Lanka. The most recent statistics from an all island socio-economic survey (Central Bank of Sri Lanka, Consumer Finances and Socio-economic Survey: 1986/87) are presented with data disaggregated at the district level. Data from Hambantota, Anuradhapura, Polonnaruwa, Ampara Puttalam and Moneragala districts which are endowed with some of largest cultivated areas under minor, medium and major irrigation, are presented as being most representative of the socio-economic conditions found under irrigation schemes at this disaggregation level. Findings from several studies selected from the available literature on irrigation schemes during the last 25 years will also be used to compare differences between systems

Table 16 shows that little difference exists in mean household size within major irrigation districts and national averages. Table 17 shows that average ages within irrigation districts are lower than the national average and all other sectors. Literacy rates in all age groups within irrigated are lower than the national average (see Table 18) perpetuating farmers' marginal status. Female literacy rates are highest amongst older age groups within all rural sectors, suggesting that access to quality educational facilities was poorer in the past in these districts. General socio-economic conditions as reflected by housing conditions are lower within irrigation districts than other rural areas (see Table 19). In particular the percentage of houses with clay floors is considerably higher than other districts. Farming is the primary livelihood of the majority of people within irrigation schemes and the majority of off-farm labour opportunities are also associated with agriculture. It is interesting to note that the level of off-farm labour is higher in Udawalawe, Minneriya and

Kirindi Oya than in Minipe and Rajangana systems. This is because the former schemes are most developed and have better access to labour from neighbouring areas. Levels of Government employment also show an increasing trend. The 1986 figure for the Kirindi Oya is exceptionally high, as this was the peak construction period of the reservoir, providing many temporary casual employment opportunities.

Table 16: Comparison of household size in major irrigation districts and all island averages (1986/87)

	All Sri Lanka	Irrigation districts
No. of Persons	% of households	% of households
1	1.61	1.40
2	6.38	7.10
3	13.52	13.70
4	18.88	18.39
5	22.43	22.73
6	15.32	15.46
7	10.04	10.26
8	6.34	5.90
9	2.85	2.60
10 or more	2.63	2.20

Source: Consumer finances and socio-economic Survey 1986/87.

Table 17: Population age distribution by sector (1986/87)

	% of persons			
Age Group	Sri Lanka (All Sectors)	Urban	Rural	Irrigation districts
0-4	9.01	7.55	8.96	9.5
5-9	12.00	10.14	12.17	12.2
10-13	9.83	9.80	9.88	9.7
14-18	11.68	11.93	11.90	11.6
19-25	12.47	13.21	12.42	12.5
26-35	14.26	14.88	13.95	14.6
36-45	11.18	12.06	10.87	11.2
46-55	8.46	8.65	8.44	8.4
>55	11.11	11.78	11.41	10.4

Source: Consumer finances and socio-economic Survey 1986/87.

Table 18: Sex and age specific literacy rates by sector (1986/87)

	Literacy Rate (major irrigation districts)			Literacy Rate (all island rural)			Literacy Rate (all island all sectors)		
Age Group	male	Female	Total	male	female	Total	male	female	Total
5-9	82.0	83.8	82.9	84.3	86.6	85.4	82.6	84.8	83.7
10-13	96.8	96.4	96.6	97.6	97.5	97.5	97.0	96.4	96.7
14-18	95.1	92.4	93.7	96.4	96.3	96.3	95.2	93.9	94.5
19-25	93.3	89.4	91.3	94.6	94.0	94.3	94.1	91.6	92.9
26-35	93.9	86.6	89.9	95.6	93.5	94.4	94.9	91.0	92.8
36-45	92.4	79.9	85.9	94.4	87.0	90.4	94.1	86.1	89.8
46-55	91.1	64.1	77.0	93.0	73.2	82.5	92.7	72.6	82.1
>55	85.4	48.1	67.6	87.4	57.8	73.0	87.8	59.5	73.7
Totals	91.2	81.3	86.1	92.8	86.5	89.5	92.2	85.2	88.6

Source: Consumer Finances and socio-economic Survey 1986/87

Table 19: Type of floor as a proxy of socio-economic conditions: a comparison of major irrigation districts and rural/urban settings in Sri Lanka (1986/87).

Type of floor	Irrigation districts	All island urban	All island rural
Unprepared	1.4	1.67	2.2
Clay	52.05	9.92	42.03
Cemented	46.38	87.77	55.62
Wooden	0.1	0.4	0.04
Other	0.07	0.24	0.11

Source: Consumer Finances and socio-economic Survey 1986/87

Table 20: Sectoral employment distribution within selected major irrigation systems for various years (percentage of persons employed)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Area	Kurunegala	Rajangane	Minipe	Udawalawe	Minneriya	Kirindi Oya	Kirindi Oya	Kirindi Oya
Year	1977	1978	1978	1978	1979-80	1980	1986	1994
Farm employment	75.8	69.4	62.9	66.2	39.8	49.4	66.7	43.3
Government and Coop	7.9	4.3	4.5	2.2	25.8	4.2	13.3	11.3
Commercial Sector	3.8	1.7	1.2	1.2	10.1	6.5		6.9
Skilled trades	1.5	0.8	0.7	1.3	3.1	0.0	5.2	4.2
Labourers	9.8	13.2	12.5	24.3	21.6	36.7	13.3	32.3
Others	1.2	0.4	0.5	1.2	0.6	3.2		2.0
Females employed	-	10.2	17.6	3.2	-	-	-	-
No. employed	264	6895	11317	11048	13395	648	377	1247

Notes on data sources:
(1) Gunawardena et.al (1981) Kurunegala District (Dry Zone sub sample)
(2), (3) and (4): Rice Book Revalidation Survey (1978) Quoted by Wimaladharma (1982).
(5) Minneriya survey reported by Wimaladharma (1982)
(6) Wanasinghe et.al (1983) Kirindi Oya (Old Irrigated Area)
(7) Gamage et.al (1988) (Old Irrigated Area)
(8) IIMI (1994) (Old Irrigated Area)

4.2 Fishermen amongst farmers.

With the introduction of tilapia into irrigation tanks in the 1950's, a new fishery was created. First to realise and exploit the potential of this new resource were migratory coastal fishermen. Only later did local settlers begin to participate in the fishery in significant numbers, after witnessing the success of the migrants. Seasonal migrations have now all but ceased, as a result of increasing access conflicts between the two groups, but many marginal fishing communities remain permanently settled near tanks, often illegally encroached. Chandrasiri (1986) reports such a situation around Yodawewa. The institutional organisation of such communities is generally weak and access to land, water and other resources poor.

It is also interesting to note that in all the studies assessed only Wimaladharma (1982) reports full time fishing as a special category (see Table 20). Over more recent years, the increasing importance to settlers of fishing as livelihood activity is due in large part to increased land fragmentation reducing access to productive land resources and lack of other alternative income generation opportunities for younger 'second generation' farmers.

Table 21 shows the secondary occupations practiced by fishermen according to Chandrasiri (1986). Farming is reported as the most common subsidiary occupation. Fishing is the only occupation for the majority of respondents from Ridiyagama. Average monthly fish production in the tank is about 15 MT and income from fishing accounts for 88 percent of annual household income in this instance. Fisherman in Ridiyagama live on illegally encroached land by contrast to the situation in Bandagiriya where most fisherman are second generation farmers adopting this livelihood due to increasing land pressure. Thus the importance of fisheries as a livelihood activity varies widely between different groups. Membership in legally registered fisheries societies should not imply that all members are full-time fishermen.

Table 22 which shows data on household income distribution between fishing and non-fishing communities in the Kirindi Oya system, reveals that in this example, the majority of households engaged in fishing belongs to lower income strata. Results of recent investigations into the socio-economic conditions of inland fisherman in Kandalama and Victoria reservoirs are reported respectively by Perera (1996) and Edirisinghe and Nanthanael (1996). Average monthly income for fish vendors in Kandalama is below Rs. 3000.00. There are about 25 vendors and 25 boats in the reservoir suggesting that each vendor depends on only one boat for his supply of fish. The average daily sales volume of roadside vendors near Victoria reservoir varies between 20 Kg to 70 Kg of fresh fish, whilst mobile vendors sell 20 Kg to 40 Kg of fish per day. Low water levels during 3 to 4 months of the year means that many fishermen and traders must look for alternative seasonal employment during this time (only 15 percent of fisherman and 10 percent of traders operate during this period). Such employment is typically on-farm.

Table 21: Percentage of persons employed in different occupation categories (including fishing) around five major tanks in Southern Province, Sri Lanka – 1985.

Tank Name	Ridiyagama	Bandagiriya	Tissa Wewa	Yoda WEwa	Wirawila	All tanks
Farm employment	14.7	32	33.3	28	0	21.4
Trader	0	0	0	12	14.3	4.8
Labourers	5.9	8	28.6	20	0	11.9
Others	0	4	14.8	0	4.76	4
With no subsidiary occupation	79.4	56	23.8	40	81	58
No. members in the fisheries society	101	65	27	48	22	263
No. in the sample	34	25	21	25	21	126

Source: Chandrasiri(1986):

Table 22: Comparison of mean annual household income between fishing and non-fishing communities of the Kirindi Oya major irrigation system and all island averages.

Average annual household Income (SL Rs.)	Kirindi Oya old irrigated Area 1986 (% persons)	Hambantota District Inland fishermen 1985 (% persons)	All island 1986/87 (% persons)
<12000	9.9	41.3	20.4
12001-18000	11.4	15.4	20.0
18001-24000	10.0	25.3	15.9
24001-30000	5.5	7.9	11.0
>30000	60.0	0.0	32.7

Source: Gamage et.al (1988), Chandrasiri (1986) and Central Bank of Sri Lanka (1993).

Part V - Management of irrigation schemes

5.1 Institutional involvement in irrigation management

Major and medium irrigation schemes come under the purview of the Irrigation Department while the Department of Agrarian Services is responsible for management of minor irrigation schemes Details of gravity irrigation schemes managed by the Department of Irrigation are presented in Table 23.

The Mahaweli Authority of Sri Lanka is responsible for managing water distribution in all areas coming under the Mahaweli Development Program. The Udawlawe scheme has recently been declared as a special development area under the Mahaweli Authority of Sri Lanka. Summary statistics relating to the various Mahaweli sub-systems are presented in Table 24.

5.2 Farmer participation in irrigation management

Cultivation committees (CCs) intended to vest decision-making powers at grass-root level were formed under the Paddy Lands Act No 1 of 1958 to represent the interests of all the farmers under a single tract of paddy land. These committees were comprised of seven elected farmer representatives (including landlords) whilst Government officers have ex-officio membership but had no voting rights. Divisional officers of the Agrarian Services Department are required to assist these organisations as a part of their regular duties. Registering the committee with the Commissioner of Agrarian Services gave the committee "body corporate" status and had the freedom to perform various functions related to the maintenance and operation of minor irrigation schemes. CCs as formal legal entities became increasingly involved in water management activities though the original objective of forming them was related to land tenure reform. Weerawardena (1975) considers as vital the contribution made by CCs in implementation of government's food production campaign during the 1960s. In 1972 the Agricultural Productivity Act of 1972 replaced CCs (the total number which then stood at 4,000) with agricultural productivity committees were introduced. The Agrarian Services Act of 1979 established in turn replaced these institutions with agrarian services committees which incorporated both farmers representatives and government officers.

Achievements of the new system were varied. Innovative approaches arising from individual initiative in Minipe; a major diversion weir scheme in Mahaweli left bank and Kimbulwana in the North Western province are widely quoted (Brewer, 1994). An important breakthrough in farmer management of irrigation systems came with the introduction of Gal Oya Irrigation Rehabilitation Program in the late 1970s. By the end of 1985, there were 415 FOs active in the project, initiated with project funds and resources.

Functions of both farmers and irrigation agencies as stakeholders of a single operating entity that utilise irrigation resources along with other inputs for agricultural production should be oriented towards efficiency. Until late 1970's poor co-ordination existed between these stakeholders. The concept of participatory management emerged as policy makers came to understand the vital need for integrating the ideas and needs of different stakeholders in planning, operation and maintenance of irrigation systems (Jinapala, 1994). Farmer organisations (FOs) and joint management committees are two key components of this approach.

Power is vested with FOs to maintain and operate distributory and field level channels, including rights to collect fees for that purpose. Farmer organisations function as individual business entities, free to initiate and conduct programs in other areas of common interest to the

membership. Today, FOs actively engage in input and product distribution and in some cases promotion of assured quality seed production.

Recent amendments to the Agrarian Services Act and the Irrigation (Amendment) Act No 13 of 1994 provided " body corporate" status to FOs. The act also allows the government to recognise efficient FOs, granting them a 'specified' status, which provides additional benefits.

Immediately above FOs In the participatory management hierarchy are Joint Management Committees (JMCs). These consist of FO representatives, irrigation agency officials and representatives of other government line. JMCs currently function in all major, medium and Mahaweli irrigation systems. The number of JMCs within a system depends on its size with a single committee being sufficient to cover a medium size irrigation scheme. In major systems several sub JMCs are required, representatives of which are selected to form a higher level JMC. JMCs meet monthly to make collective management decisions. Seasonal cultivation planning has become more effective as collective monitoring improves the reliability and relevance of data collected. Under Mahaweli systems there is a 3-tier JMC system. Unit Co-ordinating Committees operate at village level above which are Block Co-ordinating Committees. At the highest is the Project Co-ordinating Committee, chaired by the Resident Project Manager (RPM) of the System.

In 1984 and 1986 the Government initiated two programs designed to improve irrigation efficiency. INMAS (Integrated Management of Major Irrigation Schemes) and MANIS (Management of Irrigation Schemes) covered major and medium irrigation schemes respectively. In 1994 there were 715 FOs under MANIS and 152 under INMAS schemes, covering some 64,000 ha of irrigated land. The Irrigation Management Division of the Irrigation Department has continuously evaluated activities of FOs operating under these programs. Criteria include assessment of the ability of FOs to function as sustainable business ventures. Consequently, in 1997, 39 schemes were earmarked for specified status. The ownership of resources at the distributory and field canal level will assigned directly to these FOs in the near future. In return the government will sign formal agreements with the FOs whereby they will be obliged to take over operations and maintenance responsibilities from the Irrigation Department.

Table 23: No. of gravity irrigation schemes managed by the Irrigation Department.

Irrigation engineer's range	No of Schemes	Command area Ha
Ampara	14	49662
Anuradhapura	91	35120
Bandarawela	16	8094
Batticaloa	10	21929
Colombo	13	5992
Galle	14	3893
Hambantota	20	20543
Kandy	24	9292
Kurunegala	22	10669
Moneragala	26	6065
Polonnaruwa	10	22826
Puttalam	19	5845
Trincomalee	8	16801
Vauniya	10	15969
Total	**297**	**232999**

Source: Administration Report, Irrigation Department, 1996

Note: Table 4, 5 and 6 provide data on individual tanks or anicut schemes. A system can contain more than one tank. Data presented in this table refers to irrigation engineer's ranges while earlier tables refer to administrative districts. The Irrigation department controls medium and major schemes. It is therefore possible that differences exist among this and earlier tables.

Table 24: Irrigated area under the Mahaweli Authority of Sri Lanka.

System	Irrigated area (ha)
B (LB)	16118
C	20653
H	25000
L	3364
G	5500
Uda Walawe	17500

Source : Mahaweli Authority of Sri Lanka

Part VI -Potentials and constraints to promotion of aquaculture in irrigation systems

6.1 Water Adequacy

This is the key technical criterion in evaluating potential for aquaculture in tanks. Wijayaratne (1996) has classified irrigation systems in Sri Lanka into four categories according to their reliability of water availability (see Table 25). This classification is based on the potential to diversify production away from paddy cultivated to OFCs most of which require more frequent assured water supplies.

Table 25: Classification of irrigation systems in Sri Lanka according to reliability of water supply

	Water adequacy in maha (wet)	water adequacy in yala (dry)	Category
Major	Adequate	Adequate	I
major	Adequate	Unreliable	II
medium	Moderately stable	Unreliable	III
minor	Unreliable	Unreliable	IV

According to this classification it is logical to select categories I, II and III (where water is retained in the tank until the end of yala season) as most suitable for promotion of inland fisheries and aquaculture activities. A list of schemes, which correspond, to these categories are shown in Annex 3. Capture fisheries are already established in many of these tanks. Further study is necessary to assess integrated management strategies for this resource, to assure creation of a sustainable industry with viable linkages to other sectors of the economy. Potential exists to develop aquaculture in category IV tanks on a seasonal basis. Irrigation canals provide another potential source for seasonal activities, requiring further investigation.

Fish production data presented by Chandrasiri (1986) shows no significant correlation between average yield and water area or tank capacity. Bandagiriya reservoir with relatively low water spread and tank capacity shows the highest mean yield per unit area. Further investigation of the literature is required in this respect.

6.2 Potential and constraints for aquaculture and fisheries within irrigation systems.

- All major reservoirs are either situated within boundaries of wildlife sanctuaries or fisheries are strictly restricted due to security reasons.

- Fishermen report that the increasing population of crocodiles in tanks poses a threat to their industry by damaging nets and by endangering their lives. (Chandrasiri, 1986)

- Encroachment by aquatic weeds such as Salvinia and lotus reduce tank productivity with respect to fish production. Salvinia is reported to be spreading rapidly in tanks of the north central province in which we identify great potential for development of aquaculture.

- It is essential to retain a certain amount of water (dead storage) in the tank if fish production is to be sustainable. Farmers have priority rights for consumptive use of tank water. They are required to pay water fees or under participatory systems of irrigation management farmers are responsible for Operation and maintenance of field/distributory channels. This input is due from farmers only if they receive a reasonable allocation of water. Therefore co-operation of farmers is required to maintain adequate water levels in tanks and to regulate water releases in canals synchronised with fishery related activities.

- Maintaining brood stock in small ponds in the proximity of tanks is also suggested as such ponds have minimal water requirements which can be derived from the tank without conflict.

References

Aluwihare, P. B. and Masao Kikuchi. 1991. Irrigation investment trends in Sri Lanka: new constructions and beyond. Colombo: International Irrigation Management Institute.

Arumugam. S. 1968. Water resources of Ceylon. Colombo: Water Resources Board.

Agriswiss. 1991. North Western Province Water Resources Development Project, draft final report, Volume I, Main Report. Colombo.

Brewer, J.D.1994.The participatory irrigation management policy. *Economic Review 20(6) Sept. 1994: 4-9.*

Central Bank of Sri Lanka. 1993. Report on consumer finances and socio-economic survey (1986/87*), part I.* Colombo.

Chandrasiri, J. K. M. D. 1986. Socio-economic conditions of inland fisherman in Sri Lanka. Research Study No 73. (Mimeographed). Colombo: Agrarian Research and Training Institute.

De Alwis, D. 1998. Need for water research during planning of integrated rural development projects based on lessons learned in Mahaweli Ganga Development Scheme. Paper presented at National Water Conference. 4-6 November 1998, Colombo.

Dimantha. S. 1988 Irrigation management for crop diversification in Sri Lanka. In irrigation management for diversified cropping, Digana, Sri Lanka, IIMI County Paper, Sri Lanka No.14, Colombo: International Irrigation Management Institute

Edirisinghe, U and Nanthaael, S 1996. A comparison of socio-economic conditions of fish folk during high and low water levels in Victoria Reservoir. In. Proceedings of Sri Lanka Association for the Advancement of Science. 52(I)

Gamage, D., R. D. Wanigaratne, L.D.I. Wijetunga and I. Tudawe. 1988. Kirindi Oya Irrigation and Settlement Project: mid –project evaluation. Research Study No 85 (mimeographed). Colombo: Agrarian Research and Training Institute.

Gunawardana, A.M.T. Sumanasekera H.D, Gunawardena P.J. and Wijetunga, M. 1981 Kurunegala District Integrated Rural Development Project: An analysis of the pre-project situation. Research Study No. 45, Colombo, Agrarian Research and Training Institute.

IMPSA. 1991. A comprehensive comparative analysis of past and present experiences with farmer organisations in Sri Lanka. Colombo: Irrigation Management Policy Support Activity (IMPSA) secretariat.

International Irrigation Management Institute. 1994 Kirindi Oya Irrigation and Settlement Project: project impact evaluation study, volume II, annexes (final report). Colombo: IIMI.

Jinapala, K. 1994. Joint management committees. Economic Review 20(6) Sept. 1994. : 20-21.

Jogoratnam (1974) A study of fice major coloniszation schemes in Sri Lanka. Department of Agricultural Economics and Extension, University of Peradeniya.

Madduma Bandara, C. M. 1994. Tank cascades in Sri Lanka. In. K .Asharul Haq. ed. Proceedings of IRMU Seminar Series. Colombo: Irrigation Research and Management Unit/Irrigation Department Sri Lanka

Mahaweli Authority of Sri Lanka. Mahaweli Development Programme Achievements as of September 1995.

Mendis, D.L.O. 1990. Layout of channel system in irrigation projects in Sri Lanka. In. Gunawardena, E.R.N ed. Irrigation and Water Resources. Peradeniya: Department of Agricultural Engineering,University of Peradeniya.

Panabokke, C.R. 1996. Soils and agro-ecological enviornments of Sri Lanka. Colombo: Natural Resources Energy and Science Authority.

Panabokke, C.R., K. Azharul Haq, B.M.S. Samarasekera. eds. 1997. Seasonal planning procedures to improve irrigation management performances: how Kirindi Oya experience can be transferred to NIRP schemes. Colombo, Sri Lanka: Irrigation Research Management unit, Irrigation department Sri Lanka and Sri Lanka National Program, International Irrigation Management Institute.

Perera, C. 1996. Marketing channels of a reservoir fishery: A study on Kandalama Reservoir. Proceedings of Sri Lanka Association for the Advancement of Science. 52(I).

Sakthivadivel, R. C. R .Panabokke, C. M. Wijayaratna, N .Fernando, K Jinapala and R.B.Bandula Sirimal. 1996. Pre-project technical assistance study for proposed area development project of north central province. Main report. Colombo: International Irrigation Management Institute.

Samaraweera, P. 1998. Mahaweli water management to maximise benefits. paper presented at National Water Conference. 4-6 November 1998, Colombo.

Sanmugam,T. and S.M.P.Senanayake. 1982. Prospects for expansion in the production of coarse grains and grain legumes. Research Study No 51. (Mimeographed). Colombo: Agrarian Research and Training Institute.

Senanayake, S.M.P. 1980. Periodic rural markets in the Kurunegala district. Occasional publication 18 (mimeographed). Colombo: Agrarian Research and Training Institute.

Senanayake, S.M.P. and L.D.I. Wijetunga. A Study on the employment generation in Krindi Oya irrigation and settlement area. 1987. Research Study No 79 (mimeographed). Colombo: Agrarian Research and Training Institute.

Sri Lanka Department of Agriculture, Cost of cultivation of agricultural crops. (Various issues).

Sri Lanka Department of Census and Statistics, Statistical abstract of the Democratic Socialist Republic of Sri Lanka. (various issues).

Sri Lanka Department of Irrigation, 1997. Administration Report –1996. Colombo.

Sri Lanka Department of Irrigation. 1975. Register of irrigation projects in Sri Lanka. Colombo.

Thayaparan, K.1982. The role of seasonal tanks in the development of freshwater fisheries in Sri Lanka.. Journal of Inland Fisheries.. (1).December, 1982.

Wanasinghe, Y.A.D.S. 1982. Galnewa Township. In. Wimaladharma, K.P. ed. Land Settlement experiences in Sri Lanka. Selected papers from the seminar sponsored by USAID and Sri Lanka Ministry of Land and Land Development, 6-8, April 1981 Colombo, Sri Lanka: 123-138

Wanasinghe. Ananada, H. D. Sumanasekera, D .M. A. Wijetunga and D.Tennakoon. 1983. Kirindi Oya Irrigation and Settlement Project: Pre –project socio-economic conditions. Research Study No 59 (mimeographed). Colombo: Agrarian Research and Training Institute.

Water News. September 1998.

Weerawardena, I. K. 1975. The paddy lands act of 1958: lessons of an experiment. Evaluation Studies No 3. Colombo: Sri Lanka Ministry of Agriculture and Lands.

Weller, J.A., D.W.Holmes and H.Gunston.1985. Irrigation water management study at Kaudulla, Sri Lanka (Summary Report). Wilingford, UK: Hydraulics Research.

Wijayaratna, C. M., C. R. Panbokke, P. B. Aluvihare, S. H. Charles and R. Sakthivadivel. 1996. Potential for diversified cropping in the rice lands of Sri Lanka. IIMI Country Paper: Sri Lanka No 14, Colombo Sri Lanka: International Irrigation Management Institute.

Wimaladharma, K.P. Non farm employment in the major settlements in Sri Lanka. In: Wimaladharma, K.P. (ed.). Land settlement experiences in Sri Lanka. Selected papers from the seminar sponsored by USAID and Sri Lanka Ministry of Land and Land Development, 6-8, April 1982 Colombo, Sri Lanka. pp 21-40.

Appendices to Working Paper 2

Annex 1: Changes in command area of major and minor irrigation schemes in Sri Lanka 1975-1994 "000"ha.

Year	Command Area under Major irrigation (ha "000")	Command area under minor irrigation (ha "000")
1975	203.0	173.2
1976	204.8	177.5
1977	208.4	181.0
1978	217.0	185.4
1979	228.4	171.3
1980	238.5	167.4
1981	245.5	171.1
1982	259.2	172.3
1983	265.8	175.0
1984	268.8	176.2
1985	276.4	175.4
1986	288.0	176.4
1987	292.3	180.9
1988	297.8	181.5
1989	302.5	180.6
1990	307.2	179.2
1991	310.5	179.2
1992	317.2	178.3
1993	318.0	177.8
1994	321.3	174.7
1995	322.6	174.8

Source: Sri Lanka Department of Census and Statistics. (1997)

Annex 2: Gross sown area under paddy by season, by type of irrigation scheme and zone 1977-1997 ('000s ha)

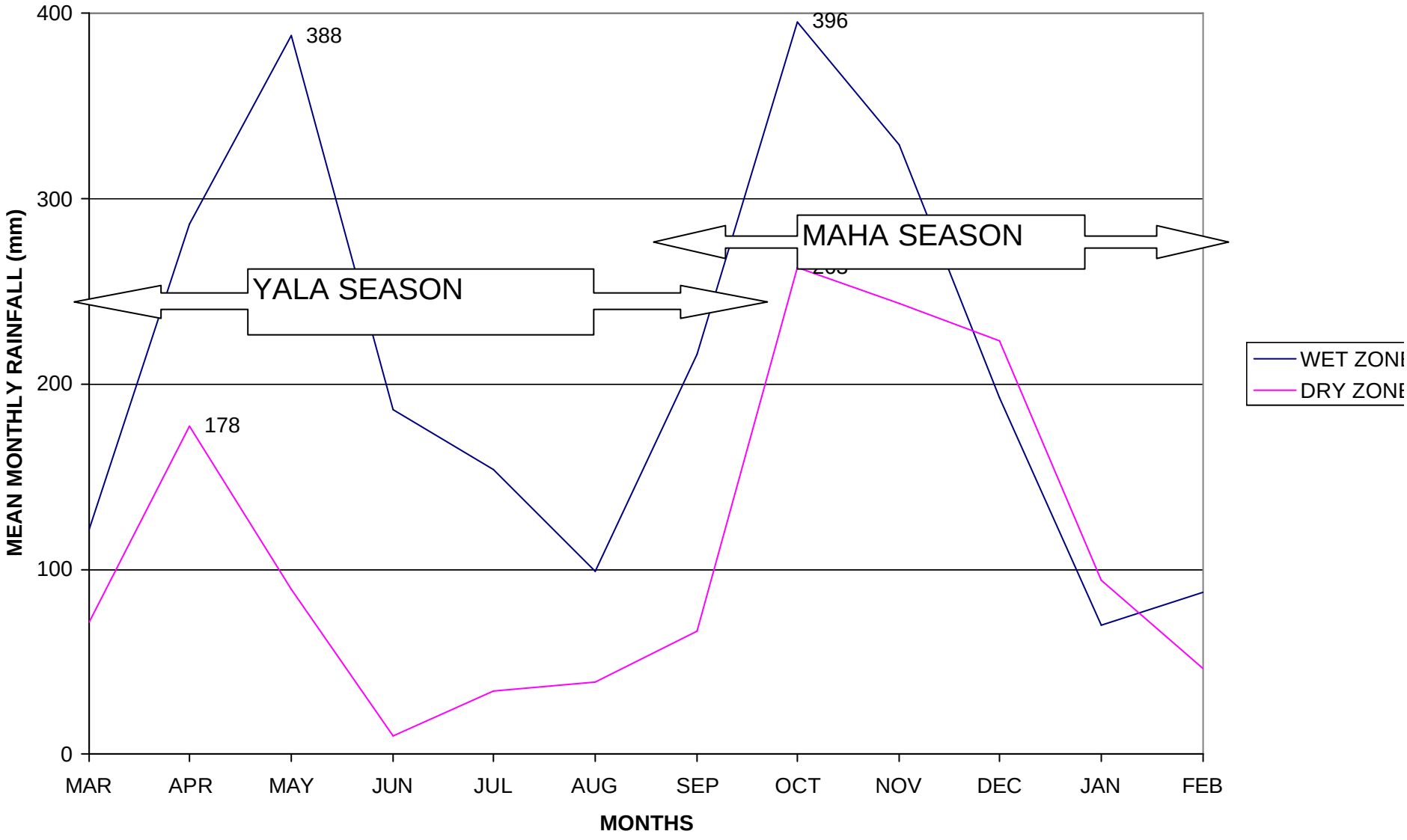
	DRY ZONE				WET ZONE			
	MAJOR (1)		MINOR (2)		MAJOR		MINOR	
YEAR	MAHA	YALA	MAHA	YALA	MAHA	YALA	MAHA	YALA
1977	169.2	92.4	103.2	37.1	11.7	10.1	34.1	28.7
1978	182.4	115.5	123.6	32.7	11.5	10.3	33.5	26.3
1979	193.7	114.6	119.8	22.5	11.0	9.0	31.1	21.2
1980	195.6	112.5	116.8	25.6	12.1	10.2	30.5	21.7
1981	108.9	116.8	118.9	24.3	12.7	10.6	32.0	23.8
1982	216.3	106.4	88.6	26.5	13.0	11.3	32.2	24.8
1983	221.4	129.1	94.2	20.2	13.2	9.3	32.8	18.2
1984	228.7	174.2	112.6	62.4	12.7	10.8	32.6	24.4
1985	224.6	145.3	100.0	30.0	12.5	10.6	33.8	26.6
1986	225.8	159.6	99.2	39.2	12.5	10.5	34.1	27.1
1987	216.6	131.5	72.7	21.1	12.6	10.0	34.4	25.4
1988	231.3	146.1	92.4	36.5	12.0	10.5	34.7	28.8
1989	203.2	130.6	60.6	16.4	11.9	10.0	35.1	25.5
1990	225.0	152.8	79.6	27.2	15.8	10.8	35.0	28.3
1991	213.9	156.8	81.9	28.7	12.4	10.0	34.4	27.4
1992	237.5	122.1	94.0	25.5	12.4	8.4	34.2	24.3
1993	235.1	152.2	96.8	22.0	12.0	10.2	33.7	23.1
1994	250.5	200.1	117.8	40.0	12.0	7.4	31.5	23.3
1995	255.5	197.6	102.8	44.5	11.7	8.8	30.8	21.9
1996	226.8	141.1	77.0	21.8	11.6	8.7	29.8	19.3
1997	213.8	135.2	66.4	26.5	11.7	9.0	30.4	20.3

Source: Department of Census and Statistics.
(1): Schemes with more than 80 ha of irrigable area
(2): Schemes with less than 80 ha of irrigable area
Note: Kurunegala is included under dry zone

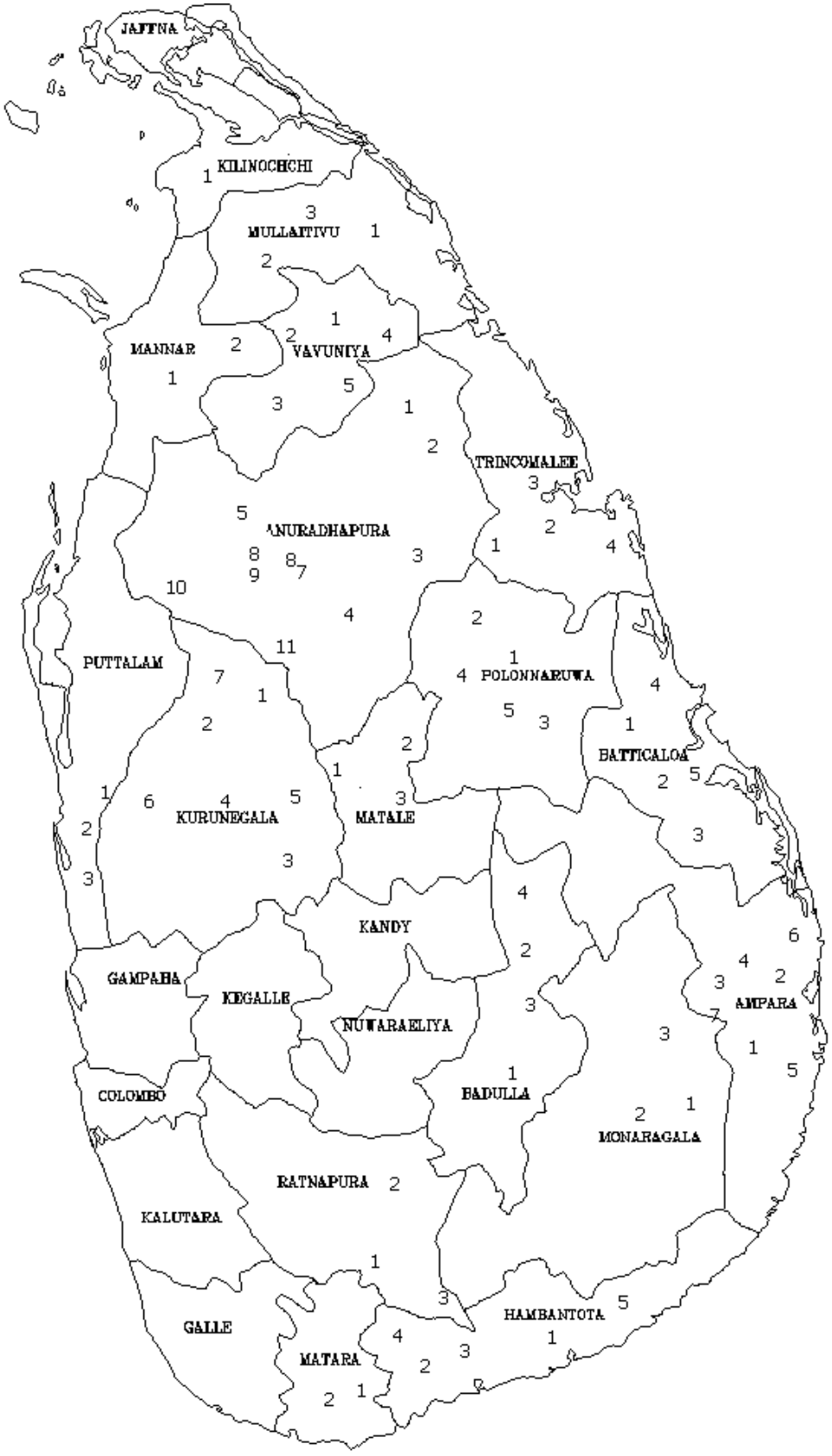
Annex 3: Irrigation schemes with fisheries of major importance to the inland fisheries sector.

District	Tank Name	Water area (ha)
Ampara	Alahena	103
	Valathipiddy	156
	Aligalge	111
	Himidurawa	113
	Ampara	369
	Malayadi	238
	Kondavattan	361
	Senanayaka Samudraya	7872
Anuradhapura	Mahakandarawa	1394
	Nuwarawewa	1230
	Nachchaduwa	1804
	HuruluWewa	1640
	Padawiya	2378
	Kalawewa	2624
	Rajangana	1640
Badulla	Mapakadawewa	189
	Soraborawewa	451
	Ulhitiya-Rathkinda	2270
	Dambarawa	349
Hambantota	Ridiyagama	902
	Bandagiriya	43
	Wirawila	574
	Tissa	236
	Yodawewa	492
Kurunegala	Mahaandarawa	129
	Kimbulwana	195
	Hakwatunaoya	394
Matale	Dewahuwa	349
	Moragahakanda	4050
	Kandalama	697
Nuwara Eliya	Norton	15
	Castlereagh	373
	Moussakeke	718
Polonnaruwa	Parakrama samudra	2296
	Kaudulla	2500
	Maduruoya	6780
	Minneriya	2583
Puttalam	Tabbowa	615
Ratnapura	Chandrika wewa	451
	Udawalawe	3444
	Smanalawewa	1123
Trincomalee	Morawewa	779
	Kantalai	2050
Total		**57076**

FIGURE 1: CULTIVATION SEASONS IN SRI LANKA



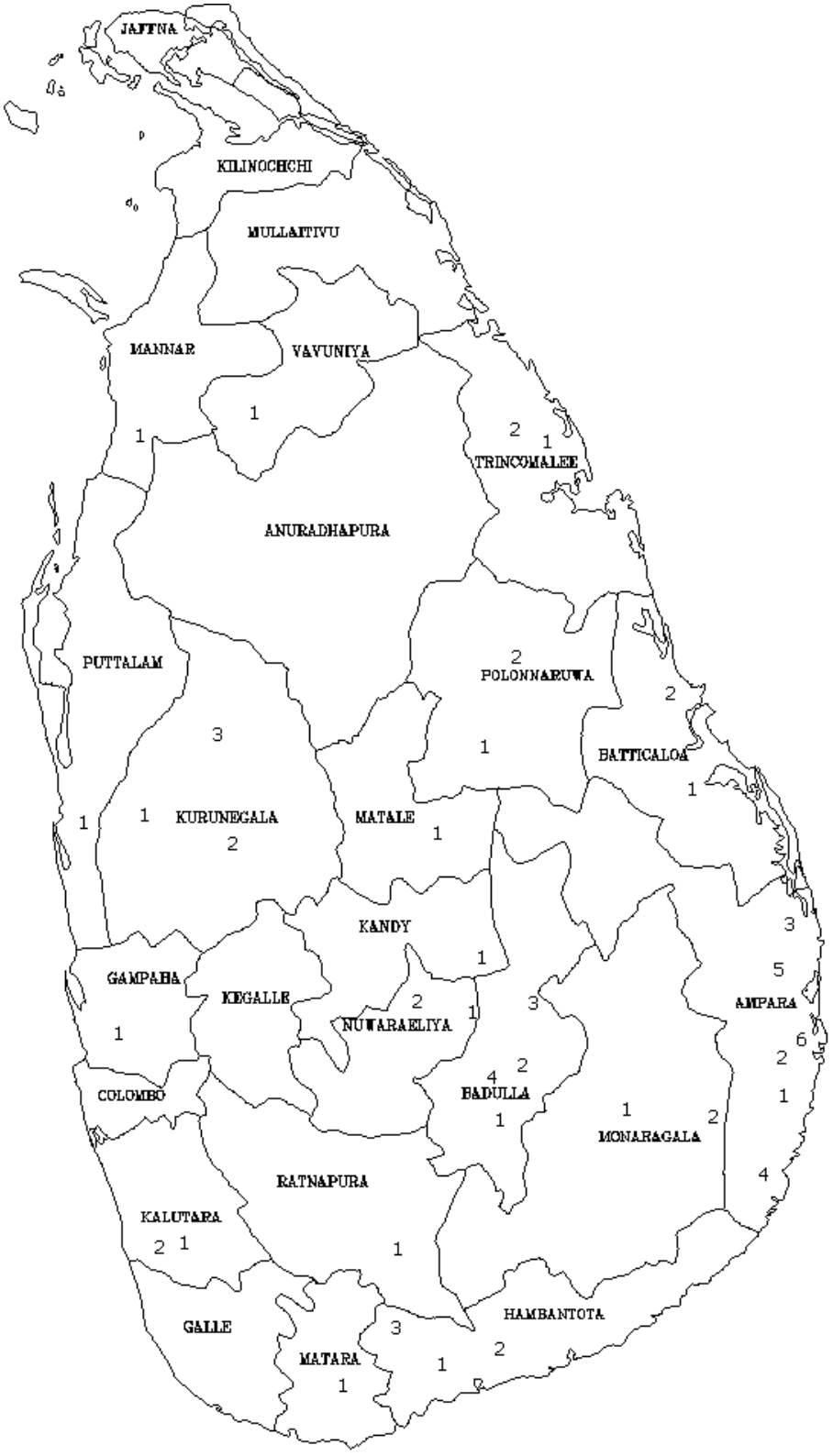
Annex 5: Map of Sri Lanka showing major tank schemes



Key to Figure 2: Major irrigation schemes in Sri Lanka

Matara District		**Polonnaruwa District**		**Kilinochchi District**	
Ellawela	1	Giritale	28	Kariyalai Nagapaduwan	58
Kekenadura	2	Kaudulla	29		
		Maduruoya	30	**Mannar District**	59
Hambantota District		Minneriya	31	Giant's tank	60
Bandagiriya	3	Parakrama Samudra	32	Vavnikulam	61
Muruthawela	4	Mahaweli System"B":	33		
Ridiyagama	5			**Puttalam District**	
Udukiriwela	6	**Anuradhapura District**		Inginimitiya	62
Kirindi Oya system	7	Padawiya	34	Magallawewa	63
		Wahalkada	35	Tabbowa	64
Moneragala District	8	HuruluWewa	36		
Ettimole	9	Kalawewa	37	**Kurunegala District**	65
Handapangala	10	Mahakandarawa	38	Usgala Siyambalangamuwa	66
Muthukandiya	11	Mahawilachchiya	39	Attaragalla	67
		Nachchaduwa	40	Batalagoda	68
Ampara District		Nuwarawewa	41	Hakwatunaoya	69
Ambalan Oya	12	Tissawewa	42	Kimbulwana	70
Andella Oya	13	Rajangana	43	Palukadawela	71
Namal Oya	14	Ambagamuwa	44	Magalle	72
Pannalagama	15				
Rufaskulam	16	**Trincomalee District**		**Matale District**	
Sagamam	17	Kantalai	45	Dewahuwa	73
Gal Oya system	18	Venderasankulam	46	Kandalama	74
		Morawewa	47	Nalandaoya	75
Badulla District		Allai tank	48		
Kandeela	19			**Ratnapura District**	
Soraborawewa	20	**Vauniya District**	49	Chandrika wewa	76
Nagadeepa	21	Pavatakulam	50	Samanalawewa	77
Mahaweli system " C'	22	Periyakulam	51	Udawalawe	78
		Kanukerni	52		
Batticalao District		Thannimuruppukulam	53		
Rugam	23	Udyar Kaddukulam	54		
Unnnichchai	24				
Vakaneri	25	**Mulativu District**			
Puluganawa	26	Akkarayan kulam	55		
Kadukkamunai	27	Iranaimadukulam	56		
		Muthuiyankaddu	57		

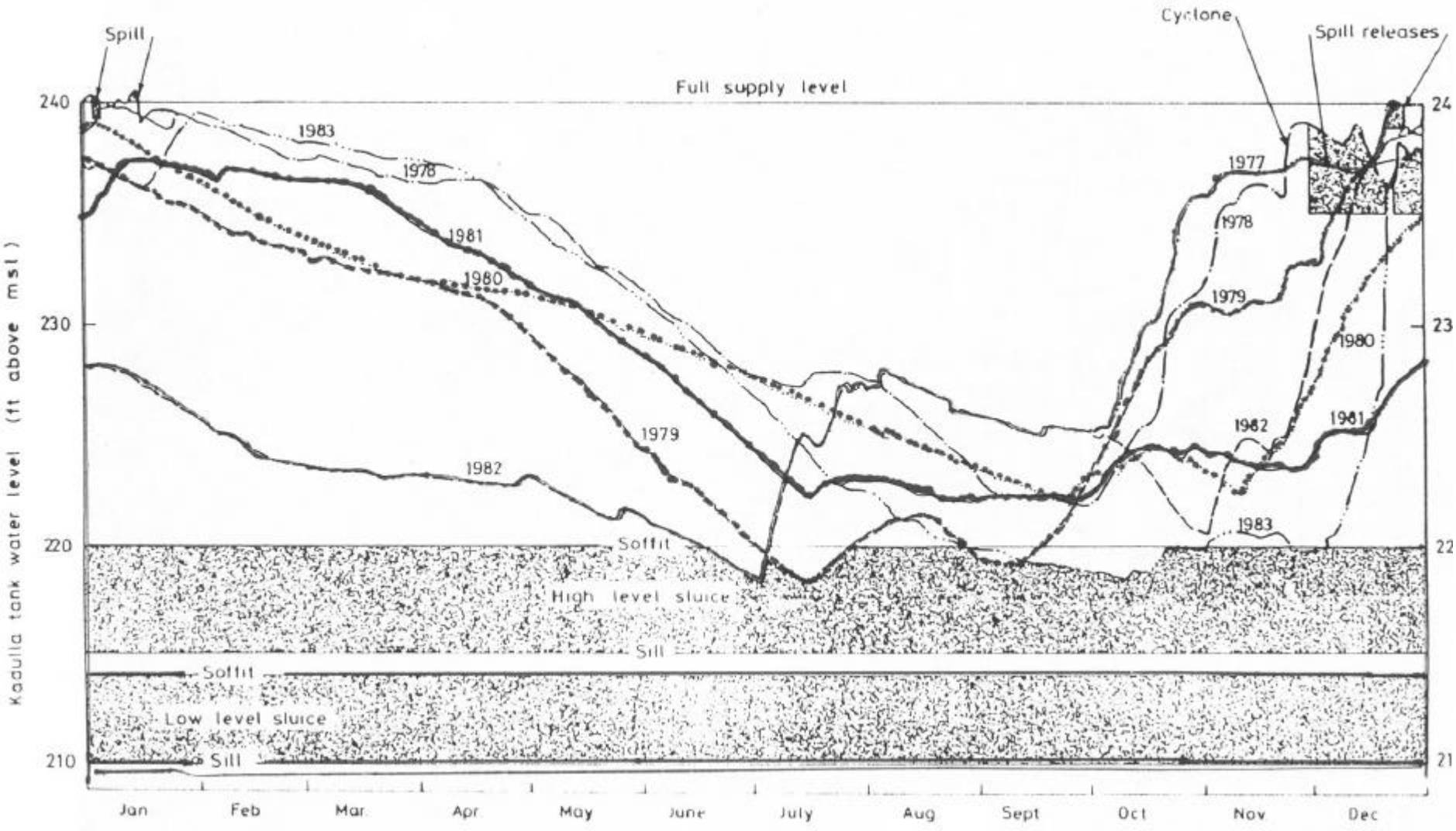
Annex 6: Map of Sri Lanka showing major anicut schemes



Key to Figure 3: Major anicut schemes in Sri Lanka

Matara District		**Vauniya District**	
Urapola	1	Kal Aru	25
Hambantota District		**Mannar District**	
Kirama Oya	2	Malwatu Oya	26
Liyanagahatota	3		
Urabokka	4	**Puttalam District**	
		Ratmala Oya	27
Moneragala District			
Butala	6	**Kurunegala District**	
Kumbukkan Oya	7	Deduru Oya	28
		Rindibendi Ela	29
Ampara District		Diyatura	30
Kaddukkayan	8		
Kurunthadi	9	**Matale District**	
Malawai	10	Hattota Amuna	32
Malwadi	11		
Naval Aru	12	**Kandy District**	
Parasadiodai	13	Minipe	33
Badulla District		**Nuwara Eliya District**	
Badulu Oya	15	Ma Ela	34
Bathmedilla	16	Murapola Ela	35
Heppola Oya	17		
Uma Oya	18	**Ratnapura District**	
		Ukgal Kaltota	36
Batticalao District			
Mawadi	19	**Kalutara District**	
Punanai	20	Kaluwamodara	37
		Talpitiya Ela	38
Polonnaruwa District			
Elehera	21	**Gampaha District**	
Galamuna	22	Attanagalu Oya	39
Trincomalee District			
Per Aru	23		
Yan Oya	24		

Annex 7: Water levels of Kaudulla tank



Appendix 3: Position paper 3. The nature and distribution of small-scale farmer managed irrigation systems in Sri Lanka and their potential for aquaculture.

Presented by: N.G.S.C. Ratnasiri, Department of Agricultural Economics, University of Peradeniya, Sri Lanka.

Table of Contents

Abstract.....**42**
Table of Contents.....**42**
1. Introduction.....**43**
1.1 Rainfall Distribution in Sri Lanka.....43
1.2 Irrigation systems in Sri Lanka.....44
1.3 Small scale farmer managed irrigation systems in Sri Lanka.....44
1.4 Nature of village irrigation systems.....44
1.5 What are village tanks?.....45
1.6 Physical characteristics of minor tanks.....45
1.6.1 Tank and channel system.....46
1.7 Small Tank Cascades.....46

2 Historical development and tenurial arrangements in minor irrigation systems in Sri Lanka.....**50**
2.1 History of the development Irrigation systems in Sri Lanka.....50
2.2 Tenurial arrangements and water use.....50
3 Distribution of minor irrigation systems and potential for aquaculture.....**53**
3.1 Quantification of irrigation systems in Sri Lanka.....52
3.2 Water quality.....54
3.3 Importance of Minor Tank Systems in the Dry Zone.....54
3.4. Potential for aquaculture in minor irrigation systems.....54
References.....57
Annex 1: Small perennial tanks in the North Western Province.....57
Annex 2: Irrigated paddy lands by year and irrigation regime (1979-1996).....58
Annex 3: Landmarks of participatory irrigation management policy in Sri Lanaka.....59
Annex 4: The current Status of Inland aquaculture in Sri Lanka.....62

1. Introduction

The irrigation systems of Sri Lanka can be classified by scale (administrative classification) or by the type of institution, community or individual managing the system (our classification). According to the administrative classification there are 3 major classes of irrigation schemes in Sri Lanka; major minor and medium systems. This paper focuses on minor irrigation system or "small-scale farmer or community managed irrigation schemes" which have command areas below 80 ha, servicing a minimum of five farm families. These systems include village tanks, anicuts, lift irrigation systems, and stream diversions on perennial rivers.

Small water storage systems, commonly referred to as village tanks are used for collecting rainfall and run off during the monsoon period. The primary use of this water resource is for irrigation. Secondary uses include domestic and livestock functions. Water is conveyed to the fields along channels by way of a sluice (horowwa) with an access tower (bisokotuwa).

It's very difficult to get accurate estimates of the number and distribution of village irrigation systems and in particular the actual number of tanks currently in operation. Estimates of operational tanks in the Dry Zone range between 8,000 to 13,000. Nearly 63% of all village tanks are located in Kurunegala and Anuradhapura districts.

Traditionally, Sri Lankan society revolved around a 'one tank one village' system. These small village tanks spread over much of the dry zone and provided a foundation for the civilization, which flourished in the period from the 4th to the 13th century AD. During the centuries which followed most of these tanks were abandoned and significant recolonisation of the dry zone began only in 1931 when the colonial government recognised the potential for restoration of the ancient irrigation works and the development of the economic activities associated with them.

The tank paddy land (*Yaya*) settlement area (*Gamgoda*) and land fallowing area (*Chena*) which are among the basic physical features of the village tank irrigation systems (Economic Review, 1986). Land for paddy cultivation often belonged to several tenurial categories (i.e *paraveni* land, freehold land, lease land, state encroached land). *Paraveni* lands are sub divided into upper (*Ihala bage*), middle (*Meda bage*), and lower (*Pahala bage*) parts. This sub-division is determined by the irrigation potential of the tank. The share system also provided an opportunity for communal cultivation practices and collective maintenance of irrigation tanks.

Through integrated aquaculture interventions such water bodies have the potential to improve food security and provide income generation opportunities for some of the poorest communities in the country, potential to diversity livelihood strategies and spread risk. Aquaculture may be practiced as part of integrated pest management (IPM) systems.

Extensive and semi intensive systems of aquaculture need not impact heavily on the workloads of regional farmers. Inland fish can be produced at lower cost and fresher condition than marine supplies. Hence, the potential for creating a wider market for inland fisheries is high (De Alwis, 1983).

1.1 Rainfall Distribution in Sri Lanka

Sri Lanka is divided into two climatic zones, the Wet Zone and the Dry Zone. Mean annual rainfall in the Wet Zone and dry zone respectively is more than 2500 mm and less than 1500mm. Both zones record a bimodal pattern of rainfall distribution within a year. Main

rainfall season in the Dry Zone is from October to January. This coincides with the major cultivation season called as the Maha season. Only a one third of the total annual rainfall is received within the minor rainy season from May to July, which coincides, with the Yala season. Cultivation in the Yala season is always supplemented with irrigation water. The Wet zone experiences nearly equal amounts of rainfall during both seasons.

1.2 Irrigation systems in Sri Lanka

The conventional classification of irrigation schemes in Sri Lanka is based on the scale and type of the organisation. Accordingly all irrigation projects in the country are categorised as minor, medium, major schemes. The Irrigation Ordinance No 32 of 1946 states that minor schemes are those that have been "constructed by the proprietors without government aid or with the aid of masonry works and sluices supplied free of charge by the government, and maintained by the proprietors". The Agrarian Services Act No. 58 of 1979 defines minor irrigation systems as those irrigating up to 80 ha of agricultural land. Design and construction is the responsibility of the Irrigation Department whilst operation and maintenance is the responsibility of the Department of Agrarian Services, which enlists the involvement of the community for the purpose (Economic Review, 1986). Since 1979, the Department of Agrarian Services (DAS) have been responsible for the operation and maintenance of some 30,000 'minor' irrigation schemes. Included in this are approximately 10,000 anicut schemes located almost entirely in the wetter parts of the island (Bentvelsen *et.al.*, 1984). The irrigated area under these minor schemes represents approximately 40% of the irrigable area of Sri Lanka (Tilakasiri, 1986).

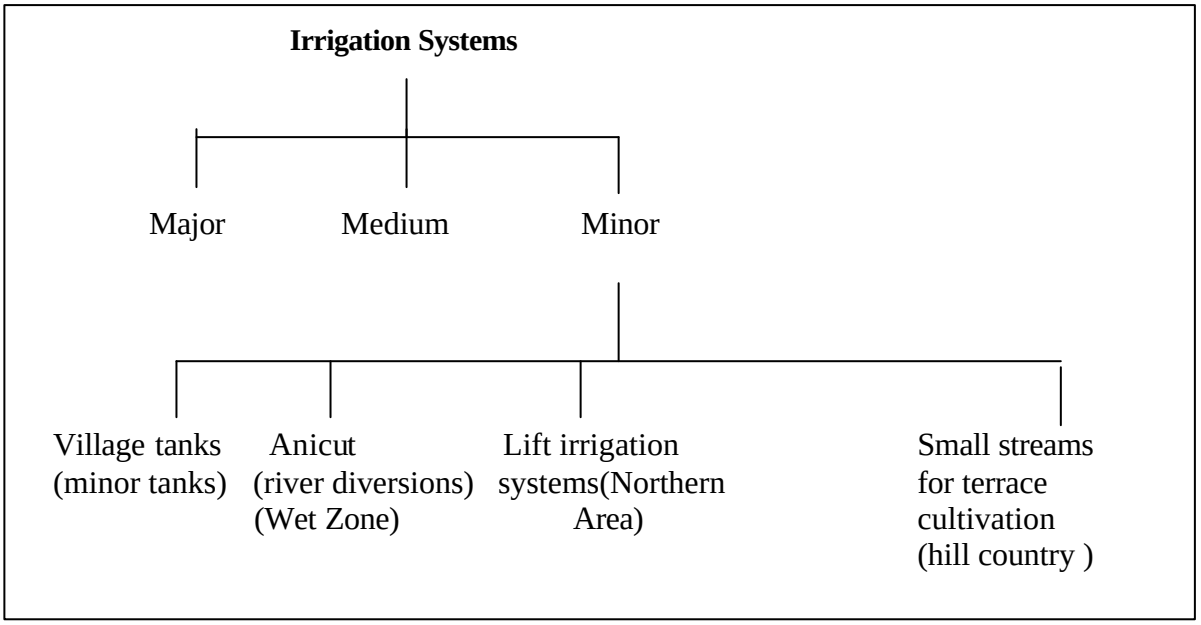
1.3 Small scale farmer managed irrigation systems in Sri Lanka

The minor irrigation systems also known as small-scale irrigation systems or village irrigation schemes serve at least 5 farm families, therefore farmer participation in operation and maintenance of the tank is correspondingly high. The Irrigation Ordinance of 1946 also defined minor irrigation systems as those constructed and maintained by the farmers themselves. The International Irrigation Management Institute (IIMI) stresses farmers' involvement in irrigation management with its use of the term Farmer Managed Irrigation Systems (Dissanayake, 1989).

1.4 Nature of village irrigation systems

The village irrigation system consists of village tanks chiefly in the Dry Zone, and anicuts (river diversions), in the Wet Zone. Lift irrigation systems are in operation in northern areas, whilst in the hill country, irrigation systems divert small streams for terrace cultivation. The Dry Zone village tanks represent the most substantial component of this small-scale irrigation resource. Figure 1 shows a classification of irrigation systems in Sri Lanka.

Figure 1: Classification of irrigation systems in Sri Lanka



1.5 What are village tanks?

Small water storage systems commonly referred to as village tanks, are small reservoirs used for collecting runoff water during the monsoon to be used for irrigation and domestic water supply. Village tanks in Sri Lanka depend entirely on direct rainfall and runoff water from their own catchment areas (Economic Review, 1986).

The distributory canal system shows close resemblance in many tanks. In a large or medium reservoir project, there are usually two main irrigation channels. Channels, which originate from head sluices on either side of the tank embankment, are referred to as the right bank (RB) main channel and the left bank (LB) main channel respectively (with respect to the flow direction of the stream). Channels generally follow natural contours to supply water to fields. The old stream, which existed prior to dam construction, usually receives drainage flow from fields.

Although the above scheme is commonly used in small tanks, restorations during recent times often installed only one head sluice at the left side or the right side of the bund.

1.6 Physical characteristics of minor tanks

Small-scale water conservation systems referred to as minor (village) tanks, are a distinctive feature of the Dry Zone of Sri Lanka, created by construction of an earthen bund across a natural drainage basin. Minor tanks in Sri Lanka depend entirely on direct rainfall and runoff water from their own catchment areas. They are used for collecting monsoon runoff water for irrigation and domestic water supply purposes. Tank water is conveyed to the fields along channels by way of a sluice (*horovva*) with access tower (*bisokotuwa*). The structure of a restored tank is different from that of an ancient tank. Since the rationale for restoring the tank is to develop the irrigable area of land, restoration naturally demands an increase of command area. A tank, which has been restored in recent times usually, has 2 sluices. The main sluice named *maha horovva* located at low level supplies water to the old or original command area. The 2nd sluice, named *goda horovva* is built at higher level and supplies water to land added to the command area when water level is sufficiently high. Figure 2 depicts a cross sectional view of a village tank.

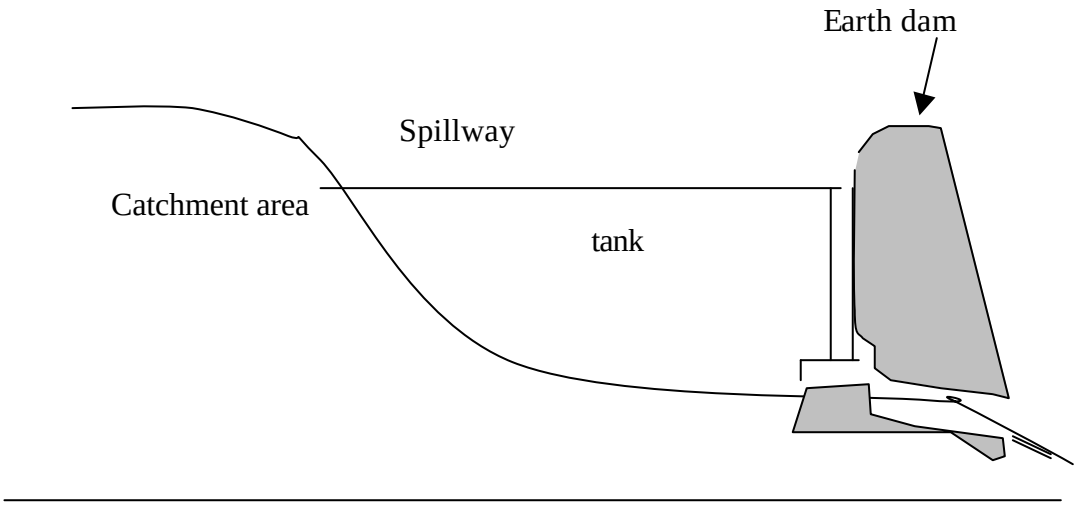


Figure 2 : Cross-sectional view of a village tank

1.6.1 Tank and channel system

The invention of *biso kotuwas* made controlled irrigation possible from early times (Leach, 1961). In more recent times there have been other types of sluices under village tank irrigation development works (*viz.* vertical pipe, sluice, plug sluice, tower sluice etc).
Irrigation channels start from the main and minor sluices. The main channels (*raja ela*) are connected to the sluices and the various minor channels take the water to various segments of paddy land. These channels are generally constructed using earthen bunds. Each paddy plot has a separate inlet (*wakkada*). A separate minor channel finally delivers water to irrigate the paddy lands (usually running parallel to the main channel).

1.7 Small Tank Cascades

A cascade is a chain of tanks or a connected series of tanks organised within the micro catchment of the dry zone landscape storing, conveying and utilising water from a ephemeral rivulet (Madduma Bandara, 1994). In these small valleys or catchments surface water flow is intercepted by small man-made earthen bunds. The size of these reservoirs increases as one moves downstream in the valley. Mendis relates how small tank cascades traditionally employed a different method to supply water to paddy fields than is commonly practiced today. Irrigation water is released through a single sluice to the old stream. Contour channels in either side of the stream then pick up water. Irrigation takes place from *liyadda* (small plots of land cultivated with paddy) to *liyadda* which are in line. Some water drains back into the stream and can be reused for irrigation further down-stream. The best example of this type of cascades is found in Mau Ara of the Walawe Ganga in the south. However, only the remains of these tanks using this system are found in the area today. Cascades situated in Anuradhapura district still function in this manner. In all these projects the layout of channels was based on topography alone. An illustrative example of a tank cascade system is depicted in Figure 3.

The mean catchment area of small-tank cascade tank systems in Anuradhapura district is 67 Km^2 (Sakthivadivel *et.al,* 1996) with an average of four tanks per cascade. The micro catchment area of a tank constructed by crossing a first order or a second order (ephemeral) stream ranges from 75 to 150ha,while meso-catchment of the system range between 3000 to 10000 ha. A cascade system generally drains in to a third order tributary of a fourth-order river that finally drains in to the sea.

1.7.1 Distribution of small tank cascade systems.

Concentrations of Small tank cascades in Sri Lanka are greatest within the Districts of Anuradhapura, Kurunegala, Puttalam and Moneragala. According to Sakthivadivel *et al* (1996) eighty five percent of operating village tanks are located within Anuradhapura district alone. The distribution of small tank cascades within major river basins of Anuradhapura district is presented in Table 2. Figure 4 shows the geographic distribution of small tank cascade systems within the district.

Table 1; Distribution of small tank cascades within major river basins of Anuradhapura District.

Main River Basin	Area (Km^2)	No of sub watersheds within the basin	No of cascades	Average cascade area (Km^2)
Yan Oya	1536	08	69	22.3
Malwatu Oya	3098	17	152	20.5
Ma Oya	1032	07	36	28.7
Modaragam Aru	1024	04	52	19.7
Kala Oya	2775	15	14	24.3

Figure 3: Schematic representation of a small tank cascade (after Sakthivadivel 1996).

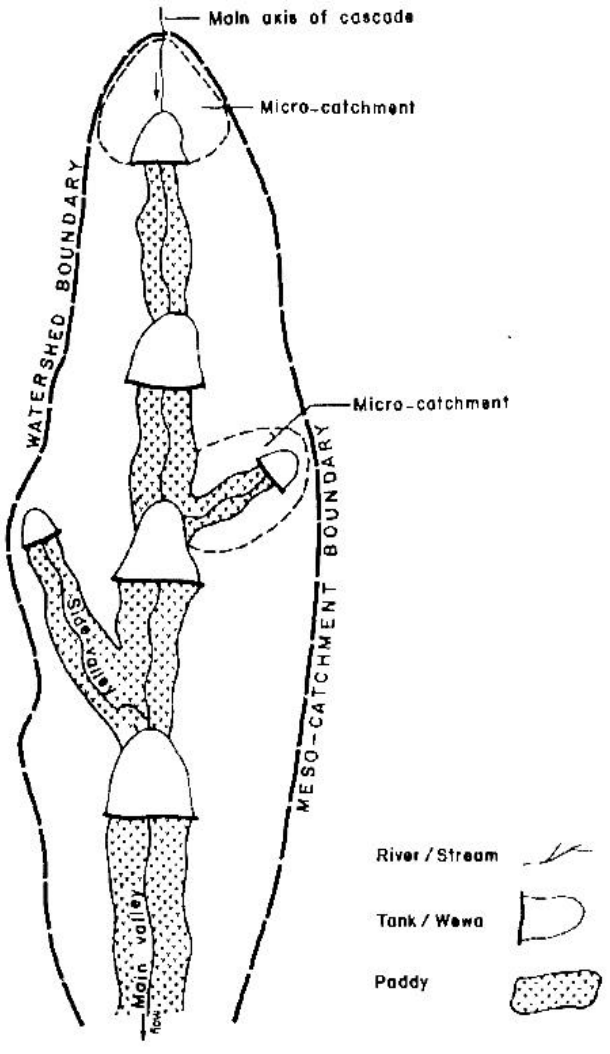
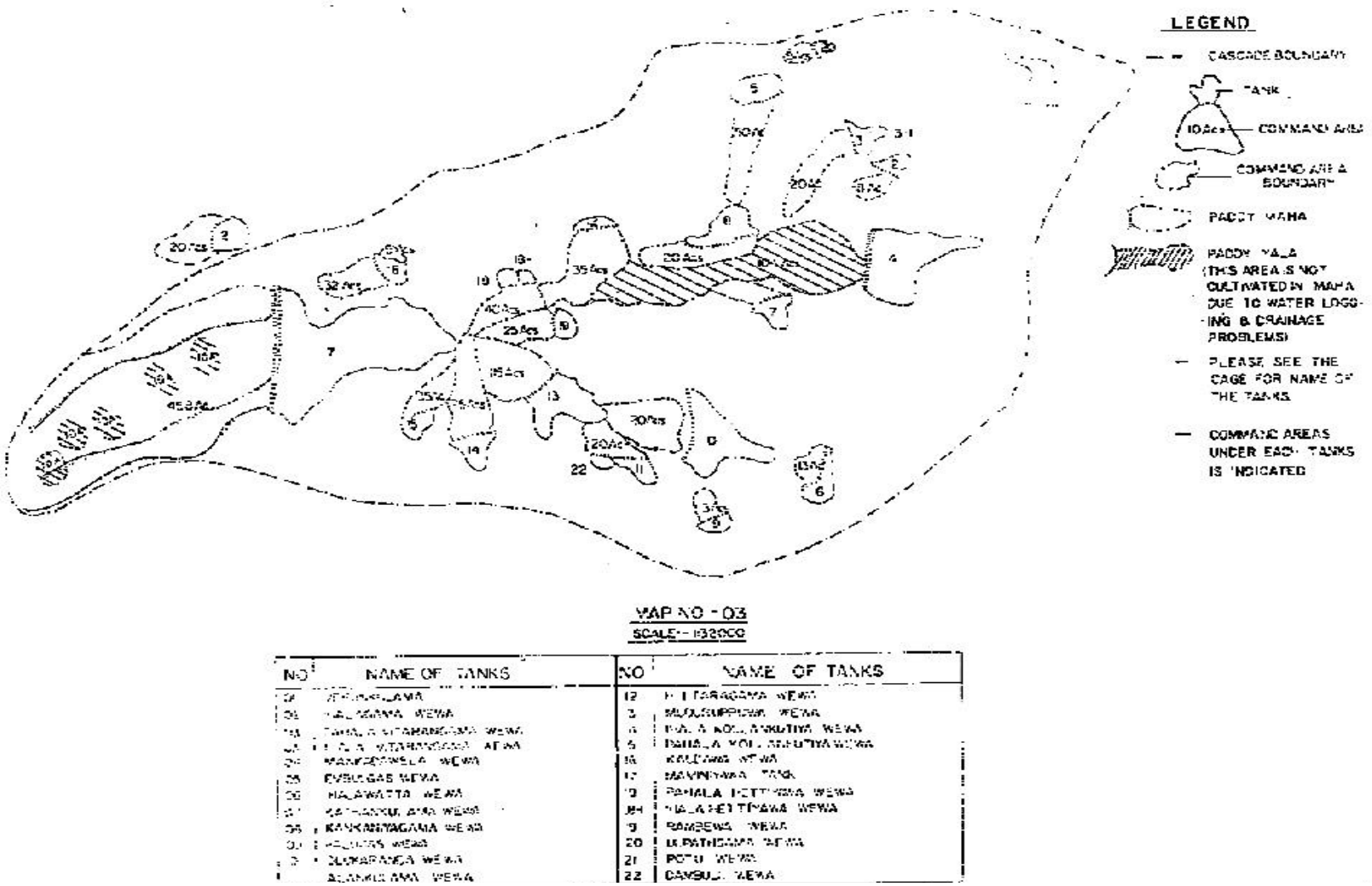


Figure 4: Map showing main watershed sub watershed and natural drainage system of Anuradhapura District.

Figure 5 Maminiyawa Oya small tank cascade in the Horiwila Oya sub basin of Malwathu Oya.



1.8 River diversion irrigation systems

River diversion irrigation schemes do not store water at head-works. A structure called as *amuna, anicut* or *tekkam* (in Tamil) diverts water from a stream to a contour channel. The stream can be a perennial river or a non-perennial stream.

2. Historical development and tenurial arrangements in minor irrigation systems in Sri Lanka

2.1 History of the development Irrigation systems in Sri Lanka

Historical records identify migrants from the Indian sub continent as the first recorded inhabitants of the Island of Sri Lanka. Human settlement process began in the 6th century BC being mainly confined to the dry zone. All such settlements were located near rivers. Increasing food requirements made it essential to cultivate two crops of rice a year. Rainfall pattern in the dry zone did not facilitate growing rice during the dry season, prompting people to find alternative means of providing water for their crops. The practice of constructing tanks to store water for this purpose began around 300BC. The tradition of constructing tanks developed to such an extent that each village in the country has a tank. Irrigation civilization in the country gradually developed its irrigation resource base by adding several large-scale tanks, diversion anicuts and trans-basin canals, arrested only by the fall of Polonnaruwa kingdom in the 13th century AD

The population began to move to the wet highland areas where smaller kingdoms prospered independently until the whole island came under the British rule in the early 19th century. Only the ruins of old cities and abandoned reservoirs remained in the dry zone areas. Population was very low in the area. The 1871 census reported population density of the northern district of Tamankaduwa (presently north central province) as only four persons per square mile.

In 1930s, the government initiated a programme to restore abandoned irrigation works in the dry zone to relieve population pressure in the densely populated wet zone. Since then substantial investments have been made to restore ancient tanks and to build new tanks in the dry zone, with the principle goal of achieving self-sufficiency in rice production within the country.

2.2 Tenurial arrangements and water use

Basic physical features of a typical dry zone village includes, the tank, paddy land (*yaya*), settlement area (*gamgoda*) and fallowing area (*chena*)(Economic Review, 1986). In response to increasing land pressure, smaller supplementary village tanks (without settlement) are typically set up adjacent to the main tank, increasing the availability of irrigated land for cultivation. A single family or several families in the village may sometimes be the private owners of such tanks. Construction of tanks and channels was typically undertaken by local individuals or groups, consequently tenurial systems arose which favoured inheritance by their descendants. Water management regulations and access also followed this pattern.

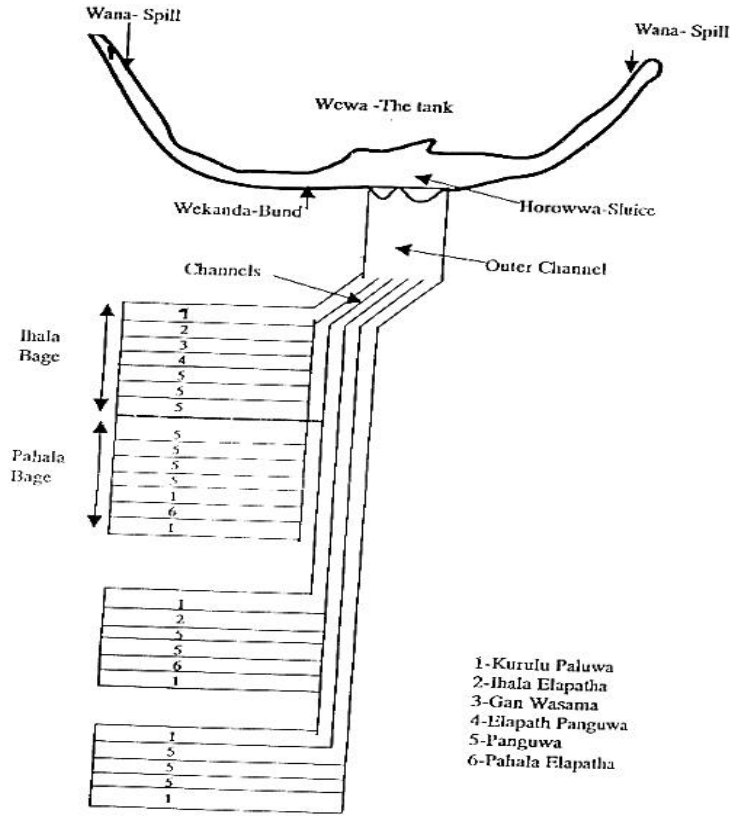
There were several categories of paddy lands under a traditional village tank. Land inherited from ancestors were referred as *paraveni* lands. Freehold lands, lease lands and encroached state lands are the main alternative tenurial forms. *Paraveni* lands, within the original area irrigated by the tank were sub divided into three segments based on the distance from the tank sluice with upper (*Ihala bage*), middle (*Meda bage*), and lower (*Pahala bage*) designations. Shareholders of the system were allocated land in each of these zones (or reserved for specialised functions – see below). This division aimed to equalise the risk of shareholders facing water shortages during deficit years. Cultivation of all or some of the lands in these areas was determined by the irrigation potential of the tank in a particular season. During

deficit seasons lands and water were allocated on a *pro rata* basis proportional to normal irrigated land holdings (this is known as the bethma system). A special land allotment was reserved for the village headman. A strip of land which sustains greater damage by birds was also set apart. Figure 6 shows the tenurial arrangements of a typical village tank. Although this division aims at fair and equitable supply of water to all farmers, this zoning is to simple to reflect real hydrological variability or does not exist at all under some small tanks (Karunanayaka, 1977).

Ownership rights for land cultivated under the tank as well as rights to other services of the tank such as fishing were distributed among villagers. Ownership was measured in share units called the *pangu* (the share). These rights were determined at the establishment of the villages and were transferred to successive generation through inheritance (Codrington, 1938, Obeysekera 1967). Villages were established by demarcating highlands, paddy land and tank areas in previously unsettled jungle or barren land. The extent of the village and the structure of ownership were set at the very beginning. Total cultivable area in the paddy tract was the sum of all shares allotted amongst owners. The share system provided an opportunity for communal cultivation and through collective action, it facilitated maintenance of irrigation tanks. All maintenance responsibilities were also allocated according to the share system, until they were taken over by the government under the Irrigation Ordinance of 1856. Population increases in villages and limited space for expansion, led to subdivision of ownership of shares and land fragmentation. The principle of exchange of user rights subsequently became commonplace in 'tank villages'.

Lacking resources for effective maintenance, the government has gradually tried to hand ownership of tanks back to over to their users. Major land marks in irrigation management are presented in Annex 3.

Figure 6: Tenurial arrangement of irrigable land under a typical village tank



3. Distribution of minor irrigation systems and their potential for aquaculture

3.1 Quantification of village irrigation systems in Sri Lanka

A large number of village irrigation works in Sri Lanka were constructed in ancient times. Some of them are still used for their intended purpose whilst many still remain abandoned. Official statistics report between 5,000 to 10,000 currently operational small tanks (supporting communities). However it is not an easy task to provide an accurate estimate of total number of minor irrigation schemes in the country. Estimates vary widely between different agencies.

In 1975 the Irrigation Department, listed 4,976 minor irrigation works in its publication, " Register of Irrigation Projects in Sri Lanka. This work can be considered as a leap forward in documenting irrigation resources in Sri Lanka. However, it lacks key information on a large number of works listed and does not necessarily follow the definitions used by the Irrigation Department in categorising irrigation works. No revision of the work has been undertaken even after two decades. Table 1 presents the district-level breakdown of two types of schemes. It is interesting to note that 97.4 percent of minor tanks are located in the Dry Zone. In contrast, only 36.5 percent of anicut schemes are located in the Dry Zone. 73.5 percent of all minor tanks in the Dry Zone are found within Anuradhapura and Kurunegala districts.

The Freedom from Hunger Campaign (1979) counted about 18,000 village tanks in Sri Lanka mainly in the Dry Zone and of ancient origin. According to the "Wewas and Reservoirs Album" prepared by the FFHC (1979) about 52% of these are operational but with widely differing degrees of efficiency.

The FAO (1980) estimates the number of operational tanks at 7,758 while the Ministry of Lands and Land Development estimates the number of village irrigation schemes at 23,000 of which 13,000 are tanks and the rest anicut schemes. The Economic Review (1986) estimates the number of operational village tanks in operation in the dry zone at 8,000. Kurunegala (in the North Western Province) and Anuradhapura (in North Central Province) districts account for nearly 63% of all village tanks (Economic Review, 1986). A district-wise breakdown of the distribution of village tanks, minor irrigation tanks and anicuts are presented in Table 2.

Table 2a: Distribution of minor tanks and minor anicut schemes by zone.

	Minor Tanks	Minor Anicuts
Dry Zone Districts		
Ampara	10	18
Anuradhapura	1047	4
Badulla	12	82
Baticaloa	82	28
Hamabantota	100	12
Jaffna	3	
Kilinochchi	33	1
Kurunegala	1298	171
Mannar	80	1
Matale	63	201
Moneragala	25	76
Polonnaruwa	29	2
Puttalam	86	10
Trincomalee	158	7
Vauniya	168	6
Total	**3194**	**619**
Wet Zone Districts		
Colombo	1	34
Gampaha	10	134
Galle	1	152
Kalutara	3	87
Kandy	31	176
Kegalle	4	102
Matara	4	60
Nuwara Eliya	22	20
Ratnapura	9	313
Total	**85**	**1078**
Sri Lanka Total	**3279**	**1697**

Table 2b: Distribution of village tanks by district in Sri Lanka

Dry Zone		**Wet Zone**	
District	**Number**	**District**	**Number**
Ampara	90	Badulla	284
Anuradhapura	1406	Colombo	228
Hambantota	311	Kalutara	45
Jaffna (&Kilinochchi)	442	Galle	636
Kurunegala	4203	Kandy	382
Moneragala	137	Matara	493
Polonnaruwa	63	Nuwara Eliya	223
Puttalam	772	Ratnapura	410
Trincomalee	192		
Vavuniya (& Mullaitivu)	610		
Subtotal	**8,927**		**2,907**
Grand total	**11,897**		

Source: Ministry of Lands & Land Development, 1971-1975, Department of Agrarian Services, 1980 in Economic Review 1986.

3.2 Water quality

Surface water draining from the granite central hills of Sri Lanka is normally clear, soft and more or less neutral in pH. Lowland standing water bodies have higher levels of dissolved solids, conductivity and are generally alkaline (see Table 3).

Table 3: Comparison of some Water quality parameters in central hills and lowlands of Sri Lanka.

Character	Riverine central hills	Static Lowland
Clarity DH	2-5	
Conductivity	18-3 (uS @ 22oC)	400-1100 (uS @ 27oC)
PH	5.8-7	7.4 – 8.4

However, continuing deforestation and poor agricultural practices, particularly in sloping lands, are increasing the siltation rate of rivers (Jaywardene 1982). Pethiyagoda (1994) showed that the range and abundance several species (including *P. Srilakensis, L. Fisheri, Garra spp., R. vaterifloris* and *M. Kretseri*) have been significantly reduced due this effect. Dissanayake (1986) concluded that the general chemical quality of the Mahaweli River was still satisfactory for most purposes.

Chandrasoma (1986) showed positive linear relationships between fish yield and conductivity and alkalinity in ten seasonal reservoirs. Such observations could be included in a limnological classification related to management strategeies.

3.3 The importance of minor tank systems in the Dry Zone

It is estimated that, about 192,085 ha out of total 520,000 ha of irrigated lands in Sri Lanka are irrigated by minor irrigation systems (Ministry of Agricultural Research and Development 1990/91). Nearly seventy percent of this area is located in the Dry Zone districts. Somasiri (1991) suggests that there are nearly 135,000 ha of land irrigated by minor tank systems. Land under minor tank systems represents a significant percentage of the country's irrigable cultivated lands. The majority of the rural population continues to depend on minor tank irrigation for their livelihood. Even today, the minor tank is the focal point of the social, economic, cultural and religious lives of most rural communities.

3.4. Potential for aquaculture in minor irrigation systems

Most small tanks and associated communities are in remote inland locations with poor access to coastal resources. Table 4 shows the percentage of minor tanks and the percentage of rural population living within different climatic zones of the country.

Table 4. Distribution of minor tanks, area and percentage of rural population by climatic zone.

Zone	Total No of tanks	% that are minor tanks (%)	% of all minor tanks, all zones	Rural Population ('000s)	Rural population (%total zone population)
Dry Zone Inland	2642	82.72	80.57	2891.8	55.74
Dry Zone Coastal	552	17.28	16.83	2295.8	44.26
All dry Zone	**3194**	**100.00**	**97.41**	**5187.6**	**100.00**
Wet Zone Inland	66	77.65	2.01	3178.8	48.99
Wet Zone Coastal	19	22.35	0.58	3309.9	51.01
All Wet Zone	**85**	**100.00**	**2.59**	**6488.7**	**100.00**
All Sri Lanka	**3279**			**11676.3**	

Dry zone districts are economically disadvantaged relative to other sectors and urban areas. In 1986.87, the mean income of the rural sector was Rs. 1,674 while that of the urban sector was Rs. 2,914 (Economic Progress of Independent Sri Lanka, 1998). Consequently demand is greatest for inland fish in these areas, rather than more expensive marine fish.

In addition to improving nutrition levels the development of aquaculture could also provide an alternative means of income generation. This is particularly relevant to the Dry Zone for the following reasons:

(i) Fisheries may offer a means of diversifying livelihoods in these risk prone environments (rainfed farmers suffer the greatest frequency of drought associated crop failures).
(ii) Aquaculture may be compatible with integrated pest management techniques reducing reliance on high cost and environmentally damaging chemical pesticides.
(iii) Fisheries can provide direct and direct indirect benefits in production (out-growing and seed supply), processing and marketing. This may offer opportunities to a wide range of stakeholders, including the landless poor, unemployed youth and women.

Cultivation of farm crops (mainly paddy) and allied activities during the two main growing seasons provide the main source of income and livelihood for the majority of the people in the Dry Zone. Consequently most farmers have two peak working seasons each year. Between those two labour intensive seasons farmers have under-utilised time resources which they may wish to invest in aquaculture related activities.

Most of the inland water bodies are far from the coastal fisheries areas and therefore good local demand exists for inland fish. Generally, the fish caught in coastal areas are packed with ice and transported to the interior of the country, which involves a middleman in the process. This may lead to spoilage of fish and higher prices. This encourages poorer consumers to consume cheaper, fresher locally available fresh water fish products. Hence, the potential for creating a wider market for inland fisheries is high

References

Bentvelsen, C. L. M., S.H Charles, J. Medagama, S. Somasiri and W.A.L. Wanigaratna. 1984. *Guidelines for water management and agricultural production in anicut schemes. Investigation report on four anicut schemes in mid & up country of the Badulla district.* Report prepared for the Department of Agrarian Services, Ministry of Agricultural Development and Research, Sri Lanka.

Central Bank of Sri Lanka. 1998. *Economic Progress of Independent Sri Lanka.*

Chandrasoma, 1986 No reference available.

Codrington, H. W. 1938. *Ancient land tenure and revenue in Ceylon*, Colombo: Government Press.

Dayaratne, M.H.S 1991. *A review of alternative strategies for improving farmer managed irrigation systems in Sri Lanka*. IIMI country paper, Sri Lanka No.7. Colombo: International Irrigation Management Institute.

De Alwis, L. 1983. *Possibilities in Inland Fisheries for Developing the Peasant Economy of the Dry Zone*. Economic Review. 8 (11 and 12).

Dissanayake, G 1989. *Minor irrigation systems in Sri Lanka, role of non governmental organisations in the improvement of minor irrigation systems in Sri Lanka.* In. Participatory Irrigation Management. Proceedings of a symposium. Kandy, Sri Lanka: International Irrigation Management Institute.

Ievers, R.W. 1989 *Manual of the North Central Province Ceylon.* Colombo: Government Press.

Jayawardena (1982): No reference available.

Karunanayake, M.M. 1978. *'Muttimangallaya', A note on the cultural and ecological Significance.* Vidyodaya journal of arts, science and literature. 6 (2): 67-69.

Karunanayake, M.M. 1977. *The attitude of peasants to land consolidation; A case study of dry zone village in Sri Lanka.* National Geographer, XII;(I):25-34.

Leach, E. R. 1961. Pul- Eliya: A village in Ceylon. Cambridge: Cambridge University Press.

Madduma Bandara, C.M. 1994. *Tank cascades in Sri Lanka.* In. K. Asharul Haq. ed. Proceedings of IRMU Seminar Series. Colombo: Irrigation Research and Management Unit/Irrigation Department Sri Lanka.

Economic Review 1994. *Irrigation management from bureaucracy to people*. 20(6).

Pethiyagoda, U. 1994. No reference available.

Sakthivadivel, R., C. R. Panabokke, C. M. Wijayaratna, N. Fernando, K. Jinapala and R. B. Bandula Sirimal. 1996. *Pre-project technical assistance study for proposed area development project of north central province. Main report*. Colombo: International Irrigation Management Institute

Somasiri, S. 1991. *Irrigation potential of minor tanks and their agricultural stability*.Tropical Agriculturist. 147:

Sri Lanka Department of Irrigation. 1975. *Register of irrigation projects in Sri Lanka.* Colombo.

Department of Census and Statistics. 1997. *Statistical Pocket Book of the Democratic Socialist Republic of Sri Lanka.*

Tilakasiri, S. L. 1986. *Tenurial arrangement and water use*. Economic Review. 11: 6-7

Tilakasiri, S. L. 1986. *Village irrigation*. Economic Review, 11: 3-13.

Annex 1: Small perennial tanks (<80ha) operational in North Western Province

District	Reservoir	Area (ha)
Puttalam	Siyambalankotuwa	240
	Kottukachchiya	
	Saliya wewa	
	Pahasiya wewa	
	Devale-Handiya wewa	
	Karatta wewa	
	Kanapota wewa	
	Thissapiti wewa	
	Mahawewa	
	Karambewewa	
	Mahakoonawewa	
	Makandarawa wewa	
	Uppalawatta	
	Mahakumbukkadawela	
	Kokupadiyawa	
	Karankodiyawa	
	Mandawa	
	Wawaranawatiya	
Kurunegala	Palukadawela	180
	Bathalagoda	281
	Kiribulwana oya	236
	Magalla	261
	Wennaruwa tank	-
	Wennaruwa	86
	Atharagalla	196
	Parumandawala	196
	Mahakanthoruwa	100
	Mealiya	53
	Ambakolawewa	203
	Mariyawa	58
	Kathnoruwa	186

Annex 2: Irrigated paddy lands by year and irrigation regime (1979-1996)

Year	Major Schemes		Minor Schemes	
	Irrigable Area(1)	Irrigated Area(2)	Irrigable Area(1)	Irrigated Area(2)
1979	228,378	328,294	171,265	194,618
1980	238,531	330,335	167,352	194,587
1981	244,014	349,091	171,066	199,004
1982	259,178	346,996	172,295	172,183
1983	265,836	372,923	175,045	165,380
1984	268,784	426,443	176,235	231,916
1985	276,376	392,824	175,414	190,250
1986	288,032	408,498	180,998	153,520
1987	202,256	376,587	181,533	192,307
1988	297,765	399,953	181,533	192,307
1989	302,472	355,673	180,640	137,544
1990	307,160	412,634	179,235	171,665
1991	310,269	344,931	178,053	161273
1992	316,839	379,302	176,619	178,407
1993	318,127	409,467	176,611	175,593
1994	321,863	469,886	174,895	212,641
1995	322,631	475,525	174,777	199,973
1996	323,318	388,330	175,215	147,735

Source: Dept. of Census and Statistics, 1997

(1) Denotes total asweddumized area under major and minor schemes during both growing seasons.
(2) Denotes the area successfully cultivated during both growing seasons of the year.

Annex 3: Landmarks of participatory irrigation management policy in Sri Lanka

Box 1. Major events of participatory irrigation management

1958 The Paddy Land Act, No. 1 of 1958 established Cultivation Committees replacing the traditional Velvidane (village leader) system. These committees consisted of elected farmer representatives responsible for resolution of land disputes, co-ordination of rice cultivation activities and the distribution of water. Irrigation committees were established in irrigation schemes.

1959 The Velvidane (usually a landowner) was elected in each village tank system by cultivators and. The Village Headman arranged a meeting with cultivators to elect the Velvidane. He was mainly responsible for water distribution, maintenance and conflict resolution. The role of Velvidane existed from ancient times and was abolished in 1958. However, after 1958 up to recent times farmers unofficially accepted this position for water management.

1972 The Agricultural Productivity Act of 1972 abolished cultivation committees and established Agricultural Productivity Committees.

1979 The Agrarian Services Act of 1979 established Agrarian Services committees with the Cultivation Officer to be responsible in cultivation matters at the village level. These committees comprised of farmer representatives and government officials. Velvidanes at the local level assisted Cultivation Officers to perform water management tasks.

1979-82 The Gal Oya Left bank Rehabilitation Project was to rehabilitate the physical system but it recognised the need for farmer participation. The Cornell University and Agrarian Research and Training Institute developed a model of federation of farmer organisations at distinct hydrological areas. Institutional Organisers (IOS) were employed to help farmers to farmers to form field channel groups, distributory channel organisations and project management committees.

1979-83 Mr.N.G.R. De Silva, the Deputy Director of Irrigation in charge of the Kandy region rehabilitated the Minipe irrigation system and also set up water management committees to increase farmer participation in decision making. Farmer representatives were selected for these committees. Also a non-governmental organisation, the National Heritage Program (NHP) and local innovators were used to educate farmers about the importance of farmer participation.

1979-84 A.M.S.S. Gunadasa, Technical Assistant of the Kimbulawana Oya scheme employed farmers for rehabilitation works. Then he prepared a rotation system to save water and implemented it with farmer participation. A water issue board was set up to prepare water allocation schedules and farmer representatives were active members in this committee.

1983 The Major Irrigation Rehabilitation Project was implemented to rehabilitate seven major irrigation systems in the Dry Zone. Although its major objective was to rehabilitate these systems committees at the project, distributory and field channel levels were established to improve relations between farmers and government officers.

1984	In April the Irrigation Management Division (IMD) was established for Major Irrigation Systems (INMAS) in 25 major irrigation systems. A batch of Project Managers was trained and stationed in each system to form farmer organisations and project management committees.
1986	Irrigation System Management Projects (ISMP) were implemented to rehabilitate Parakrama Samudra, Minneriya, Giritale and Kaudulla. One of the components of this project was to create farmer organisations at the distributory level and joint management committees to increase farmer participation. Farmer organisations were given maintenance contracts in order to save money for O&M activities.
1987	Management of Irrigation Systems (MANIS) similar to the Integrated Management of Major Irrigation Systems (INMAS) in terms of objectives was implemented by the Irrigation Department to establish farmer organisations and project management committees in about 175 medium systems. Technical Assistants have been appointed as Project Managers.
1988	The government of Sri Lanka formally approved and accepted the policy for participatory irrigation management by a Cabinet Paper. The turnover of O&M Responsibilities and transfer of ownership of irrigation channels and structures to farmer organization were accepted as major objectives.
1989	A program called Mahaweli Agricultural and Rural Development Project (MARD) was commenced in system B area of the Mahaweli Project and catalysts designated as Irrigation Community Organisers (ICOS) were employed to develop farmer organisations.
1990	The Irrigation Management Policy Support Activity (IMPSA) was initiated by the Ministry of Lands and Land Development in association with the Ministry of Agriculture, and the International Irrigation Management Institute to prepare strategies and guidelines for implementation of the participatory irrigation management policy approved by the government in 1988.
1991	The Agrarian Services Act was amended to grant legal recognition to farmer organisations
1992	Under the National Irrigation Rehabilitation Project it was decided to hand over management of irrigation systems to farmer organisations after physical rehabilitation. Farmers are also involved in planning and implementing O&M activities in addition to their labour contributions.
1994	The Irrigation Ordinance was amended to grant more power and responsibilities to registered farmer organization including the management of distributor channel areas in major schemes and collection of Operation & Maintenance (O&M) fees.

Source: Economic Review, 1994

Annex 4: Summary of key points arising from open discussion of position Paper 3

Land and water resource management issues

- We need to consider the negative impacts of unregulated agro and bore well construction for agriculture, on ground water levels.
- Increased extraction is resulting in perennial tanks becoming seasonal. Crops are sometimes grown on tank beds to make use of nutrients, with subsequent negative water quality impacts.
- Resource management is becoming increasingly difficult due to shrinking access to land resources (due to division through inheritance and the traditional attachment of water rights to land ownership). In addition increased land clearance for agriculture results in the volume of water available to each plot diminishing
- Point raised on issue of inefficiency of irrigation authorities, illustrated with case study of the Lunugamwhera reservoir which is allowed to flood a nearby canal and then flow into the sea, resulting in a dramatic fall in salinity, totally changing the lagoons ecology
- Need to change focus from dam to system approach

Integrated aquaculture options & bio-technical constraints

- Questioned ability of fish to move between water bodies constructed using 'modern' techniques.
- Questioned ability of indigenous fish to breed in tanks and consequent increased dependence on exotic breeds with negative bio-diversity impacts
- Issue of using fish under an integrated pest management system
- Issue of water in paddy fields for fish use. Rains are heavy and of short duration therefore there is a need to feasibility of fish use in theses areas

Institutional issues

- Participant emphasised the importance of incorporating farm organisations and co-operatives into the decision making process to mitigate potential conflicts
- Institutional conflicts associated with attempts to integrate aquaculture into irrigation systems may arise due to the primacy of crop production.
- Participant responded to above points, by describing a government permit system in seasonal tanks that divides farmers interested in fishing into small user groups which decreases conflict between fisherman and crop farmers. Plus as others witness potential benefits, they join the system

Data validity

- The validity of old data and the accuracy of secondary data sources were questioned.

Appendix 4: Position Paper 4a: The current Status of Inland aquaculture in Sri Lanka

Presented by Mr Mahinda Agalawatte, Ministry of Agriculture and Lands.

Executive summary

Sri Lanka, with a documented history that runs over 2500 years is renown for its irrigation civilisation. Ariyapala (1956) has documented that inland fisheries were practised in the 13th century BC. Siriweera (1986) also documented historical evidence on the existence of inland capture fisheries as well as aquaculture. Robert Knox (1861) described the practice of capture fisheries in lakes and streams of the country. Knox's description includes diagrams of some fishing gear used by villagers.

The fisheries sector has always been recognised as having the capacity to provide employment opportunities as well as cheap high quality animal protein (fish 0.56mg of Lysine, an essential amino acid, compared to 0.15mg in meat - Subasinghe, 1982). The present per capita consumption of fish in the country is estimated to be around 16.9 Kg/ year, representing an estimated 70% of total annual protein consumption. The demand for fish is expected to increase with the population expansion currently growing at 1.1 per cent per annum. Sri Lanka at present captures around 90 per cent of the fish consumed in the country (form both marine and inland fisheries). However, performance of the fisheries sector still remains below its potential (Soysa, 1981). It is estimated that around 45 per cent of the fish consumed in the inland areas are fresh water fish. With the increasing price trends of seawater fish, fresh water fish is also becoming more popular in urban areas.

The inland fish capture fishery developed, steadily after 1970, with the intensification of tilapia/ carp fingerling production for stocking of inland water bodies, with bilateral support from IDRC, JICA, and the FAO. In 1989, around 10 million fish fry, including, artificially bred Chinese and Indian Carp species were stocked from Government Inland Fish Breeding Stations. The estimated yield was nearly 40,000 MT, the highest level achieved to date.

The inland fisheries development programme came to a standstill with the decision of the government to terminate state patronage for the inland fishery sub sector in June 1990. All the extension programmes ceased to operate and farmer assistance programmes supported by the Ministry were terminated. This action resulted in a decline of inland fish production development activities became to a standstill. The seed development programmes of the Fisheries Ministry were abandoned and the breeding stations handed over to the private sector (most of them turning over to more lucrative ornamental production). Around 500 employees of the Ministry had to find alternate employment. As a result the production of inland fish gradually decreased to around 12,000 MT in the year 1994 (Annex I). However, following revival of state support during the same year, production increased once more, rising to around 27,250 MT by 1997 (Central Bank, 1998).

The importance of the inland fisheries sector

The fisheries sector of Sri Lanka plays a significant role in the economy for several reasons:

- It contributes 65-70 per cent of the animal protein, which is consumed almost daily by the majority of the population. Fish from inland sources is especially important as a source of animal protein to the rural population. Nationally most fish consumed is mainly from the marine sub sector, though the inshore fishery is reaching its maximum sustainable yield.
- It is a cheap quality protein source compared to other animal substitutes.
- It provides direct full time employment to around 96,000 and part time employment to further 15000 fishermen, processors and small-scale vendors (Fernando, 1990).

- The export earnings from fish exports in 1976 were around 2 per cent of the GDP, though there is further scope for development of this sector (Economic Review, 1997)

Sri Lanka possesses some 262,500 ha of fresh water bodies, of which 162,500 ha are comprised of large, medium and small-scale irrigation systems. Another 100,000 ha of small seasonal irrigation systems remain relatively unexploited with respect to inland fisheries and aquaculture (Fernando, 1990). The number and size of all sizes of water bodies have increased in recent years with the expansion of existing tanks and construction of new reservoirs to meet the rising demand of power and irrigation water. Fish yields of these water bodies vary widely from region to region and between reservoirs within the same region due to ecological differences (Jayasekara, 1986).

Increased fish production in inland water bodies could potentially improve the daily protein consumption and reduce the high incidence of malnutrition amongst rural communities. Income from aquatic resources could also reduce the fluctuation of farm incomes based on seasonal agricultural production, particularly in the dry zone of Sri Lanka.

Tables 1 and 2 show the production and imports of fish into the country during 1986, 1990 and 1995. The reduced availability of fish after 1990 has led to increased levels of dried fish imports. Imported dried fish consequently represents a significant proportion of total fish consumption. Total fish availability in the country has increased during the period under review despite the decrease in inland production. Per capita GNP of the country has also increased during this period increasing the demand for protein rich diets, which has been met predominantly with dried fish imports. Supply of fresh marine fish to inland urban centres requires further development of distribution and marketing infrastructure. Demand for inland fish from inland towns is not sufficient to support commercially viable transport and storage systems.

Table 1. Domestic production and imports of fish during selected years (MT/Year).

Production/Imports	1986	1990	1995
Coastal	144266	134132	157550
Deep sea	3400	11666	60000
Inland	35390	31265	20000
Total	183056	177063	237550
Imported dried fish	24094	38350	48748
Imported other fish	8362	9652	22684
Imported dried fish - wet basis	96376	153400	194992
Total imported	104738	163052	217676
Total availability	287794	340115	455226

Source: Central Bank, 1997
Note: 1Kg dried fish = 4 Kg fresh fish

Table 2. Changing importance of fish products in the Sri Lankan diet (% consumption)

Year	1986	1990	1995
Imported dried fish	33	45	43
Coastal	50	39	35
Inland	01	03	13
Deep sea	12	09	04
Other imported	03	03	05

Source: Central Bank, 1997

The capture methods and gears used in inland fisheries are mostly small-scale and artisanal, relying on un-motorised craft. Hence production costs are generally below those of the marine sector. Table 3 illustrates the cost per pound of fish captured using these methods.

Table 3: Average cost of inland capture fish/pound (Rs)

Type of craft and gear	Total cost	External cost
Oru (canoe)	0.95	01
Teppam	1.10	01
Cast Nets	1.66	01
Jakotu	4.13	14

Source: Economic Review, 1997

The marine sub sector has faced major setbacks over recent decades. Stocks are becoming depleted due to over exploitation. Also, there are heavy capital requirements for deep sea fishing crafts and equipment, which are required to reduce over dependency on inshore fisheries. This situation highlights the need for investment in the inland fisheries sector to help meet the countries future protein requirements.

Inland fisheries – the potential

The inland waters scattered over the island cover an extent of around 800,000 acres including brackish water lagoons. They have an estimated fish production capacity of 60,000 to 70,000 tons per annum. The cost of developing inland fisheries is expected to be comparatively low compared to the marine fisheries sector, while benefits are benefits are likely to accrue directly to some of the most resource poor and malnourished sections of the community, (Economic Review, 1986).

The introduction of fast growing exotic species into tanks and reservoirs since the 1950's, has dramatically increased productivity (see Table 4). With an estimated capture of around 17,150 tons of inland fish, 1979 saw the first a dramatic increase in production (De Silva, 1983). The Parakrama Samudraya recorded an average capture from 2.7 tons of fish per year prior to the introduction of exotics, subsequently increasing to 500 tons per year in 1996 and 900 tons in 1996 (Economic Review, 1997).

Table 4: Growth of fish yields in two tanks in dry zone of Sri Lanka (kg/ha /annum)

Tank	1957	1962	1996	1997
Parakrama Samudraya	45	128	500	900
Minneriya	12	129	480	860

Source: Economic Review, 1997

Dry Zone

The dry zone of Sri Lanka covers approximately 66 per cent of the total land area and is home to 33 per cent of the country's population. of whom some 90 per cent are directly involved in farming. These communities also experience high levels of malnutrition (De Alwis, 1983). It is in this context that the need to develop inland fisheries in the dry zone is emphasised.

An estimated 70,000 families make a living from paddy cultivation in the dry zone. Many farmers are seasonally under employed, as few alternative livelihood strategies are available. Therefore there is a good potential for inland fisheries in the dry zone (Economic Review, 1997). The dry zone labour requirement follows the bimodal pattern of cultivation with two peak seasons in a year. Peaks occur around the land preparation and harvesting periods (see Table 5). Between these two labour intensive peak seasons, the farmers have sufficient time to participate in fisheries related activities should they so wish. The sector could provide

potential employment for all active members of the family in allied areas of production, processing and marketing.

Table 5. The dry zone cropping calendar

Period	Activity	Season
October 15th January	Land preparation & sowing	Maha
February 15th to April 15th	Harvesting	
May to June	Land preparation & sowing	Yala
August to September	Harvesting	

Source: Economic Review, 1986

It is anticipated that in the near future, as the population increases there will be acute pressure for cultivatable land in the irrigated re-settlement areas of the dry zone. Development of secondary activities such as inland fisheries may help to alleviate this pressure (see Table 6).

Table 6. Potential for inland fisheries in Sri Lanka (1997)

Type of Tank	No. of Tanks	Area (Ha)	Potential (MT)	Production (MT)	Comments/Advantages Constraints
Major Tanks	73	70,850	26,000	13,600	Tilapia has proved highly adaptable and capable of withstanding heavy fishing pressure due to its breeding habits.
Medium Tanks	160	19,000	6,000	2,600	Tilapia again highly productive, Carp stocking may be viable
Minor Tanks	3279	39,270	13,000	1,600	Tilapias and Carps suited, both may require stocking in more seasonal tanks
Villu		12,000	1,900	640	Drainage has reduced flood area and time of under inundation reducing natural breeding Many habitats lost
Hill Country		8,000	3,000	1,447	Low potential compared to dry zone tanks. Carp Spp. Suitable
Mahaweli Tanks		39,000	10,000	2,600	As major tanks.

Source: Economic Review, 1997

Inland water bodies

Summary statistics for different classes of water body, along with an assessment of their capture fishery potential, are presented in Table 6 (further detail is presented in Annex 2).

The shrimp industry

Shrimp culture in Sri Lanka has a short history dating back to the early 1980s. The Inland Fisheries Department of the Fisheries Ministry initiated shrimp culture trials with technical assistance from the FAO Bay of Bengal Program beginning in 1981. A shrimp culture

development project was subsequently launched in 1984 to develop shrimp hatchery and culture techniques.

Growth of the industry was slow during the 1980s. However, large-scale private sector development of the Shrimp industry took place after the withdrawal of government assistance from inland fisheries. Shrimp culture became a lucrative industry and hence drew investment from multi nationals, large national corporations and a range of local private sector speculators. In 1996 there were a total of 970 farms concentrated mainly in the North Western and Western coastal belts, in addition to 589 smaller unauthorised farms (Siriwardena, 1997).

The government assisted the finance of these ventures through development bank loans and provided export incentives through the Export Development Board (EDB). This was in stark contrast to the concurrent government policy of non-support for inland fisheries. The Shrimp industry has contributed to the economy by providing both direct and indirect employment opportunities. The industry has also made an important contribution to the regional development by improving infrastructure facilities (Siriwardena, 1997). However, there are major questions over the sustainability of the industry based on it's existing environmental record (see Annex III).

There have been two major disease outbreaks, Monodon Baculo Virus (MBV) outbreak in 1988, which was marginal and was easily controlled. The outbreak of White Spot Viral infection in 1996 brought a major threat to the industry. Nearly, 90 per cent of the shrimp farms became un-operational. Relief programmes were launched to assist the affected farms. The National Aquatic Resources Research and Development Agency (NARA) provided technical assistance while the Central Bank introduced a credit scheme to facilitate fast recovery of affected farms. A third (yellow head) viral disease outbreak in January 1999, has been responsible for the layoff of around 40,000 farm workers 1999, who are now experiencing severe hardship.

Cage culture and ornamental fish farming

The Fisheries Department is trying to promote the small-scale adoption of food fish and ornamental fish production at a subsistence and commercial level. The government is able to provide training and technical knowledge and also arranges bank loans for construction of farm ponds and cages. Though since the government 'ban', resources and capacity for these purposes is extremely limited. Development of Export capacity for ornamental fish has the focus of several Board of Investment (BOI) projects.

Integration of rice/livestock/fish

The integration of crop, livestock and fish production can offer greater efficiency in resource use, diversifying livelihood strategies thus providing additional income to the farmer. The Department of Animal Science of the Faculty of Agriculture have developed the following fish-based semi intensive integrated systems:

- Duck – Fish Integration: In this system the Ducks have access to fishpond in which a polyculture of several fish species is usually practiced. Duck litter fertiliser increases productivity and can reduce dependence of inorganic inputs.

Variations on Integrated methods such as this have been widely developed and extended by government agencies throughout Asia and represent proven options with good returns for farmers with sufficient resources to initiate them. However their intensive high input nature and consequently the higher risks associated with failure means that the majority of resource poor farmers are unlikely to be able to adopt them.

- Rice – Fish Integration: 2.5 to 5 cm of water is retained in the paddy fields for nearly 3 to 3.5 months during the early stages of paddy, enabling the nursing of fry up to the fingerling stage.

Advantages of Rice -Fish Integration

- Additional income from fish production (up to Rs. 2500/ac estimated in Sri Lanka)
- Increase of rice yields and costs of production due to pest and disease control
- Environment protection through control of disease vectors such as malaria larvae
- Provision of cheap, high quality protein to rural areas.
- Employment and income opportunities in seed production and tank stocking programs.

Potential for Rice/Fish Integration

The profitability of paddy production has steadily decreased in many areas due to the influx of cheap imports and environmental problems. In some of the wet zone districts such as Gampaha and Kandy yields have been steadily decreasing due to environmental degradation. The wet zone is particularly suited for rice-fish integration as the water supply is generally assured. However, excess water and flash floods can result in fish losses, requiring some modifications (i.e. bund heightening) of existing paddy structures.

Short season paddy varieties (3.5 to 4 months) are amongst the most popular strains grown in Sri Lanka. Under normal conditions, fish production will be limited to very specific areas and varieties where the required water can be retained in the field for the entire three-month period.

The water requirement for a three-month paddy crop in the dry zone has been estimated to be 250 mm in clay soils and 1500 mm in sandy soils (DOA, 1980). To nurse fry up to fingerling stage, it is necessary to hold water to a minimum height of 2.5 to 5 cm for at least three months. Refuges should also be excavated to allow fish to escape low water episodes and temperature fluctuations. In the Dry zone with it's well drained soils and seasonal water deficits, little potential exists, particularly under seasonal or 'non-system tanks'. Most Irrigation department and Mahaweli scheme releases currently take place on a 7 to 10 day cycle with all free-standing water being lost in the interim. Poor co-ordination between the different line agencies involved in fisheries, irrigation management and farmer extension under irrigation systems represents an additional constraint.

The Rice Research Institute (RRI)of the Department of Agriculture (DOA) has initiated on-farm trials in collaboration with the Department of Inland Fisheries (during Yala 1996 and Maha 1997). In the high potential paddy areas of the Dry Zone, use of agro-chemicals and high fertilisation rates can be harmful to fish, requiring modification of current agricultural practices, and co-operation between farmers to prevent drainage returns poisoning fish. Extension programmes to disseminate the appropriate technology and raise awareness will be part of any successful adoption (Amitiyagoda, 1996).

Some other recommendations for Rice/Fish integration:

- Culture sites should be close to the farmhouse for security reasons (this may also allow supplementary feeding of fish with household waste).
- Prevention of fish migrations may require permanent structures or excavation of fish refuges for low water episodes..
- Integrated pest management systems are necessary to avoid the use of toxic substances in paddy that may be harmful to fish. Further research is required in this respect.

Development of the inland fisheries sector

Institutional development

The history of fisheries institutional development begins in the 1940's. Since then several generations of research, training and support service institutions have been established, mostly with foreign assistance (see Tables 7 & 8).

Table 7. Milestones in inland fisheries development

Year	Institution	Objectives
1941	Department of Fisheries	Increase production, make fish available at reasonable prices, increase welfare of fishermen by organising co-operatives
1950	Department restructured under three divisions	• Administration & Socio -Economics • Development & Production • Research
1970	Ministry of Fisheries	Development plans, improve extension and research, disseminate new technology, introduce subsidy/credit programmes,
1972	Ceylon Fisheries Corporation (CFC)	Regulate marketing (attempt to set floor and ceiling prices through construction of cold storage facilities).
1974	Inland Fisheries Department (IFD)	Seed production & supply, subsidy programmes, research & extension
1976	Breeding Station at Udawalawe	Chinese assistance for artificial breeding of Carp Spp., supply seeds to farmers, training programmes
1975	Sri Lanka Fisheries Training Institute	Training of officers and farmers, theoretical & practical knowledge, demonstrations
1978	Institute of Fisheries Technology	Production and processing technology improvements, FAO assistance program
1981	NARA[1]	Upgrade research work, breed improvements and production technology, disease control
1989	Unique ban on inland fisheries activities	Withdraw government support, extension, research and propaganda work
1995	Revival of government activities	Five year plan, Fisheries and Aquatic Resource Act.2 of 1996

Source: MOFARD (1995)
[1]National Aquatic-Resource Research Agency

Table 8: Foreign assistance

Year	Funding Agent	Area of Support
1974	FAO / UNDP	Training programmes for aquaculture personnel
1976	Republic of China	Experimental Fish Breeding Station
1976	FAO / SIDA	Processing techniques to minimise fish spoilage
	FAO / UNDP	Small-scale fishery development
	FAO / SIDA	Development of traditional fishing communities

Source: Soysa (1981), MOFARD (1995)

The need for separate inland fisheries division within the department of fisheries was recognised early on. The Inland Fisheries Division (IFD) functioned until the government withdrew support for all inland fisheries activities in June 1990 with the loss of about 500 jobs. Consequently fish production from inland sources declined as development and regulation activities came to a standstill. Chinese and Indian Carp species do not naturally breed under Sri Lankan conditions (De Silva, 1991), therefore fingerling stocking programs in

smaller reservoirs with fingerlings ceased as only the Government undertook this activity prior to the ban in 1990. Inland fish production in the country recorded a continuous decline from 40,000 MT in 1990 to 12,000 MT in 1994. The total loss to the economy as a consequence of the ban is estimated by the World Bank in 1994 as Rs.1240 million (Jayasekera, 1987). However the validity of such assertions is brought into serious doubt due to the absence of any formal means of assessing catch returns during this period. In addition the contribution and cost benefits of carp stocking programs have been brought into question in the context of an existing highly productive self-sustaining tilapia fishery. Currently a new aquaculture division is n the process of being established within the fisheries department as a separate authority which will benefit from greater autonomy in decision making and resource allocation (see Annex IV).

The major cause of the 'ban' was officially attributed to the influence of Buddhism. The Chief Prelates of the three Buddhist chapters presented a joint memorandum to the President stating that inland fisheries were against the teaching of Buddha (see Annex V). However the threat of encroachment of traditional rural Buddhist hinterlands by Christian coastal fishermen (with the promotion of various NGOs) is alleged to be a more realistic reason. A strong vested interest also existed amongst the canned fish importers and this sector is known to have supported the ban.(Pers. Com Jayasekara, 1998).

Since the 1940s co–operative societies have assisted fishermen in the production and marketing of fish. In 1947 there were 49 co-operative societies supervised by the Department of Co-operatives. In 1950 an Assistant Registrar of fisheries co-operatives was appointed and a Co-operative Union was established in 1954 to undertake fish sales. In addition to marketing of fish, it imported fishing gear and equipment to service the fisheries sector at competitive prices.

The membership of Fisheries Co-operative Societies (FCSs) consists of fishermen and fish traders who depend on a common fishery resource. All fisheries co-operatives are registered under the Co-operatives Ordinance. The co-operative societies are administered and supervised by officials of the Department of Co-operative Development. The co-operative societies are linked to district and national level federations and also the Central Council of Co-operatives of Sri Lanka, the apex organisation of the co-operative movement in the country.

Fisheries development plans

There have been several strategic fisheries development plans in the country (Annex VI), the major objectives of which are shown in table 9.

Table 9: Fisheries development plans

Objectives	1972 –1976	1979 -1983	1990 - 1994	1995 - 2000
Increase production	X	X	X	X
Improve nutritional status		X	X	X
Generate employment		X	X	X
Uplift socio-economic standards		X	X	X
Foreign exchange earnings			X	X
Conserve and manage environment and resources			X	X

Source: MOFARD (1995) - after Fernando (1997)

Legislation

The Fisheries and Aquatic Resources Act No. 2 of 1996 represents the latest attempt to regulate the inland capture fishery and ensure sustainability of the resource. It requires all inland fishermen to register with the Inland Fisheries Department. There are rules on net types and mesh size. The co-operative societies and farmer organisations are expected to play a major role in the regulation process, particularly with respect to enforcement of access rights, and the implementation of community based stocking programs.

Present Status of Inland Fisheries in Sri Lanka

The introduction of exotic fish into reservoirs since the 1950's has resulted in dramatically increased fish yields. This in turn has met the demand of the increasing population, especially in the settlement areas of the dry zone. Poor communications infrastructure and the lack of cold chain facilities required for the supply of sea fish, combined with the local availability an low price of inland fish, has made inland fish more popular among the low income groups of the dry zone (Indrasena, 1965). Increased availability of fish in inland tanks has also encouraged seasonal migration followed by permanent settlement of coastal fishermen around inland tanks. Many of these settlements are illegally encroached and the conditions of their inhabitants generally very poor.

Extension activities

The Inland Fisheries Department (IFD) was established in 1979 to development the countries inland fisheries resources. Activities included the technology extension, formation of Fisheries Co-operative Societies (FCSs) and provision of financial services and subsidy programmes. Fisheries Inspectors provided technical support at village level and arranged training programs for the co-operative members or farmer groups. Five-day training programs for 20-member groups continue to be held at Udawalawe Fisheries Station. In the late 1980's financial assistance was provided for the purchase of fibreglass fishing boats and fishing gear. Production and supply of fingerlings for stocking in reservoirs is vital for proper functioning of the extension and support systems. Thirteen Inland Fish Breeding Centres were operating in the country under the Ministry in 1989 and produced ten million fingerlings during the year (Annex VII). The IFD has taken over the management of three of these Fish Breeding Stations (Udawalawe, Inginiyagala and Dambulla) all of which were sold or leased to the private sector during the 'ban'. Two are currently operational.

Capacity building of community organisations, seed production and distribution, fisheries regulation, and promotion of marketing continue to be core activities of the division. FCSs and Framer Organisations are encouraged to maintain their own hatcheries. In an attempt to stimulate seed marketing networks, the Ministry operates a fingerling buy-back scheme, whereby fry are provide free of charge to the FCSs and fingerlings bought back at Rs.1.00 per fingerling. Two such mini hatcheries function at Bandagiriya, South Panduwasnuwara in the North Western Province and the bilateral GTZ (funded) project in Tangalle in Hambantota District are due to commence soon (Pers. Com. Rohitha, 1998). However the scope of such initiatives currently remains extremely limited and accessible to very FCSs.

Additional steps have been taken in an attempt to revitalise the sector including rehabilitation of the fish breeding centres returned to government ownership. Strengthening of regulatory activities, creation of a separate cadre for extension work and launching a community based seed production programme are other activities. Recruitment and training of new staff is taking place in an attempt to re-establish the technical advisory service system. Foreign assistance is also expected to strengthen the extension system. Finally, the Division undertakes preparation of commercial project reports to assist societies and farmer groups requiring bank assistance. The Division will enjoy greater autonomy when it is reformed as

the National Aquaculture Development Authority (NAQDA) under the MOFARD, sometime during 1999.

Foreign Funds for the development work of the Ministry has been made available from FAO (Annex VIII). The Australian Centre for International Agricultural Research (ACIAR) currently has a collaborative fisheries research project underway in Sri Lanka (modelling sustainable yields), while the Asian Development Bank (ADB) also provides funds for development of fisheries industry in the two districts of Chilaw and Hambantota.

Welfare programs

The Department of Fisheries provides infra-structural facilities such as roads and markets for fishing communities. In addition there is a separate division in the MOFARD to implement welfare programs for fishermen. A socio–economic survey of fishermen undertaken by this division, has revealed the temporary and inadequate nature of most fishermen's homes, and the lack of educational and health facilities in fishing villages. Several development plans implemented in past, focussed on improving this situation (in particular the 1979-83 plan) with little success.

Present, MOFARD initiatives designed to increase the living conditions of inland fishermen, include a housing program ("Dheewara Gammana") with a budget of Rs. 70 million. Plans have been formulated to build 10 such villages around major tanks in the country. The first such fresh water fishing village was recently completed at Lunugamvehera reservoir in Hambantota District. However there is some question as to whether housing here has in fact been allocated to the intended beneficiaries (Desanayake, Sewa Lanka, Pers Comm 1999).

The government provides social security benefits to fishermen in the form of a Fishermen's Pension Scheme. The program is similar to the Farmers' Pension Scheme, which is a contributory scheme with widow and orphan benefits.

Research and training

NARA is the apex body for fisheries and aquaculture research. The Universities and line departments collaborate in research activities in various aspects of inland fisheries and aquaculture. The Department of Fisheries Biology in the University of Ruhuna, the Department of Animal Science and the Agribusiness Centre of the Faculty of Agriculture at Peradeniya University and the Sociology Department of Kelaniya University. Tthe Department of Agriculture (DOA) also has several on going inland fisheries research programs.

Educational programmes

Since the early 1980s inland Fisheries has become an optional subject in the General Certificate of Education (Ordinary Level) Examination and a compulsory subject for students following Zoology as part of the General Certificate of Education (Advanced Level. Aquaculture has also become a popular subject among undergraduate students following courses in biological sciences and agriculture. The University of Kelaniya offers a Masters Degree in Aquaculture. NARA conducts several training programs on various aspects of fisheries management including ornamental fish culture. The EDB in collaboration with FAO/INFOFISH conducts training programs on quality management and export procedures of fish products. However, this is mainly associated with marine and shrimp based fish products.

Seed production

Fingerling requirements for fresh production are estimated to rise to around 60 million by year 2000 (Jayasekera, 1987). The MOFARD has commenced breeding work at the two

fisheries stations in Dambulla and Uda Walawe. The fisheries stations at Muruthawela, Panapitiya, Ginigathhena, Pitipana, Rambodagalla, Polonnaruwa, have been long leased to the private sector and will not contribute to production in the near future. To help meet the deficit, co-operatives and farmer organisations are being encouraged to participate in community based fingerling production (facilitated by a variety of NGOs). The Ministry is responsible for the National Seed Production and Supply Programme with Seed produced in the government breeding stations. Currently, these stations are the only producers of Chinese and Indian Carp seed. With limited seed availability, primary stocking activities are focussing on seasonal tanks and smaller reservoirs[1].

Development strategies

Strategies for developing aquaculture in Sri Lanka currently focus on the following areas:

- promoting community participation in fish seed production diversification of fish species and diversification farming systems through integration of fish/livestock/crops,
- strengthening of extension systems,
- improved management and regulation of capture fisheries (effective law enforcement).

Constraints for development of the inland fisheries sector

Insufficient seeds and fingerling production capacity has been identified as a major constraint to the development of the inland fisheries sector. This is due to the lack of physical capacity especially pond space for fingerling nursing and also the lack of trained personnel at the fish breeding stations. The Ministry has now taken steps to expand pond area and is also trying to develop more decentralised systems for the rearing of fingerlings.

As indicated earlier, the Government provides a 'buy-back' subsidy to co-operatives and farmer organisations, where seeds are supplied free and the fingerlings are later bought back to be stocked elsewhere by the government. However unless a market can be established for these fingerlings, such production will be difficult to sustain once these subsidies are withdrawn.. This contributed to the drop in inland fish production following the ban in 1990 (Per. Com, Jayasekara, 1998). Obviously for such a market to develop the *de facto* 'free access' nature of most reservoirs will have to change to regulated fisheries, if benefits of stocking are to accrue to the communities and groups involved in fingerling production.

Current links between the farmer and the researcher is very weak. Rarely are the farmers consulted regarding their own problems when identifying research priorities and also, the research findings do not reach the farmers. Extension services and awareness programmes are insufficient. Fishing is still undertaken mostly be low-income groups because of the low levels of social status of the activity in society. This means the industry operates largely on a low input subsistence basis. The high input and costly technological options being researched and extended to them are often unsuitable (Per. Com, Jayasekara, 1998).

Apart from the low levels of income of the fishermen, the inadequacy of infrastructure facilities and basic amenities has also constrained development.

With the introduction of the high yielding tilapia fishier in the dry zone tanks and increasing pressure on agricultural land, more people have engaged themselves in fishing activities. This has resulted in over fishing leading to the depletion of fish resources (depletion of indigenous species and reduction in average sizes of all species landed). Consequently the income earned

[1] Seasonal tanks: These are typically 0.5 to 40 ha reservoirs with 6-10 month availability of water thus requiring regular stocking. Seed should be stocked during from Nov – Feb with final harvests usually taking place between Aug to the end of Nov.
Ponds: Are essentially perennial water sources allowing year round production subject to seed availability constraints. Post Larvae are often nursed in 8 months cycles Nov/Dec, July/Aug and March/April
Perennial Reservoirs: may be stocked at any time of the year. Hence post larvae surplus to other requirements may be issued to them. Accordingly, Jan/ Feb and May/June are as optimum stocking times for these reservoirs.

per fishing family has decreased with the increase in the number of operational units. Increased competition has resulted in the adoption of unsustainable fishing techniques with the use of progressively smaller mesh sizes. One potential solution to this problem could be the introduction of co-operative farms and cage fish culture. This method makes it possible to raise fish through individual effort in public waters. The ease of harvesting being particular incentive. Nile Tilapia has been raised in cages at a demonstration level. However the high demand and low market price for tilapia, may mean that such technology may only make economic sense when it used for the fattening of wild caught fish for subsequent supply in periods of seasonal deficit.

The Mahaweli Diversion Scheme has reduced the water flow in the river by about 50 per cent. As a result, the flood plain, which is the breeding grounds of many marsh dwelling indigenous fish species has reduced by nearly 50 per cent. The duration of inundation of the floodwaters of the 16,200 ha, of villus has also substantially decreased.

The first major epizootic in the short history of the shrimp farming industry was recorded in 1988 – 1990. The main pathogen responsible was MBV (a virus). The production losses in farms ranged from 35 per cent to 72 per cent. White spot disease first appeared in mid 1996 and 90 per cent of the farm became non-functional as a result. The second outbreak was recorded in December 1996 losses in foreign exchange earning during the entire year (1996) has been estimated at Rs. 100 million. These diseases have arisen largely because of poor attention to environmental management (i.e. safe farm waste disposal) during the rush to cash in on the shrimp boom. The risk bearing capacity of the industry is limited and several larger multi-nationals have already pulled out (Jayasekara, 1986).

The marketing system for marine fish is dominated by monopsonic and oligopsonic middlemen (single or very few middlemen) affecting the producer's price and the consumer's price of fish. The middleman provides loans to fisherman and in turn collect the entire catch, taking advantage of the perishable nature of the commodity. (fish has to be disposed of quickly to be in acceptable condition to the consumer). This is less of a constraint for fresh inland fish the bulk of which is sold locally keeping overheads and retail prices low.

Export of ornamental fish has developed under several BOI projects. However, difficulties meeting the demand of exporters (i.e. the required sizes, varieties, numbers and delivery times) have constrained the participation of smaller producers in contract production.

The high cost of pond constructions, difficulties in obtaining loans has been the major obstacle in promoting fish production in ponds. Again in view of the low prices of fish from the capture fishery, the economic sense of such initiatives should be questioned. The integration of fish into ponds built primarily for other functions (i.e. emergency irrigation ponds may prove more profitable.

Development programs

In accordance with the government's policy to increase inland fisheries production, the MOFARD has incorporated an Aquaculture Development Programme in the current Five-Year Fisheries Development Programme (1995 – 2000). This includes the establishment of more breeding stations and stocking centres, provision of subsidies for pond construction and loans for the purchase of fishing canoes.

Several new steps have been taken to revitalise the sector and rehabilitate the fish breeding centres. Strengthening of regulatory activities (Fisheries and Aquatic Resources Act, 1996), creation of a separate cadre for extension work and launching a decentralised community based seed production programme through the co-operatives and Samurdhi programmes are

some of them. Action being taken to recruit new staff, trains them and re-establishes the technical advisory service system and extension system (see earlier notes).

Government statistics show fish production during 1997 achieving a significant increase of 22 per cent to register 27,250 metric tons on the previous year (Central Bank, 1998) and this was in large part attributed to improvements in the inland fisheries sector. Some of the reasons cited for this improved performance are as follows: an increase in numbers of fingerlings released to tanks, adequate water in tanks due to favourable distribution of rainfall, better management under fisheries co-operatives and better co-ordination with awareness programs. However the severe lack of trained personnel and mechanisms for reliable monitoring of the inland catch (much of which is distributed through diffuse local networks) means that the reliability of such statistics has to be brought into serious question.

The majority of prawn farmers are small-scale operators with pond areas less than 1 hectare in extent. Most farm operators were not able to repay their loans or carry out remedial maintenance and improvements to discharge systems. Government financial assistance has been channelled through the Development Finance Corporation of the Central Bank for modification of the affected farms. This has enabled the construction of sedimentation reservoirs and recycling systems to arrest the spread of white spot disease. In addition, the FAO Technical Co-operation Programme has improved the diagnostic capability of relevant institutions including provision of training for research officers and scientists. Training is also provided to Prawn farmers on disease prevention and control.

The private sector dominates the fisheries marketing sector. However, through its limited cold chain and sales outlets, the Ceylon Fisheries Corporation (CFC) attempts to set floor and ceiling prices, fair to both consumers and producers and the provision of hygenic retail conditions. In 1997, the total fish supply of the CFC was 2,144 metric tons, representing an increase of 3 per cent on the previous year.

Subsidies to the aquaculture sector increased by 33 per cent to Rs.4 million. The inland fisheries sector currently meets much of the demand for fish from the interior villages of the country and must be sustained in this capacity. The ‘post ban’ reorganisation of fishereis cooperative societies commenced in 1996. By 1997 there were an estimated 746 societies in existence (Central Bank, 1998), though the capacity of these organisations remains unclear.

The fisheries sector and devolution of power

Under a fully devolved system of government, responsibility for fisheries regulation and policy will comes under the provincial councils. Although this will not present undue complications for marine fisheries, most of inland water bodies receive water from inter-provincial water resources. Thus water allocation will become a complex issue affecting management of inland fisheries with the potential to create inter-provincial conflicts. It is proposed to set up a central agency, the Water Resources Authority to allocate water to the tanks in the different regions to address this problem.

Although the central government imposes rules and regulations, for the inland fisheries sector, co-ordinates breeding, research and training activities no co-ordination currently exists between the central government and the provincial councils on these matters.

By contrast as extension and co-operative activities are devolved subjects; the provincial councils collaborate with the Fisheries Ministry of the central government in training and extension activities. Presently there are 117 active Inland Fisheries Co-operatives (Per.Com. Mr.Bandara and Mr. Herath , 1998) functioning under the Regional Co-operative Commissioners. The Co-operative Division of the Ministry is responsible for the wider co-

ordination of the co-operative activities. In addition, community based field training and seed production programmes are organised by the Government Samurdhi programme.

Aquaculture Extension Officers/Fisheries Inspectors carry out district-level extension activities in collaboration with the Co-operative Inspectors who are the field level officers of the Department of Co-operative Development. Deputy Commissioners of the same department are responsible for activities at the district level. The Provincial Commissioner of Co-operative Development is the provincial authority for all co-operative functions. The government has established a special unit to facilitate liaison with the Department of Co-operative Development in order to promote growth and proper functioning of FCSs.
However despite the intricate institutional framework little capacity currently exists on the ground due to lack of sufficiently trained personnel and lack of other requisite assets such as transport facilities.

The first subsidy scheme for Inland Fisheries was started in 1980 under which a subsidy of 35 per cent of the total cost of non-mechanised craft and gear used for fishing in the dry zone was granted (De Alwis, 1983). The subsidy was increased to 90 per cent of the total cost of craft and gear in 1981. It is likely that the widespread uptake of these subsidies and intensified exploitation of the Tilapia fishery was in large part responsible for dramatic increases in inland fisheries production recorded in the 1980's. In addition to this subsidy scheme the Ministry of Fisheries provided a 50 per cent subsidy for the establishment of pond fish farming units. This scheme granted Rs. 2,000 to Rs. 10,000 for a pond covering an area of 10 perches to one acre (De Alwis, 1983). Little sustainable adoption has resulted.

In addition to these subsidies, loan facilities were made available through the network of state banks. The People's Bank and Bank of Ceylon provided a maximum amount of Rs. 4,000 per fish unit for the purchase of craft and allied gear (De Alwis, 1983). These lone facilities were granted on easy terms. The government has also granted a tax waiver on feed imports and removed the turnover tax. The relief measures available from lending banks include a 15 months concession. However inability of fishermen to distinguish between a loan and a grant has led to the subsequent withdrawal of many of these schemes and much of the 1980's 'fleet' of canoes has now fallen into a poor state of repair.

Marketing and Distribution

In urban areas poor demand for inland fish exists compared to marine fish. Reason for this include the limited species availability of inland fish, consumer taste preferences and the ability of urban consumers to pay higher prices for marine varieties. However, Sri Lankan cooking utilises a large amount of spices to upgrade the taste and smell of fish. Therefore, introduction of suitable cooking methods and valued added fish preparations may serve to increase the market for inland species.

Marketing of fresh water fish is mainly around the tanks through bicycle vendors and a few large-scale traders. Generally the fingerlings introduced into the tanks during the September – December period is harvested during June –September period of the following year resulting in a glut during this season. Staggered harvesting methods are required to prolong the harvesting season, whereby selective gear is used to catch large fish at the beginning of the harvesting season allowing smaller fish to grow for harvesting later in the season. Marketing of fresh water fish is mainly confined to areas close to the production areas (Perera, 1996) However, there are some innovative businessmen emerging from the inland fish marketing sector. " Rajarata Wew Malu " a frozen ready to cook freshwater fish product is available in the market in Colombo. Another fresh water fish product called 'Minneriya Fillets' are also available in the urban markets. These value added products intended as marine fish substitutes are in fact processed Tilapia.

Conclusions

A dramatic increase in production and participation in the inland fisheries sector was recorded during the 1980-90 period. Several factors contributed towards this production increase. Firstly institutional strengthening and structural development took place, with the establishment of special divisions in the Ministry for inland fisheries for education/training and welfare. As a result a separate cadre of aquaculturists and extension workers was established and several extension and welfare programmes have been implemented. Secondly the provision subsidies and easy credit for fishing gear and craft, resulted in the entry of a large number of new participants to the sector. The scale of investments planned in the 1979-83 Master Plan was well supported by substantial foreign assistance received. However, government policy relating to co-operatives has not resulted in the development of self-reliant community organisations. This was clearly seen with the impact of the withdrawal of government support from the inland fisheries sector. The inland fish production dropped from 40,000 MT in 1989 to 12,000 MT by 1994 largely due to deregulation of the capture fishery.

Sri Lanka continues to import large quantities of dried and canned fish in order to maintain it's per capita fish consumption of around 15 kg/year. It is estimated that only 40 – 50 per cent of the potential of inland water bodies have been achieved to date, with the major tanks accounting for nearly 75 per cent of production. Seed production and supply, water rights and regulated harvesting, credit and subsidy disbursements have been identified as the major limiting factors of the development of the sector, which may be best addressed through community participation. Most of the functional credit schemes have now dried up due to poor loan repayments. Another area where community organisations may help in the development process would be in dissemination of suitable technology. The shrimp and ornamental fish industries have the potential of earning more foreign exchange but the industries require clear policy directions. Already, some environmental issues have been raised concerning the shrimp industry, whilst it has been reported that we have been unable to meet the ornamental fish demand due to organisational problems.

In summary, this review demonstrates that there is good potential for further development of inland fisheries in the dry zone. However, issues such as the cost of water and national priorities for water use have to be considered before launching new programmes integration programmes such as fish/paddy programmes. Such integration typically involves several line departments/ministries and there is a requirement for greater co-ordination of research and extension effort to meet the needs of producers and consumers effectively.

References

Amitiyagoda, G.A.M.S. (1996), *Integration of Inland Fisheries and Paddy* , A speech delivered at Inservice Training Centre, Gannoruwa on 17th Oct. 1996

Ariyapala, M.B. (1956), *Society in Medieval Ceylon*. Department of Cultural Affairs: Colombo.

Central Bank of Sri Lanka. *Economic and Social Statistics of Sri Lanka* (Various Issues).

Central Bank of Sri Lanka (1998), Economic Progress of Independent Sri Lanka. Annual Report. (Various Years)

Daily News, February 9, 1990. *Mahanayakes call for ban on inland fishing.*

Dawasa, March 3, 1990.

De Alwis, L. (1983), *Possibilities in Inland Fisheries for Developing the Peasant Economy of the Dry Zone* :Part II. Economic Review. Feb/Mar. 1983: People's Bank, Colombo:

De Silva, K. H. M. (1991*), The Predicament of the Freshwater Fisheries in Sri Lanka.* Naga. ICLARM Quarterly Jan. 1991 Pp.6 – 7.

De Silva, S. S (1983),*The Reservoir Fishery: Present Status and Future Strategies*, Journal of Inland Fisheries, Ministry of Fisheries: Colombo: Vol.2 Dec. 1983. Pp. 3-13

DOA (1980), Proceedings of Rice Symposium :1980

Economic Review (1986), *Inland fisheries*. April: People's Bank: Colombo: Pp. 3-17

----------(1997), *A special issue on aquatic resources Development.* Vol.23 No.6 September :People's Bank:: Colombo:

Fernando, C. (1990), *New Directions in Sri Lankan Fisheries*, Bay of Bengal News, December:1990: Pp16-19.

Fernando,C .(1997), *Fisheries Development, Fifty Years of Sri Lanka's Independence: A Socio economics Review*: Ed. A.D.V de S Indraratne: Sri Lanka Institute of Social and Economic Studies: Colombo ; pp. 124-146

Fisheries and Aquatic Resources Act No. 2 of 1996. Government of Sri Lanka. Colombo.

Indrasena, H. H. .A. (1965), *Fisheries in Two Lakes, Parakrama Samudraya and Minneriya*. Bulletin of the Ceylon Fisheries Research Station.

Jayasekara, A .M (1986), *Potential Role of Inland Fisheries in Biological Control of Malaria.* Journal of Inland Fisheries, Ministry of Fisheries: Colombo: Vol. 3 Dec.1986

Jayasekera, A.M. (1987) *Freshwater fish production in three major reservoirs in the dry zone of Sri Lanka.* Aquaculturist, Vol 1, 1987.

Peoples Bank (1997), *Inland fisheries and aquaculture development*, Economic Review 23 (6): Peoples Bank, Colombo Pp.26 – 28.

Knox, Robert (1861). *Historical Relation of the Island of Ceylon*: London (First Facsimile reprint by K V G de Silva and Sons, Colombo).

Mahalingasivam, (1995), *Proceedings of the National Seminar Towards a New Era in Fisheries Development* held on 25th July at BMICH, Colombo

MOFARD, (1995), !995-2000 Master Plan: Colombo:

NARA (1987), *Socio Economics Survey-1987*:Colombo:

Perera, C.(1996) ,*Fish Marketing in Kandalama Reservoir*, Proc.of SLAAS Vol. 53 Part 1

Personal Communication with Dr. A.M. Jayasekara, Director, Aquaculture Development Division of the MOFARD on 20th and 24 th July 1998.

Personal communication with Mr. Shantha Bandara (AD)& Mr. H.M.G. Herath (AC) of the Co-operative Division of the MOFARD , June 1998.

Personal Communication had with Mr.W.R Rohitha, Ministry of Fisheries of the North Western Province, June 1998.

Siriwardena, P.P.G.S.N. (1997), *Shrimp Culture in Sri Lanka, The Benefits, Problems and Constraints Associated with the Development and Management and Responses to Address Problems*, FAO Technical Consultation on Policies for Sustainable Shrimp Culture, Bangkok:Thailand:

Siriweera, W. I. (1986), *The Inland Fisheries in Sri Lanka: A Historical Perspective.* Occasional Publication # 33, Agrarian Research & Training Institute: Colombo:

Soysa, C.H.(1981), *Economics of Fisheries in Sri Lanka*, Doc:/M/99-Res/71/IDRC- Jan. 1981, Marga Institute, Colombo:

Subasinghe, S. (1982), *Fresh Water Fish Production in Sri Lanka and Its Role in the Nutrition of the Population Living in the Inland Areas*, Journal of Inland Fisheries, Ministry of Fisheries: Colombo: Vol. 1. Dec.1982. Pp. 86-96

Thayaparan , K (1982), *The Role of Seasonal Tanks in the Development of Fresh Water Fisheries in Sri Lanka*. Journal of Inland Fisheries, Ministry of Fisheries: Colombo: Vol. 1. Dec. 1982

Annex I: Mean annual Inland Fish Production 1960-96

Total	MT x 10^3
1960	3.3
1965	7.4
1970	8.2
1975	13.1
1980	19.9
1981	29.0
1983	36.1
1984	31.8
1986	35.3
1987	36.4
1989	39.7
1990	38.1
1991	23.8
1993	18.0
1994	12.0
** 1996	22.2

Source: De Silva (1983)

* Source: Calculated from Soysa (1981)

** Source: Central Bank (1998)

Annex II: Potential water resources

1. Major Tanks

Over 90 per cent of annual inland fish production is reported to originate from 73 major tanks (extent 70,000 ha). Tilapia species have proved to be the most suitable species for stocking in the major tanks. A tilapia breeding station is located in Polonnaruwa, whilst artificial breeding of Indian and Chinese Carps is undertaken at Dambulla and Uda Walawe Breeding Stations respectively (each station also holds reserve quantities of all broodstocks). Twelve sub-stations undertake fingerling production with fry from the breeding stations. The Ministry in collaboration with line departments and other agencies including co-operatives, the Samurdhi programme and NGO's promote participatory seed production programmes. This strategy is aimed to increase community participation in the development programmes, lack of which has been identified as a major constraint to sustainability in the past (Jayasekara, 1997).

2 Medium and Minor Tanks

There are 163 medium and 3,279 minor tanks with a potential of 20,000 Mt/year. The uncertainty of water availability is the main constraint encountered with these tanks. Since the water capacity varies with rainfall, sustainable seed production and stocking programmes can not be projected. Tilapia and carp species have been introduced into some of these tanks. However, progress to date has been poor (Jayasekara 1986). It is envisaged promotion of greater community participation is required to redress this problem.

There are 7 hill country tanks with a total extent of 8000 ha. Mahaweli tanks have a total water spread of 22,670 ha and 26570 ha in upcountry and dry zone tanks respectively. However, the potential in the upcountry tanks is low compared to the dry zone tanks (many of the upcountry tanks which include hydroelectric functions are deep and relatively unproductive). The following table illustrates the current and estimated potential production levels in various Mahaweli tanks.

Potential & Production of Mahaweli Tanks (MOFARD 1997)

Tank	Acreage	Potential per Ha	Production('000 MT)
Victoria	2270	750/ha	1.70 MT
Maduru Oya	6780	150/ha	1.01 MT
Randenigala	2750	50/ha	0.14 MT
Ulhitiyawa	2270	200/ha	0.46 MT
Moragahakanda	4050	150/ha	0.60 MT
Kotmale	1500	50/ha	0.01 MT

3 Seasonal Tanks

There is around 100,000 ha total water spread of seasonal tanks which hold water for an average of 6 to 8 months. Cattle grazing around these tanks make the tanks extremely fertile and rich in nutrients for fish. Major constraints include high predation pressure and erratic water availability. Great potential is envisaged for use of seasonal tanks to expand fingerling production, capacity for which is lacking within the state breeding stations. Since 1979 more attention has focussed production programmes in the seasonal tanks. Early trials showed mixed results but potentially high yields (averaging over twice the perennial fisheries mean yield of 280kg/ha). Pioneers in this field has estimated the production potential to be around 25,000 tons per annum if the resource is fully harnessed (Thayaparan, 1982).

Annex III: Constraints faced by the Shrimp Industry

- Reduction of inshore marine and lagoon fisheries access to commercial fishermen, i.e. through physical impediments and environmental degradation.
- Unregulated entry of small-scale operators with no capacity for waste redemption and hence increasing frequency of major losses to disease.
- Salinisation of wells and irrigation canals with salt with negative long-term impact on agricultural production capacity.
- Opportunity cost for other production activities, i.e. reduction in grazing lands, forest and mangrove resources (NARA,1987).

Annex IV: Responsibilities of the Ministry of Fisheries and Aquatic Resources Development.

1) Maintenance and operation of inland fisheries centres

2) Regulation according to the inland fisheries act through:
- Control of type of fishing gear and mesh size used in reservoirs.
- Determination and enforcement of fishing seasons.
- Issuing of fishing permits
- Settlement of fishing villagers.

3) Improving the welfare of fisherfolk through:
- Allocation of lands for settlement.
- Provision of housing and sanitary facilities.
- Implementation of insurance schemes for the fisheries sector
- Formation of Fisheries Co-operative Societies (FCSs).

4) District level co-ordination and implementation of ministry activities through fisheries inspectors in collaboration with the FCSs.

5) Facilitate bank loans to the private sector under normal credit schemes.

6) Encourage self- employment schemes.

7) Environmental protection for sustainable development of the industry.

8) Promote Research activities in collaboration with the NARA and other research organisations such as universities and line departments.

9) Collaborate with the Export Development Board (EDB) in the following activities with regard to ornamental fish culture.
- Improvement of quality standards and packing
- Overseas market development
- Training
- Consulting services for product/supply/market development.
- Provision of concessionary loans for the establishment or expansion of ornamental fish breeding capacity for export purposes.

Proposed future activities of the Ministry:

1. Expansion of breeding capacity for major carp varieties at Uda Walawe and Dambulla stations for supply of fry to fisheries sub-stations, NGOs, private and co-operative organisations for fingerling production.
2. Conduct training programmes for community based organisations, co-operatives and the private sector
3. Promote fingerling production in the estate sector (using existing ponds).
4. Encourage NGOs, co-operatives and private sector including agricultural farmers to establish community based seed production programmes
5. Promotion of food fish farming in ponds, cages and pens
6. Integration of rice/fish farming in selected areas and selected paddy fields.
7. Integration of fish/livestock farming with the involvement of farmer organisations
8. Promotion of fish culture in seasonal tanks

Annex V: The Memorandum Released by the Buddhist Priests in Relation to the Ban.

1. Breeding, eating and killing of fish is one of the five vocations prohibited by Lord Buddha.
2. Buddhists should not only avoid breeding of animals for food but also consider killing of animals for food as a crime.
3. Rearing of fresh water fish in the homestead and in reservoirs is considered as an incentive for Buddhists to break the first precept and condition their minds to crime.
4. Rearing of fish for food at home will reduce the fear to kill.

The demands included:

- Bank loans and subsidies for fresh water fish and prawn exports to be withdrawn.
- Research/Extension and breeding programmes of fish should be stopped.
- All propaganda work on matters pertaining to fresh water fisheries over the mass media should be discontinued.

Source:Daily News, 1990 Dawasa, 1990.

Annex VI: Development plans and their impact

According to Mahalingasivam (1995) the first fisheries sector five year plan (1972-1976) aimed to raise production by 52 % to 175,000 MT per annum over the period. However, the ultimately only 133,731 MT was achieved. The 1979 – 1983 plan recognised the vast potential of the inland fisheries sub sector and aimed to achieve a total of 302,000 MT per annum of which 36,000 MT would come from the inland fisheries sector. It also aimed to raise per capita fish consumption from 11 to 20kg and generate additional employment in the sector. The objectives of 1990-1994 plan deviated from other plans through its greater emphasises on involvement of the private sector (however, due to government ban at during this time, the plan neglected the inland fisheries sector entirely).

In the 1995-2000 Development Plan, the private, co-operative and the public sector roles have been identified separately. The private sector will function as the engine of growth and is expected to play a key role in fish production, processing and marketing activities. The public sector role will be the management of aquatic resources and planning sectoral development. In particular the public sector would be responsible for regulation and law enforcement, research, education and training, extension and provide infrastructure facilities where necessary. The co-operative sector will be encouraged to manage and organise the social and physical infrastructure within fishing villages (Fernando, 1997). The five-year Fisheries Development Master Plan (1995 – 2000) is the blueprint for fisheries development activities of the country with a major component for development of Inland Fisheries and Aquaculture.

The three major objectives are to ensure production of fish as a cheap source of animal protein for rural communities, to increase income and employment opportunities for the rural population and to increase production of high value aquatic species for export to earn foreign exchange. The Division of Inland Fisheries and Aquaculture Development recently established under the MOFARD will function as the principal government agency responsible for development of aquaculture and inland fisheries in the country. Major functions of the division are to revitalise the inland fisheries sector through rehabilitation of fish breeding centres; strengthening of regulatory activities; promoting extension/advisory services and encouraging community-based seed production programs. The functions of the Division includes those traditionally undertaken by the old Inland Fisheries Department (IFD) such as fish breeding, stocking of reservoirs with fingerlings as well as capacity building of regional organisation to ensure sustainability in operations.

Annex VII: Fish Breeding Centres of the IFD in 1989 (prior to the Government ban)

1. Udawalawe*
2. Dambulla*
3. Inginiyagala*
4. Muruthawela
5. Panapitiya
6. Ginigathhena
7. Pitipana
8. Rambodagalla**
9. Polonnaruwa
10. Nuwara Eliya*
11. Karukapona (Shrimp)
12. Bambarakelle
13.

* Stations which have reverted back to state control after withdrawal of the 'ban' on inland fisheries.
**Stations in private hands, but still with some food fish production capacity (all other stations are long-leased to the private sector and have switched to more lucrative ornamental production).
The government plans to repossess further stations who's leasehold arrangements prove to be unsound or conditions violated.

Annex VIII: Major areas of Assistance in the FAO Development Program TCL/SRL/8804, commenced in 1979.

1. 50 per cent subsidy for pond construction (Rs.1000 for 1/16 acres to Rs.5000 for 1 Acre). 35 per cent subsidy for boats. Bank credit scheme to supplement up to 57.3 per cent from Bank of Ceylon and People's Bank
2. Intensive stocking program of fingerlings, improvements to breeding and stocking centres
3. Experimental fishing in major tanks
4. Removal of obstacles (stumps) in major reservoirs
5. Stocking and harvesting demonstrations in small tanks
6. Experiments with cage culture
7. Improve welfare of fishermen
8. Extension and training on aquaculture
9. Introduction of new types/breeds of fish
10. Aquaculture research to identify problems
11. Promote new fish products

Appendix 4b: Position Paper 4b. Socio-economic and gender issues with relevance to aquaculture development in Sri Lanka.

Presented by Malika Perera, Gender and Women's Initiative Group, Peradeniya University.

Terms of reference

Gender division of labour, Ethnic distributions, Consumption patterns, Culture- caste and religion, Seasonal work load, Literacy, Access to resources-Land/Property, Information and Training, R&D- extension, Women and law- family law and public law, Decision making, Potentials and constraints

1. Gender background

All societies have character expectations for their members. Gender is one basis for these expectations. The division of tasks in family, occupation responsibilities, the expression of emotions and even personality traits are governed by gender. Notions of masculinity and femininity are the psychological attributes associated with the role assigned by society to its members.

Goonatilleke (1990) explained how these gender differences are used to stereotype a person or a group of persons. Stereotyping has been defined as a view or characterisation of humans based upon narrow and frequently incorrect assumptions. Moreover, it is powerful because it affects our expectations of what people should and should not be. It is also stated that people who cannot or will not take time to understand what a person is really like, rely on stereotypes. Thus Jayasena (1991) stated that gender roles are defined by the society based on its belief, traditions and norms.

Sri Lanka being a South Asian country holds typically patriarchal values in society. The socialisation process has been able to perpetuate these values and major social institutions have contributed to it by and large. The values held by these major social institutions have been able to stereotype men and women in Sri Lanka while keeping gender division of labour at work. Major social institutions like family, law, education, culture and media have been able to maintain gender stereotyping. Thus gender stereotyping has led females to be subordinate from cradle to grave as a daughter to the parents, as a wife to the husband and as a widow to the son (Goonatilake, 1976). Though all groups of people suffer from stereotyping, most of the time it is women who suffer most often facing double discrimination within low status groups. Therefore the gender issues presently emerging in many different spheres are foundered on stereotyping.

In the sphere of fishing there is a clear distinction between economic and social status of men and women, which is not novel. The major social factors that mould the fishing community are culture, law and family. Due to diverse cultural elements caused by caste, class and race, gender division of labour in the fisheries sector shows considerable variation.

Gender division of labour can be defined as the assignment of work to people based on their gender, where economic, reproductive, social and personal activities are based on how masculinity and femininity are defined in a particular society. Thus there are masculine, feminine and neutral work activities defined by the values and norms of the society concerned. Wickramasinghe (1997b) pointed out that the division of labour based on gender has caused low paid labour intensive work to be typically stereotyped as feminine. She also highlighted that the reproductive responsibilities of women have confined many women to

home based activities. Participation in both reproductive and income generating tasks means women often have to work longer cumulative hours than their male counterparts.

1.1 Legal Status

Important laws that regulate the lives of citizen outside the domestic/family situation reveal that the legal system adopts a generally egalitarian view of women's rights. However a survey on family law demonstrates clearly how patriarchal values are established to place constraints on the legal rights and responsibilities of women (Goonasekara, 1993). Goonasekara described different types of indigenous customary family laws practiced in Sri Lanka. Most citizens are regulated under Roman Dutch and English common law, alongside which the indigenous Kandyan; Tesawalamai laws also exist. She attributed the introduction of patriarchal values to the judicial conservatism of Roman Dutch law and English Customary law values. Kandyan law by contrast allows entitlement to property base on the type of marriage. In widower or 'binna' marriage the husband cannot inherit his wife's immovable property, whilst in 'diga' marriage; the married daughter has no claim over ancestral property. According to the (British) land development ordinance of 1935, women are considered as legitimate grantees of land and may succeed to a holding as the surviving spouse. However, Goonasekara (1993) notes that with respect to land tenure, preference has favoured males in the allocation of lands in settlement areas and other state lands as a consequence of values enshrined in early English land law. Sri Lankan courts have extended this by interpretation to mean that these women cannot manage their property or enter in to commercial transitions without their husband's consent. Women's inferior state is also depicted in Muslim law through reduction of the daughters share of inheritance to half of that of the sons share (Sthree Prabodha, 1990). Wickramsinghe (1997b) emphasised that women's usufructary rights to land is not relevant with respect to changing the status of women, the problem of women farmers at grass root level is instead related more directly to their legal rights to land. Agarwal (1995) discusses the need to ensure women's independent land rights with respect to improvement in welfare, production efficiency, equity, empowerment and practical and strategic gender needs. She highlights four additional distinctions with relevance to land rights, distinguishing between social and legal recognition, ownership and control, thirdly ownership and usufructary rights and finally between rights conferred via inheritance and state land transference. She shows that lack of clear distinction between these terms had led to the lowering of women's status in society. By way of example, the requirement for a husband's consent for transfer of immovable property under Tesawalamai law is of one instance of the unsatisfactory distinction between land ownership and control.

1.2 Access to Resources

The Sri Lanka national report (1995) reported that men control most of the productive resources and capital in the country. Most women seeking access to these resources find that they need to surmount not only the socio economic disparities and the differential created by the gender gap, but also discriminatory social attitudes which impact adversely on women. The high incidence of female employment as unpaid family workers also excludes women from the economic decision making process outside the home. Women generally find it difficult to provide the collateral necessary to obtain formal credit and their position in the home further reduces their contacts with elite's or other people who might be likely to provide collateral. A sample survey done by the Women's Bureau indicated that of 284 loans issued by the agrarian services centre banks 757 loans issued by 3 public banks in urban areas, only 9.5-13.5% and 19-25% respectively were obtained by women. A Central bank / IFAD rural credit scheme highlighted the fact that women do not obtain institutional credit principally due to the problem of creditworthiness, not because they do not seek or need credit. The same scheme provided credit to some of the least creditworthy landless and small farmers during 1992/93, with 60-65% of the loans going to women women. There are some instances indigenous efforts of women aimed at redressing this problem. In 1993 nearly 100% of the

shareholders of the Janashakthi bank located in Hambantota district were women belonging to 368 women's groups.

Land ownership patterns also has effected women's creditworthiness. Women are estimated to own only 8-10% of all land holdings in Sri Lanka Wickramasinghe (1997a). A UN national report (1995) also showed that 8-9% of women in Mahaweli settlements do not hold title for land while in the similar world figure is not more than 1%. The Report also describes how the 3rd schedule of land development ordinance discriminates against women with respect to land alienation (although under the general law there is equal right of women for inheritance of property). According to a survey conducted by Rasanayagam (1998) women own less than 30% land in Kurunegala district and much of this belongs to widows, divorced and separated women.

1.3 Women's participation in aquaculture

A study conducted by BOBP (1985) revealed that women's participation in fishing activities varies according to various factors, including the economic development of the region, the level of technological application, the existing infrastructure, topography, cultural and religious backgrounds. For example, mechanisation and motorised transport has contributed to the withdrawal of women from some fishery related activities. Thus advances in fisheries technology such as net making machines, imported machine made nets, modern forms of fish handling and marketing have in fact further marginalised women.

Due to a paucity of relevant socio-economic data, women's contribution to inland fisheries sector alone cannot be measured. Generally occupations of fisheries and agriculture are aggregated. Within this grouping, women's overall participation was as high as 43% in 1996, while 53% of women in formal employment belonged to the category (Census and Statistics, 1997). Lack of gender-disaggregated data on industrial and occupational sub-sectors has contributed resulted in the underestimation of the role of women in fishing communities and hence their exclusion in development plans. This problem is particularly severe in the inland fishery sector where the local database is very poor. Thus one can assume that many of the gender issues prevailing in the agriculture sector are also broadly relevant to the fisheries sector. Often the marine and inland fisheries sectors are pooled together in national statistics, (some inland fishermen are migrant marine fishermen) from which some broader trends can be gleaned. Another common factor is the low status accorded to fisheries related occupations, which further compromises accurate data gathering.

As in subsistence agriculture, women's contribution to inland fisheries is invisible and such invisibility is caused by the lack of gender disaggregated data on their contribution in addition to women's poor perception of themselves as a contributors to production. This in turn has lead policy makers to neglect the problems specific to women.

Within fishing communities along the southern coast, women's major role is management of finances. In the migrant fishing families, women participate in fish sorting, cutting, and processing and in dragging the boats ashore. Along the northern and north & western coasts, women participate in similar activities. However in along the Northwest and East coasts approximately 75% of women engage in fishing related activities while the figure is only 25% along the West Coast (BOBP, 1980).

Amarasuriya (1991) reported that the economic status of the family is another significant factor affecting women's participation in fisheries. She also highlighted the traditional role of fisher women in fish handling, processing and marketing. Processing, including drying and salting of fish, mending of nets (supporting male family members) are generally home-based activities. Women are also often responsible for local vending of fish amongst coastal communities. Fishing in lagoons in the north, north western and western regions has been

identified as a sphere where more women are directly involved. Fishing here is undertaken with a variety of gears including gill, seine and cast nets, sometimes from log rafts and dug-out canoes (Amarasuriya 1991). The percentage of women belong to the occupational category of self employed persons involved in fishing and fish breeding activities within the rural and urban sub-sectors were 35% and 1% respectively in 1984/85 (Census and Statistics, 1995).

Though women's participation and the gender distribution of economic benefits and opportunities in the fishery industry vary from country to country, in general women within the Bay of Bengal region are at a great disadvantage. Compared to men they are typically employed in the lowest paid unskilled jobs. Women's active involvement in small-scale fish marketing as retail stall-holders, itinerant hawkers is also common to this region. In the context of aquaculture in Asia, the tasks of looking after a pond and preparing fish feed are usually relegated to women while men involve in other aspects of fish farming, such as ploughing the land, digging the drains, pond repairs and harvesting. There is scope for the expansion and improvement of women's role in fishing with respect to water management, stocking and fertilisation with the help of training (BOPBP, 1980) Table 1 shows some basic aquaculture activities, which have successfully attracted women's participation.

Table 1. Some basic aquaculture activities which can attract women's participation.

Activity	Instruction and training required
Stocking of the pond	How to avoid under-stocking and over stocking.
Stock correction and growth measurement.	Timing and methods of growth assessment
Stock manipulation in mixed fish culture	How to maximise returns through exploitation of diverse feeding niches by stocking species with varied and complementary feeding habits.
Fertilisation	As above
Feeding of cultured fish	Preparation of feed; the use of artificial feed; daily ration calculation in respect of total fish stock and mean weight
Storage and transport of fish	Ratio of water supply necessary for the storage of live fish awaiting marketing; minimising weight loss of fish
Transport of live fish from pond to storage tanks	Methods of transport
Other activities; canning and preservation	Simple canning methods; the use of materials for fish canning and other preservation techniques.

Adopted from BOBP, 1980

1.4 Seasonal workloads

Agricultural production systems are generally characterised by highly seasonal workloads, which generally leaves a slack period between main cropping season. Wickramasinghe (1997) reported a slack period for female labour between February and March (where the average number of days worked per month falls to around 10) and between July and august (when the days worked falls to below 5 days per month). Often such labour as there is involves preserving and processing activities within agrarian societies. Amongst the coastal fishing communities the seasonality of workloads is due to the "Warakan" (seasonal winds). During this period, females from fishing communities participate in non fishing activities such as livestock rearing, boutique keeping and some times, the preparation and selling of dried fish (Leitan and Gunasekara, 1995). Amarasuriya (1991) also stated that women engage in the preparation of Maldevian fish principally during May-August along the southern coast.

1.5 Consumption patterns

Leitan and Gunasekara (1995) noted very poor savings habits amongst fishermen, in part attributed to their religious belief and high levels of alcoholism. Drinking is an accepted norm and many women consider that working men are entitled to relax in this manner. This leads to chronic indebtedness and lower priority being given to basic household needs including food and clothing.

1.6 Literacy rates

In 1992, the national literacy rate for persons age 15 years and over was 85% for females and 94% for males (Dube, 1997). A study within two fishing villages (Ninamadama and Mankuliya) showed that 40% and 47% of villagers had studied only to grade 5 and 15% to O/L. This study also revealed that most children in these largely Christian communities receive the first Holy Communion around age nine. This has great religious significance consequently most parents send children to school to this level (Leitan and Gunasekara, 1995)

1.6 Decision making

Wicramasinghe, (1997a) attributed the lower participation of women in decision making and development planning to a general lack of property rights. She emphasized the need of right to land to guarantee freedom of individual action, and opportunity to fill leadership roles. She also attributed women's exclusion to a perception whereby they are seen merely as helpers in agrarian societies. Census figures for 1995 shows that 90% of women in seasonal agriculture and 70% in the agriculture sector as whole are unpaid family workers, underlining this observation.

Wickramasinghe (1997a) compared the results of a gender empowerment measure (GEM - reflecting women's involvement in political, economic and decision making) applied across the states of south Asia. Everywhere within the region levels of this index are very low compared to global human development levels. In Sri Lanka the GEM was only 0.288 which was attributed to static gender ideologies with an attendant lack of access to many resource bases. Dube (1997) compared human development indices between South Asian and South East Asian counties. The analysis revealed that in south Asia women's participation in politics averages less than 10% while participation in Sri Lanka was only 5% in 1992, lower than the levels of Bangladesh and India.

2. Ethnic division and status.

A study by the Marga institute (1985) revealed that many commonly used socio economic indicators do not accurately reflect the commonly accepted racial/ethnic differences in the country. In 1981 (i.e prior to the current ethnic conflict) the infant mortality rate amongst Sri Lankan Tamils was 28.5 per thousand live births, which is lower than that of Sinhala community. Jaffna had the highest level of physical well being with the infant mortality rate at only 17 per 1,000 live births, a literacy rate of 92% and life expectancy of 66.5 years, although some of these values are only marginally higher than some Sinhala areas. In the context of unemployment, Sri Lankan Tamils recorded a rate of 10.9% which was the second lowest for the country. Their Kandyan and low country counter parts (Indian Tamils) recorded rates of 13.8% and 18.5% respectively. This study also compared the income levels of Sinhalese and Tamil populations and found no significant difference. The ethnic distribution is heavily polarised in different areas of the country. In 1981 Jaffna had a majority of Sri Lankan Tamils while Hambantota had Sinhala majorities amounting to 95% and 97% of the population respectively. The report also shows that Malays in Colombo and Hambantota and Burgers in Colombo represent slightly above 1% of the population. Forty one percent of the

population in Ampara are Sri Lankan Moors, while in Nuwara Eliya 47% were Indian Tamils. This study also pointed out that overall no significant ethnic difference existed in literacy rates and an education index. When one considers the distribution of land in Sri Lanka, 25% of the total land area consists of the Tamil dominated districts of Jaffna, Kilinochchi, Mannar, Vavuniya, Mullativu, Trincomalee and Batticaloa in 1982, where only 5% of total population lived.

3. Culture and caste status

For historic reasons Sri Lanka is a multi-cultural country with feudal, colonial and capitalistic characteristics. Emancipation of women in a such a cultural field is particularly difficult as competing customs, values, attitudes and prejudices become particularly entrenched (Goonatilake, 1976). Thus the culture of the particular community to which women belong has a major impact on their economic and social status. In Muslim communities their contribution is confined almost exclusively to home based activities. Some researchers have identified cultural differences based on caste. Caste differences are much more profound in rural areas than urban (the rural population represented 72.2% of the total population in the 1981 census). Extensive regional variations exist in caste composition and demarcation. In central province the variety and differentials in status are high. This is perhaps because the caste system originated under a monarchical system, which flourished here most recently with a tradition of bringing south Indian brides for local kings during the Kandyan era.

Across all ethnic groups, livelihood related fishing activities have traditionally been the preserve of lower castes. Amongst the Sinhalese community the Karawa are the main fishing caste, whilst amongst Tamils, these are the Karawa, Thimila and Mukuwas castes (Rupamurty 1998). As intermarriage is still rare social integration between these and higher castes is still rare. These castes were principally active in marine fisheries, though for a while became involved in seasonal migrations with the advent of the Tilapia fishery. Leitan and Gunasekara (1995) reported that Sinhalese fishermen close to communicate mostly in Tamil. They attributed this to migration of these fishermen to Tamil areas of Mannar and Batticoloa during the low marine fishing season prior to intensification of the ethnic conflict. The request of Buddhist priests to withdraw patronage to the inland fisheries sector between 1989-94 has been widely interpreted as a reaction to the perceived threat of these mostly catholic migrants settling in Buddhist dominated rural societies in inland areas (Pers. Com, Dr. Rupamurty; NARA). Subsequently the practice of these seasonal migrations has all but terminated though small communities of permanently encroached Christian fishing groups remain around many larger perennial reservoirs. Religion plays a significant role in the daily lives of these fishing communities (Leitan and Gunasekara, 1995).

4. Research and development and access to information

The necessity of providing training for women to encourage their participation in fisheries related development activities, was amongst the conclusions of the1980 BOBP report. Specific requirements were identified for training in pond management, stocking, feeding, fertilization, harvesting, handling, transport and marketing.

Amarasuriya (1991) investigated the socio-economic impacts of research and development *vis a vis* mechanization of the fishing industry during the early 1960s. Under a government sponsored mechanization programme, female operators were supplied with 31% of fiberglass boats given to inland fisheries activities in perennial tanks at that time. However a more common negative consequence of unplanned modern technology has been the displacement of traditional female roles in the sector. For example, improved methods of handling, preservation and transportation have lead to a reduction in home-based processing, traditionally a role for small-scale female vendors. Furthermore, much of the training offered through various development initiatives continues to be focussed on increasing production which mainly encompasses male dominated activities. In a prevailing climate of patriarchal

values, males are generally considered the breadwinners, however in 1993 20% of the household heads were reported to be women in 1993 (Dept. Census and statistics, 1995). Therefore in order to support women's position as a bread winner and home maker it is vital to identify potential for upgrading technology which support women in their traditional livelihood arenas in addition to exploring innovative new opportunities (Amarasuroiya, 1991). In Sri Lanka transfer of technology mainly takes place through extension services yet only 0.025% of the staff in agricultural extension are women (Wickramasinghe 1997a).

5. Future potentials and constraints

In 1994 an estimated 46% of the Sri Lankan population were under the absolute poverty level. Women and children represent the largest and poorest component of this group where poverty and malnutrition are inextricably linked (Wickramasinghe 1997a). To improve the standard of living of the poor it is important to integrate women into the whole development process beginning with the planning phase. Many women in developing countries are constrained by a requirement to stay close to their homesteads to attend to reproductive tasks. Many aquaculture options which do not require long absence from home are compatible with this need (BOBP 1980) offering greater potential for more women to become involved in aquaculture. Amarasuriya (1991) identified new employment avenues for women in processing of molluscan shellfish, collection and drying of seaweed, the fishmeal and prawn farming industry. However low literacy levels, inadequate training, inferior socio economic conditions of fishing communities, under development of fishermen and inadequate appreciation of the actual status of fishing communities. BOBP (1980) all continue to be major constraints to the participation of poor women in aquaculture.

References

Agarwal, Bina (1995) *Gender and command over property; an economic analysis of South Asia*

Amarasuriya N.R (1991) *Women and Technology*; Working paper no 3 CENWWOR; Colombo

Anon. (1993) *Women and law in status of women (Sri Lanka)* Ministry of health and women's affairs: Colombo: pp1-8

Anon. (1997b) Rural Women's Problems as issues for agrarian reforms in *Development issues across region- Women, Land and Forestry*: Ed. Anoja Wickramasinghe CORRENSA: Sri Lanka:

Anon (1997) Socio-economic statistic: Department of Census and Statistics, Colombo.

Bay of Bengal Programme (1980) *Role of Women in Small Scale Fisheries of the Bay of Bengal*: BOBP/REP/4: GCP/RAS/040/SWE: India

CENWOR (1994) *Integration of Gender Issue in Development Planning: Fisheries Sector*, A report on a workshop held on 19th October, 1994: Document Series No. 52

Census and Statistics (1995) Men and women in Sri Lanka: department of census and Statistics: Colombo:

Dube, L 1997, *Women and Kinship: Comparative perspectives on Gender in South and South –East Asia:* Vistaar publication, New Delhi

Goonasekara, S .W.E (1993) *Status of women in the family law of Sri Lankan women at the cross roads: a Sri Lankan perspective* Ed., S Kiribamune and V Samarasinghe ICES Sri Lanka study series: Vikas publishing house Pvt. LTD: India pp. 153-181)

Goonatilake, H. (1976) *Social and Political participation – tradition, prejudice, myth, reality* in *Economic Review.* Sept. 1976; pp.16-17

Goonatilleke, A.E. (1990) *Women and Media*. A paper resented at the 2nd national convention on Women's Studies 20-22 September 1990

Jayasena, A (1991) *Sexism in the Post primary school curriculum in Sri Lanka,* Gender and Education in Sri Lanka- women, schooling and work ed. S. Jayaweera; CENWOR; 1991 pp. 45-54

Leitan, T. and S. Gunasekara (1995) *Women in the Fishing Industry:* Participatory Development Through Cooperatives: *Logos*: March 1995 Vol. 34 No.1: Center for Society & Religion: Colombo:

Marga (1985) *Inter racial equity and national unity in Sri Lanka*: Marga institute: Colombo

Rasanayagam, Y. (1998) *Globalization and flexibility of female labour; case studies of selected villages in the district of Kurunegala* in *Logos* Vol.36. No.2 July 1998. Centre for society and religion; Colombo

Sthree Prabodha. (1990) *Image and reality-Women in media* CNWOR 1990; June; Vol.3 No. 1 pp. 1-2

The Sri Lanka National Report: to the UN fourth world conference on women, *Towards Gender Equity*

Ministry of Transport, Environment and Women's affairs (1995)

Wickramasinghe, Anoja. (1997a) Land and Forestry: Women's Local Resource Based Occupations for Sustainable Survival in South Asia. CORRENSA: Sri Lanka:

Annex 1: Summary of key points arising from open discussion of Position Paper 4.

General points

- A male participant disagreed with the importance of the family law issue claiming women were not discriminated against.
- Decision making and access to resources
- Female participant claimed that women often control the family income as they are perceived as being better at handling money then men!
- Credit; there are Samurdhi (Welfare) schemes in which small groups of women (about 5) can borrow up to 50,000 Rs without collateral

Female participation in aquaculture and labour markets

- Male participant explained in Colombo markets, women dominate fish market and men only catch them. Claim also made that women sometimes have greater negotiating strength than men
- ACIAR participant questioned emphasis on gender claiming poverty per se as the key issue. She explained in some areas, women fish in the reservoirs and men look after the children. In addition, in some areas where the ACIAR project is involved in cage cultures, women are equal in number and status to men in recently established co-operatives
- The strength of women in inland fisheries is not as great as their marine counterparts. This is large due to religious/cultural differences between difference the two groups.
- Female unemployment; male participant claimed this was due in part to governments demand for maternity pay (3 months) and other benefits for women
- A female participant claimed that many educated middle class women wish to say at home and look after their children

Appendix 5a: Position paper 5: Production of aquatic organisms in large and small-scale irrigation systems - Lessons learnt from elsewhere.

Presented by Mr Francis Murray, Institute of Aquaculture, Stirling University

1. Introduction:

To offer sustainable aquaculture options to the poor, social, economic, institutional and technical factors each set against the primary functions of the system must be considered. This paper will focus on the technical constraints and opportunities imposed by large and small-scale irrigation systems.

In the past development capacity has suffered as a consequence of strict demarcation between capture fisheries and aquaculture. Many farmers who have a tradition of fisheries exploitation seem willing to switch between capture and culture as it suits their requirements. Such diversity in livelihood strategies is a means of spreading and reducing risk. Where fingerling culture is practised to enhance a capture fishery, or wild seed is used to stock small ponds the functional distinction between capture and culture fisheries becomes blurred. Consequently a question that should always be asked at the onset of a development program is what can be done to sustain or increase opportunities for the poor to benefit from incidental/informal opportunities for capture of non-stocked fish and other organisms from irrigation structures?

With this in mind we can envisage three ways of targeting poor farmers who wish to enhance their ability to harvest aquatic organisms from irrigation systems.

1. *Extensive:* Improved management of existing systems, typically encouraging sustainable exploitation of wild fisheries
2. *Semi-intensive*: Improved technology is extended to exploit low input / low output systems.
3. *Increasing Intensification*: Credit or subsidy is offered for inputs required to increase the productivity of existing systems or initiate new ones

Many development institutions focus only on the third option (often relying on intensive pond or cage systems) although high investment requirements and risk of losses mean such systems typically have little relevance to poorer farmers in risk prone, marginal environments.

If interventions are to succeed, farmers must be made aware of the risks implied by the associated with each of these approaches. Financial and environmental risks typically rise with increasing intensity. Increasing intensity brings greater reliance on high levels of expensive off-farm inputs (formulated feeds, fertilisers, therapeutants etc) and the use of complex integration's of livestock and fish polycultures. The most marginal farmers seek to minimise risk and maximise the sustainable use of their limited on farm resources to fulfil their basic needs, rather than maximising productivity.

Semi-intensive systems may be adopted where wild fisheries have declined due to over-exploitation or loss of habitat (i.e due to intensification of agriculture) or where previously no wild fishery existed. The most sustainable systems often make opportunistic use of transient water supplies and are integrated into the whole farm system, receiving inputs and outputting into other on farm practices, with only strategic use of off-farm inputs such as inorganic fertilisers.

Usually the relevant technologies will be straightforward, but their application will be complex, especially with respect to who participates. We must learn from current forms of

irrigation management what could be managed on a community or group basis and what could be established on an individual basis.

Because the physical size of irrigation systems brings additional opportunities, constraints and synergies (most significantly through differences in accessibility and seasonality). The following examples of best practice will be considered first in a large then small-scale system context. The above themes will be developed throughout the following examples.

The following regional examples of productivity in extensive reservoir systems are presented to demonstrate the wide range of productivity that can be expected in such systems.

Table 1. Average productivity of major regional reservoirs (Kg/ha/yr):

India:	8-80 (mean 10kg/ha).
Bangladesh	46
China	150 (Chinese carp polyculture)
Sri Lanka	283 (70% *O. mossambicus* in shallow reservoirs).

2. Potential for aquaculture in major irrigation systems

Introduction:

The area irrigated by major systems has increased by an order of magnitude during the 20th century with most of this development occurring in Asia.. In addition to storage reservoirs aquaculture can be undertaken in distribution channels, in irrigated fields and in the drainage systems:

2.1 Cage based grow-out in storage reservoirs:

With increasing water spread stocking programmes rapidly become less economical as the effort required to catch fish increases. Here the introductions of grow out cage production systems can dramatically increase yields from such waters. Cage production is typically associated as a high input /output system, with potentially high returns but this also brings high risk of losses.

Benefits:

- High yields and potential economic returns.
- High productivity within small (modular) units increases marketing flexibility
- High degree of Individual control
- In waters <8m, savings can be made by supporting cages from posts.

Constraints:

- Changing sedimentation patterns,
- Physical obstruction
- Phosphate eutrophication.
- High risk of losses
- High cost of inputs on an intensive scale.
- Access to high quality feed.
- Access to high quality cage materials.

Examples:

Saguling reservoir (Java):

- 7 x 7m net floating cages has annual productivity of 3t (over three harvests). A potential increase of 4x the productivity of the conventional fishery (177kg ha).

- A subsistence' aquaculture system in the same project using 17m3 cage units yielded 150kg of common carp in 90 days (enough to meet the protein requirements of a family of 5 for a year.

However, although these statistics are often presented to convey a success story by the world bank, it is widely recognised that this programme has become a planning, management and environmental disaster, with high dependence on high quality feeds and huge markets for common carp in West Java. The Sri Lankan fishing of *O. mossambicus* by contrast is highly sustainable and poverty focussed catering mainly to local rural markets.

In Bangladesh and Vietnam a CARE CAGES Project is investigating the most cost effective cage systems for low input farming, through farmer conducted trials. The project addresses lack of technologies appropriate to the social, institutional, resource and environmental context of the poor in these countries. Target groups include the landless and it is envisaged such systems could earn operators around $60 per year.
Other objectives:

- Comparative economic assessment of alternative species (grouper, shrimp, crab).
- Feeding systems and stocking densities investigated to provide different options for farmers with different investment abilities.
- Reducing risk in fingerling transportation and the culture cycle.

2.2 Production in irrigation supply canals

It is estimated that 2/3 of stream flow will be regulated by the end of the century.

Constraints:

- Additional management burden (where competition for water is most intense)
- Current speeds range from 1m/s in large to 0.5 m/s in small canals.
- Secondary purpose of flood control: Wide fluctuation in current, water level and possible flooding.
- Water quality: Wide fluctuation in temperature, oxygen, hydrogen sulphide levels, silt loading and natural productivity depending on extraction point.
- Lined canals offer poor habitat diversity.
- Above conditions constrain survival and spawning of many species of fish

Benefits:

- Increased fertility of irrigation water,
- Control of aquatic plants by grass and silver carp (key economic / environmental benefit)
- Control of disease vectors.

Regional examples:

Production varies from 50-2,800 kg/ha/year as most populations depend on recruitment from source waters rather than deliberate stocking.

China
Carp polyculture using regularly spaced barrier nets produces 300-350 kg/ha /yr.

Indonesia and Thailand:

- Hapas, and floating cages - obstructive.
- Pens occupy 1/3 of canal width (inside bends) - See fig 1,- less obstructive.
- Pens incorporated into bund walls and canal floors – least obstructive
- But costly and causes structural weakening.

2.3 Production in seepage zones.

Where the water table is elevated in the command areas of major irrigation systems fish can be grown in borrow pits or shallow excavated emergency irrigation ponds. In the lowest tail end regions water-logging can reduce agricultural productivity through salinisation and the creation of anaerobic conditions in crop root zones. Such areas also tend to be most susceptible to flooding during the rainy season. Poorer farmers who could benefit from the type of aquaculture options described above typically occupy such degraded lands.

2.4 Fish in rice aquaculture in the farm sub-system.

The most important crops grown in temporarily submerged fields is rice. Ninety percent of the worlds paddies are found in Asia, where an estimated 21 million ha are irrigated. In Indonesia and West Java intensive rice/fish systems are used to produce fingerling for the stocking of perennial reservoirs. Where such production is for the stocking of seasonal tanks, the timing of rice field irrigation in perennial irrigation systems is critical. By contrast, in North East Laos, Cambodia and Thailand low yielding extensive systems produce small fish for subsistence consumption and local sale, in rain fed rice fields.

Benefits:

- Weed control,
- Increased fertility of water,
- Minimum labour required,
- Quick return on investment and income generation out-with rice harvest period,
- Simultaneous high carbohydrate and protein production.

Constraints:

- Herbivorous fish can attack crops
- Increased fertiliser inputs may be required
- Ability to use pesticides compromised (key constraint).
- Reduction in cropped area (may be compensated by increased yield).
- Water quality: Low oxygen, high pH, temperature and turbidity more suitable to swamp than riverine species. Common species include, air breathers (Clariids and Anabantids) Indian carps, common carp and Tilapia.

Modifications required to paddy fields:

- Prevention of escape and refuge:
  - Inlets and outlets screened,
  - Bunds heightened and re-enforced (33-50cm)
  - Shaded refuges: Water quality fluctuations due to shallow depth.
- Operational water depths: 4-60cm depending on fish/rice species (typically 10-20cm).

Regional examples:

West Java and Indonesia (intensive systems)

- Economy of tenant farmers: Experienced farmer cede the entire rice crop for the right to culture fish.
- Acceptable rice yields (3-5 Mt/ha) and cultured fish yields (200-300kg/ha) typical. Best wild capture systems yield up to 135 kg/ha, therefore makes economic sense

Farming methods used:

- Rotational Systems: Exploit fallow periods allowing separation of pesticide use and fish culture short growing period (30-120days) yields fingerlings and 125-200g (75-80kg/ha) common carp for local consumption.

- Concurrent Systems: Used for fingerling production and grow-out yield 150-300 kg/ha. Higher water requirement.

China (intensive systems)
Mainly fingerling culture due to difficulties feeding large areas.
- Experimental use of azolla (a symbiotic nitrogen fixer) increase yields of fish and rice, whilst reducing fertiliser inputs. Demonstration yields; 600kg to 1,800 kg / ha and rice yields increased by 5%, though little successful adoption on farm to date.

2.5 Aquaculture in waste water:

The intentional re-use of wastewater for crop irrigation is likely to become increasingly important as pressure on this resource grows.

Benefits

- Effluent quality improvement: Suspended solids, dissolved nutrients and pathogen loads.

Constraints:

- *Real and perceived health risks*:
  - Low levels of coliforms detected in gut contents, but no systemic detection.
  - Depuration and appropriate processing can eliminate potential contamination.
  - Chemical contaminants (pesticides) are more intractable – Dilution

Examples:

India: Untreated sewage ponds: 900-8,000kg common carp and Oreochromis Sp. /ha/ year.
West Java: Common carp cage culture in open sewers, with some supplementary feeding.

3. Fish production in On-Farm Reservoirs (OFR's).

Introduction

The majority of the poorest farmers in the most marginal areas have traditionally relied on small groundwater or rainfall harvesting systems (from 10's to under 1ha) to increase outputs from their land. Only over the last few decades have serious attempts been made to integrate production of aquatic organisms into these systems. In semi-arid regions one of the major constraints is the short Seasonality of many of these water bodies. Due to the small scale of these systems, the trade-offs between the primary irrigation usage and their use to hold fish are often more critical.

Farmers typically have to stock what ever is available at the point of inundation, which may not be the most suitable species or size. The following 'short season harvesting options' have been used to overcome this constraint.
- Advanced fingerlings spawned several months prior to the onset of rains and held in perennial water bodies
- The use of fast growing exotic species can maximise growth potential in growing seasons ranging from only 4 to 11months.
- The use of stunted fingerlings, which may exhibit accelerated 'compensatory growth' when stocked at suitable densities in seasonal systems.

Seasonal water bodies also offer the following benefits and constraints to poor farmers:
- Harvest in seasonal structures can be very efficient with respect to effort. As waters draw down capture becomes much easier and gear requirements are reduced. Such activity is often undertaken on a communal basis. Design of deeper dead storage areas to concentrate fish in seasonal systems could be a technical option explored.

- Although smaller water bodies are often extremely productive, fish often reach less than 100g in a single growing season. This is sufficient size to meet farming families own food requirements but can constrain the potential for income generation.
- Harvest typically takes place over several weeks resulting in a seasonal surplus often when demand is at a minimum. Lack of infrastructure, storage and processing facilities often results in the availability poor terms of trade to small producers.
- Enhanced fisheries options in seasonal water bodies, which require regular stocking, are often constrained by poor or irregular seed availability.

3.1 Regional examples:

3.1.1 Semi-intensive systems:

China:

Has nearly 2 million ha of small shallow artificial reservoirs (<1-500ha) in which aquaculture has become and integral component of agro-farming systems. Production is an extension of traditional pond polyculture using Chinese and common carps.

- Stocking small reservoirs at 1,500 fingerling per ha, yielded 127-150 kg/ha.

Common integrated practices:

High yield Integration with other resources systems (Ponds <50ha):

- Water fertilized with manure of pigs fed Industrial starch dregs: Yield 1,350 kg/ha
- Draw down area planted with barnyard grass for grass carp: Yield 1599 kg/ha.

Combination of aquaculture and capture fisheries.

- Silver and Bighead carp fingerlings produced in cages, pens or draw down bunds for subsequent release (freeing land and water resources)
- Example 1: During low water, coves are converted into terraced earthen ponds and fertilized with 22-52 kg/ha urea
- Example 2: Bamboo or plastic floating cages (typically 20-40m2) are stocked with 200-500 fry/m2 and and given supplementary feed when natural productivity becomes limiting.

Japan

- Farm or irrigation ponds 0.5 to 20ha in area are commonly used for intensive fish culture
- Small ponds, between 10-15ha are stocked at 100,000 (1g) fry/ha and fed intensively.
- 50k to 100k, 100g Juveniles ready for on-growing after one year.
- floating piers and aerators used to counter water level fluctuation associated . with irrigation demand.

Taiwan

- Half of the 4,000ha of irrigation ponds in Northern Taiwan used for Polyculture of Chinese carps, predominantly Silver carp.
- Super-phosphate fertilizers have increased yield by 50-80%.

3.1.2 Intensive systems:

Israel

In a reversal of the normal direction of integration, fishponds have been converted into irrigation reservoirs, to conserve water. Intensive culture in these dual-purpose reservoirs accounts for >60% of production.

Example:

Cotton reservoirs: between 10 to 40ha and 5 to 7m in depth (reducing evaporation losses 6-10x)

- Stocking densities as high as 10,000 to 18,000 per ha (Yield: 5-12mt per season in 50,000m3) due to great depth.
- Polyculture: 5,000 common carp, 10,000 tilapia, 2,000 mullet and 300 silver carp per ha.
- Feeding: 80kg/ha/day dry chicken manure and Sorghum supplementary feed. 1/3 of complete rate.
- As biomass increases oxygen is limiting, manuring rate is halved, pellets fed at 1/2 complete rate.

Constraints:

- Greater reliance on artificial feeds than shallow ponds
- Lack of access to the bottom and crowding due to diurnal water quality fluctuation.
- Management restrictions imposed by depth: i.e sample weighing for food and harvest determination. Can be overcome by terracing one side of the reservoir or using cages
- Dinoflagellate (*Prymnesium parvum*) blooms producing ichthyotoxins controlled by the application of ammonium sulphate.
- Collapse of *Gymmodinium bogoriense* blooms causes serious economic losses. Requires careful monitoring of the bloom and adjustment of organic additions.

4. Summary

Despite great potential for the incorporation of fisheries in these large and small-scale systems, production levels are currently still very low, even where conventional aquaculture is widely adopted. Reasons for this include

- Institution conflicts arising from misconceptions by the primary users or managers of irrigation systems about the potential detrimental effects of fisheries interventions
- Lack of awareness of potential.

Poor people including the landless can benefit directly from enhanced or sustained production of aquatic organisms in these systems. In addition the production of fingerlings in perennial waters can facilitate fish culture in the smaller on farm reservoirs of some of the poorest farmers in rain fed areas.

References:

De Silva, S. (1988) *Reservoirs of Sri Lanka and their fisheries*. FAO fisheries technical paper. Rome.

De Silva, S. (1983) *The reservoir fishery: Present status and future strategies*. J inland fish 7. 3-13

Haylor, G. (1994) *Fish Production from Engineered water systems in Developing Countries.* In: Recent advances in aquaculture IV. Ed Muir, J. Pisces Press, Stirling. 1-95

Rothius, A.J (1993) *Enhanced fisheries the transition form fishery to aquacutlture: It's potential in the African region.* 13pp.

Annex 1: Summary of key points arising from open discussion of Position Paper 5.

(Comments on papers by Mr Francis Murray and Dr Udeni Edirisinghe)

Integrated resource management

- Department of agriculture claims that water needed to maintain fish is too expensive in relation to paddy, therefore need to acquire fish at fingerling stage compatible with shorter growing periods.
- How much additional water will aquaculture consume?
- Further need for a classification of water bodies relevant to engineers, cultivators and fish farmers.

Seed availability and constraints

- Fast growing species and advanced fingerlings required to overcome seasonal constraints. This needs to be considered with reference to consumer preferences.
- Potential for rearing fingerlings in paddy fields of perennial systems.
- Need to stimulate private sector seed production to replace government subsidy dependency.
- Private sector producing only ornamental seed after the government withdrew support for aquaculture in 1990

Bio-technical issues and constraints

- Problem of high predation in paddy fields raised and need for community and regional level research.
- What is the amount of water needed in rice fields to keep fish & minimum possible levels?
- Poor knowledge of effects of over-application of pesticides and the toxic residence time within the irrigation systems.
- High encroachment of many smaller tanks with aquatic weeds reduces productivity (for agriculture and aquaculture).
- Need to assess not only the seasonality of tanks, but their productivity. Especially, the contribution of grazing animals for carp (production) which are preferred by producers, but do not breed in tanks.
- Need for better understanding of nutrient flows within the micro-catchment.
- How can we maintain /enhance fertility of small tanks? importance of trees in catchment and importance of livestock in catchment, indicators of change
- How will aquaculture impact on the levels of fish migration within a cascade?
- Percentage of tanks that seasonal and no. of years that they are dry

Environmental impacts

- Bio-diversity impacts: Poor knowledge of indigenous fish production (who catches what, when, how much etc). Consumer demand is good for many of these species.

Institutional issues and constraints

- Dispute over potential government inputs / subsidies in the process...pros and cons of government intervention and subsequent withdrawal.
- Ministry of fisheries and aquaculture research development emphasised compatibility of workshop aims with their own and emphasised the 1994 government statement supporting aquaculture. A bill has been announced to set up an 'Ocean Institute' for the fisheries sector.

Appendix 6: Workshop timetable and agenda.

A two day residential workshop was held at the Hotel Topaz in Kandy on November 26th and 27th 1998. The timetable and agenda for the workshop is presented below:

Day 1: 26/11/98

Pre workshop agenda review. University of Peradeniya and UK research staff.

9.0 Opening ceremony
Welcome speech by Dean of Peradeniya University (10mins)
Introduction to the project, Dr John Gowing and Dr Dave Little, (10mins)
9.30 Key-note address by chief guest – Additional Secretary to Fisheries Ministry.
10.00 Tea and registration
10.30 Introduction - Dr Sarath Kodithuwaku, Peradeniya University (Chair)
10.50 Position paper 1 **Integrated water resource management**
11.25 Position Paper 2 **Large scale systems**
12.00 Position Paper 3 **Small scale systems**
12.35 Lunch
1.35 Position Paper 4a **Current status of aquaculture**
1.55 Position Paper 4b **Gender and Poverty focus**
2.15 Position Paper 5a **Aquaculture options from elsewhere**
2.40 Position Paper 5b **Historical context of Aquaculture**.
3.00 Tea
3.30 Stakeholder analysis session 1. (Chaired by Dr Dave Little IoA)
5.30 Close

Day 2: 27/11/98

9.0 Plenary; feedback on stakeholder session 1.
10.0 Tea break
10.30 Stakeholder analysis session 2 (Chaired by Dr John Gowing CLWRR)
12.00 Plenary; feedback on stakeholder session 2
12.35 Lunch
1.35 Stakeholder analysis session 3 (Chaired by Dr Dave Little IoA)
3.00 Plenary; feedback on stakeholder session 3
3.00 Rounding up & summary of workshop outputs, Dr Dave Little and Dr John Gowing.
3.30 Concluding thanks (Mrs Yoga Perera, University of Peradeniya).
3.40 Close.

Appendix 7: List of participants attending workshop and affiliation.

UK Participants	Affiliation (Researchers)
1. Dr John Gowing	CLWRR[2] – Newcastle University, UK
2. Dr Dave Little	Institute of Aquaculture (IoA), Stirling University
3. Mr Francis J P Murray	Institute of Aquaculture (IoA), Stirling University
4. Ms Julie Robson	CLWRR – Newcastle University, UK

Sri Lanka Participants	Affiliation
5. Mr Mahinda Alagawatte	Economist, Ministry of Agriculture & Lands (MAL)
6. Ms Soma Ariyaratne	Researcher, NARA[3]
7. Mr G A Ariyasena	GTZ FCDRMP[4]
8. Mr Ananda Athukorala	Researcher, NARA
9. Ms Magaretha Bakker	Economist, IIMI[5]
10. Dr. U Ederisinghe	Senior Lecturer, Dept. Animal Science, Uni. of Peradeniya
11. Dr ERN Gunawardena	University of Peradeniya
12. Mr G P Gunawardena	National Irrigation Research Programme (NIRP)
13. Dr M M Haniffa	Director, Animal Husbandry, Fisheries & Livestock Samurdhi Authority
14. Mr D C Hettiarachhi	NCCSL[6]
15. Mr Ilanagaratne	Project Officer & Integrated Pest Management trainer,. CARE[7] International, North West Province
16. Mr Kumarasiri Jayasekera	FORUT (rural development NGO)
17. Mr K Jinapala	Economist & participatory methods specialist, IIMI
18. Dr Sarath S Kodithuwaku	Agribusiness Department, Peradeniya University
19. Mr Mahinda Kulathilaka	Senior Aquaculturist, MOFARD[8]
20. Mr Sunil Kumara	Field director, GTZ[9] North West Province Rural Development Programme
21. Mr Kumarasiri	FORUT (rural development NGO)
22. Dr R Kumuranatunga	Researcher, Animal Science Department, Rohuna University
23. Mr Nanayakkara	Senior Programme Officer, SLCDF[10]
24. Ms Shirani Nathaniel	Aquaculture researcher, University of Peradeniya
25. Mr S M A Nelugolla	Irrigation Engineer, Irrigation Department
26. Mr Jayathilika Perera	Small Fisheries Federation (SFF)
27. Mr Laxman Perera	Director, CARE International (North West Province)
28. Ms Malika Perera	Research assistant, GEWIU[11], University of Peradeniya
29. Ms K B C Pushpalatha	Aquaculturist & Programme Officer, MOFARD, AIDB[12] Anuradhapura seasonal tank project.
30. Mr N A Ranasinghe	Small Fisheries Federation (SFF)
31. Ms Shyama Ratnasiri	Research assistant, University of Peradeniya
32. Dr L Siriwardene	Director of economic research, Peoples Bank
33. Mr J Thalpawila –	Project Director, AIDB North Central Province Rural Development Project
34. Dr S Thiruchelvam	Agricultural Economist, Ruhuna University
35. Mr Luxman Wijewardena	Consultant/Aquaculturist, ISB [13]

[2] Centre for Land Use and Water Resource Research
[3] National Aquatic Research Agency
[4] Fisheries Community Development and Resources Management Project
[5] International Irrigation Management Institute
[6] National Chamber of Commerce of Sri Lanka
[7] Caring About Relief Everywhere
[8] Ministry of Fisheries and Aquatic Resources Development
[9] German Technical Co-operation
[10] Sri Lanka Canada Development Fund
[11] Gender Education and Women's Initiative Unit
[12] Asian Development Bank
[13] Industrial Services Bureau

36. Dr W M W Weerakoon	Director, Fish in rice programme, MAL
37. Mr L Welamedage -	NCCSL
38. Mr P Weligamade	IIMI Economist, IIMI

Appologies

Mr Lionel Desanayake	Programme Officer, Sewa Lanka (rural development NGO)
Mr A M Jayasekara	Director MOFARD
Mr Kanakage	Aquaculture consultant, Wayamba Development Authority
Dr H. B Kotagamma	Agricultural economist, University of Peradeniya

Appendix 8. Composition of groups participating in stakeholder session 1. :

A: Donors
1. Mr Luxman Wijewardena – ISB
2. Dr Dave Little IoA
3. Dr John Gowing CLWRR
4. Mr L Welamedage - NCCSL
5. Dr L Siriwardene - Peoples Bank
6. Mr Nanayakkara – SLCDF
7. Mr D C Hettiarachhi – NCCSL

B: Development
1. Mr Kanakage WDA
2. Mr M Alagawatte – Min Ag & Lands
3. Dr M M Haniffa - Samurdhi
4. Ms K B C Pushpalatha ADB/NCP
5. Mr J Thalpawila – ADB/NCP
6. Mr A M Jayasekara – MOFARD

C: Fisheries NGO's
1. Mr G A Ariyasena – FCDRMP
2. Mr N A Ranasinghe – SFF
3. Mr Lionel Desanayake – Sewa Lanka

D: Non Fisheries NGO's
4. Mr Sunil Kumara - GTZ
5. Mr Jayathilika Perera - SFF
6. Mr Lakshman Perera – CARE
7. Mr Ilanagaratne - CARE
8. Mr Kumarasiri – FORUT

E: Government Research
- Ms Soma Ariyaratne - NARA
- Dr W M Weerakoon – Rice research
- Mr M Kulatilaka - ?
- Mr Ananda Athukorala – NARA

F: University Irrigation Research
1. Ms Magaretha Bakker – IIMI
2. Dr ERN Gunawardena, UniPeradeniya
3. Mr G P Gunawardena - NIRP
4. Mr K Jinapala IIMI
5. Mr P Weligamade - IIMI

G: University Research Male
1. Mr Francis J P Murray – IoA
2. Dr. U Ederisinghe – Uni Peradeniya
3. Dr S Thiruchelvam – Rohuna Uni
4. Dr H. B Kotagamma – Uni Peradeniya
5. Dr Sarath S Kodithuwaku- Peradeniya

H University Research Female
1. Ms Shirani Nathaniel –Uni Peradeniya
2. Ms Malika Perera – Uni Peradeniya
3. Dr R Kumuranatunga – Uni Ruhuna
4. Ms Julie Robson – CLWRR
5. Ms Shyama Ratnasiri –Uni Peradeniya

Appendix 9: Composition of groups participating in stakeholder sessions 2 & 3.

GROUP A

1. Ms Margaretha Bakker
2. Ms Malika Perera
3. Mr Francis Murray
4. Mr Ananda Athukorala
5. Mr Mahinda Kulathilaka
6. Mr Lakshman Wijewardena
7. Mr S M A Nelugolla

GROUP B

1. Dr M M Haniffa
2. Dr L Siriwardena
3. Mr M Agalawatta
4. Mr V K J Thalpawila
5. Mr Parakrama Weligamage
6. Ms Soma Ariyaratne
7. Mr Jayathilaka Perera
8. Dr Sarath S Kodithuwakku
9. Ms K B C Pushpalatha

GROUP C

1. Mr Laxman Perera
2. Mr C Nanayakkara
3. Mr Kumarasiri Jayasekera
4. Ms Shirani Nathanael
5. Ms Julie Robson
6. Dr U Edirisinghe
7. Mr G A Ariyasena
8. Mr Nimal Ranasinghe

GROUP D

1. Dr John Gowing
2. Mr D M Ilangaratne
3. Dr S Thiruchelvam
4. Dr P R T Cumaranatunga
5. Mr D C Hettiarachchi
6. Dr W M W Weerakoon