‘Aquaculture in small-scale farmer-managed irrigation systems’

June 1999

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Acronyms

ARP	Aquaculture Research Programme
ARS	Agricultural Research Scientists
CD	Check Dam
CIFA	Central Institute for Freshwater Aquaculture
DFID	Department for International Development
DoF	Department of Fisheries
FFDA	Fish Farmers Development Agencies
FIT	Farm Irrigation Tank
FP	Farm Pond
GDP	Gross Domestic Product
GTZ	German Technical Co-operation
ICAR	Indian Council of Agricultural Research
IFAD	International Fund for Agricultural Development
IPM	Integrated Pest Management
IIMI	International Irrigation Management Institute
KAR	Knowledge And Research
KAWAD	Karnataka
KCIFF	Karnataka Co-operative Inland Fisheries Federation
KVK	Krishi Vigyan Kendra (Farm Science Centres)
MOFARD	Ministry of Fisheries and Aquatic Resources Development
MT	Mini Tank
NARA	National Aquatic Research and Development Agency
NARS	National Agricultural Research Scientists
NDF	National Development foundation (NGO Sri Lanka)
NGO	Non Governmental Organisation
NR	Natural Resource
OW	Open Well
PAD	Peninsular Aquaculture Division
PRDP	Participatory Rural Development Programme (Tank rehabilitation -Sri Lanka)
PWDS	Pampanagar Women's Development Society (Devadasi group)
SC	Scheduled Caste. Lower castes identified by the Indian government as a means of classifying castes for the allocation of benefits
SLCDF	Sri Lanka Canada Development Fund
SP	Surface Pond
ST	Scheduled Tribe. All tribals. SCs and STs together constitute the 'socially and educationally backward classes of citizens'. The terms form the basis for policies of protection and positive discrimination
STC	Small Tank Cascade system

Scope of report

This report provides a description of the 'Aquaculture in Small-Scale Farmer-Managed Irrigation Systems' project. In the report the research framework is outlined, and the main project activities to date described, along with major outputs and findings, and plans for future project activities.

Table of Contents

Executive summary

Output 1:
The potential of aquaculture in small-scale farmer-managed water resources assessed.

Activity	*Progress to date*
1.1 Conduct an in-depth study of one location in Karnataka and one location in Sri Lanka selected to represent water scarce areas farmed by poor people.	Situation analysis Karnataka completed, 10 Working Papers produced: Project Summary Report 1. Raichur District: Site for a Study of Aquaculture Development in the Semi-arid Tropics 2. Methods for Participatory Information Gathering and Analysis 3. Socio-economic Analysis of Villages in Relation to Aquaculture Potential in Raichur District, Karnataka, India 4. Investigation of Gender Issues in Relation to Aquaculture Potential in Raichur District, Karnataka, India 5. On-farm Resources for Small-scale Farmer-managed Aquaculture in Raichur District, Karnataka, India 6. Inland Fisheries Resources and the Current Status of Aquaculture in Raichur District and Karnataka State, India 7. An Investigation of Aquaculture Potential in Small-scale Farmer-managed Irrigation Systems of Raichur District, Karnataka, India 8. Indigenous Freshwater Fish Resources of Karnataka State and their Potential for Aquaculture 9. Institutional Linkages of Relevance to Small-scale Aquaculture Development in Karnataka State, India 10. Fisheries Marketing, Demand and Credit in Raichur District, Karnataka, India Sri Lanka Working papers. Project Summary Report 1. Puttalam and Kurunegala Districts; Site for study of aquaculture development in the lowland dry-zone of Sri Lanka and methodology for participatory information and analysis. 2. Inland fisheries resources and the current status of aquaculture in Sri Lanka, Puttalam and Kurunegala districts. 3. Fisheries marketing systems and consumer preferences in Puttalam and Kuruegala Districts of Sri Lanka. 4. The nature of small-scale farmer managed water resources in Sri Lanka, Puttalam and Kurunegala Districts. 5. An investigation of on-farm resources with relevance to aquaculture in farmer managed irrigation systems of Puttalam and Kurunegala Districts. 6. Socio-econonmic analysis of villages within cascading tank systems of Puttalam and Kurunegala districts. On-going situation analysis investigating seasonal livelihood patterns in villages of selected cascade systems within Puttalam and Kurunegala Districts of Sri Lanka carried out April to November 1999.

Output 2:
Identification and testing of research methods / tools.

Activity	*Progress to date*
2.1 Characterise with farmers and NARS the researchable social, technical and economic issues relating to development of fish production in farmer-managed water resources from case study areas in Southern India and Sri Lanka	Key researchable constraints identified with NARS at Stakeholder Workshop in Coimbatore, Tamil Nadu, 19-20 November 1998 and Kandy, Sri Lanka 26-27 November 1998.Key researchable constraints identified with farmers from Koppal and Raichur districts (India) and Puttalam and Kurunegale Districts (Sri Lanka) during participatory situation analysis Karnataka. Elaboration on Indian farmers constraints identified during Farmer Workshop in Koppal, Karnataka, 20-21 April 1999. Sri Lanka farmer workshop to take place in October 1999.
2.2 Develop in conjunction with farmers and ARS a farmer ranked research agenda for the development of fish production in these systems	Farmer derived research agenda formulated at Farmer Workshop Koppal, Karnataka 20-21 April 1999 (facilitated by the NGO SAMUHA). Ranking being carried out as part of current baseline survey. Sri-Lanka: preliminary research hypotheses formulated as component of participatory situation analyses. Further definition and ranking to be undertaken during farmer workshop to be held October 1999 and longitudinal situation analysis.
2.3 Hold regional workshop on use of small-scale farmer-managed water resources for production of fish and other aquatic products.	Stakeholder Workshop in Coimbatore, Tamil Nadu, 19-20 November 1998 and Kandy, Sri Lanka 26-27 November 1998: stakeholder analysis completed and major constraints to aquaculture identified. Workshop proceedings expected completed in July 1999. Farmer Workshop in Koppal, Karnataka, 20-21 April 1999: Farmers' research priorities identified. Workshop proceedings in Appendix 3. Sri Lanka: Activity to be included as part of a farmer workshop October 1999.

Output 3:
Approaches to key engineering and management options investigated and promoted.

Activity	*Progress to date*
3.1 Investigate options for enhanced natural fish production, cultured fish, non-fish aquatic production	Preliminary trials with groups 33 Farmers associated with Samuha Akanksha and Kanakanala watershed development projects in four different types of water body, using carp combinations, initiated May 1999. Baseline information collection for participating farmers expected completion 30 June 1999. Participatory trial monitoring forms and database developed in collaboration with local NGO Samuha in May 1999, monitoring of trials to start after stocking of water bodies commencing 30 June 1999. Sri Lanka: Farmer trials to be initiated by November 1999 after formulation of farmer derived research agenda in October.
3.2 Define / compare draw down / water use of the land and water based production systems.	Economic impacts of the integration of aquaculture in irrigation systems investigated by Cecile Brugere (IoA) March 1999. Post-trial Farmer Workshop in December 1999/ January 2000 will incorporate a thorough analysis of benefits and drawbacks of water based compared to land based production systems.
3.3 Investigate health and welfare implications.	Impacts of pesticide use in large and small scale irrigated areas investigated as a joint activity between the large scale and the small-scale projects in Sri Lanka by Graham Taylor

	(IoA) Feb-Mar 1999 The potential of aquaculture in poverty alleviation investigated as a joint activity between the large scale and the small-scale projects by Mike Bruce (IoA) Feb-Mar 1999.
3.4 Develop an index of water resource development potential.	Index of water resource development potential completed March 1999 (using information from situation analysis). Index presented to and modified with farmers and Samuha field staff April-May 1999. Index left as a working document, which will be expanded as research yields new findings. Sri Lanka: Index based on farmer indicators and field measurements during situation analysis (inc. frequencies of spill and seasonality, ratios of catchment, command and water spread, farmer water usage ranking). To be developed further during longitudinal situation analysis.
3.5 Produce guidelines, information and other dissemination / promotion materials.	Written extension materials with farmers. Written policy guidelines with NARS and farmers. Project reports, peer-reviewed articles based on findings from farmer-trials in Karnataka and Sri Lanka. Iterative process of information resource update as research cycles continues. Video on options for and constraints to aquaculture development in small-scale farmer-managed irrigation systems recorded in field in Karnataka and Tamil Nadu April – May 1999, expected edited output July 1999.

1 Introduction

1.1 Project approach

The different stages of the project are shown in Figure 1. Activities at each stage are outlined in subsequent sections. A brief introduction to the participatory approaches used in the project is given below.

Participation

Early approaches to development were often top-down, target-driven and often not very successful (Rennie and Singh, 1996). The apparent failure of development to improve the lives of poor people is now believed to be related to the absence of stakeholder involvement of those "undergoing" development. In the early 1980s approaches incorporating people's participation started gaining foothold (Chambers, 1984). In the late 1980s, it was argued that participatory research methods and approaches could serve as a powerful tool for meeting farmers needs, especially those who manage complex, diverse and risk prone agriculture (Chambers *et al*., 1989).

Farmer Participatory Research (FPR)

It has long been recognised that farmer participation is vital for agricultural research directed towards producing strategies for farmers in marginal areas. Low-income farmers most often operate in complex, diverse, risk-prone environments where farming strategies are unusually flexible and complex and therefore difficult to replicate in on-station trials (Marsh and Appendini, 1998). Where experiments on research stations have optimal levels of all inputs other than the experimental variable, the situation is quite different in the complex farming systems of poorer, more marginalised farmers (Shah *et al*., 1991); (Farrington, 1989; Okali *et al*., 1994). The failure to elicit farmers' views in the technology development process is now widely regarded as a major reason for the low adoption by farmers of technologies generated on research stations (Farrington, 1989). On-station research most often does not take into account the interdependent social and economic activities of the farm, variables which are just as important as pure production figures for the viability of farming activities (Delince, 1998); (Hodge *et al*., 1998; Veach, 1996)). Better suited for the special conditions of marginal areas is farmer participatory research, where on-farm trials are used in an attempt to develop technology in the environment in which it is to be used (Collinson, 1998); (Farrington, 1996a); (Jones, 1998); (Lightfoot, 1987); (Loevinsohn and Simpson, 1998); (Tripp, 1991)). Research should therefore not only take place in farmers' fields but farmers need to actively participate in the research needs assessment, and the planning and management of research (Leelapatra *et al*., 1992).

Participatory approaches are well established and integrated into e.g. rural agriculture and agroforestry research projects (e.g. (Chambers *et al*., 1989); (Farrington, 1989), (Lightfoot, 1987); (Okali *et al*., 1994); (Farrington, 1996b); (Loevinsohn and Simpson, 1998), (Roling *et al*., 1998)), but scientist-led on-station research dominates in the field of aquaculture. Whereas this approach may be appropriate for resource-intensive, high-technology aquaculture research, it is clearly unsuitable for yielding suitable outputs for marginal farmers in risk-prone areas.

Presently in India research into options for resource-poor farmers is virtually non-existent and participatory research approaches not used.

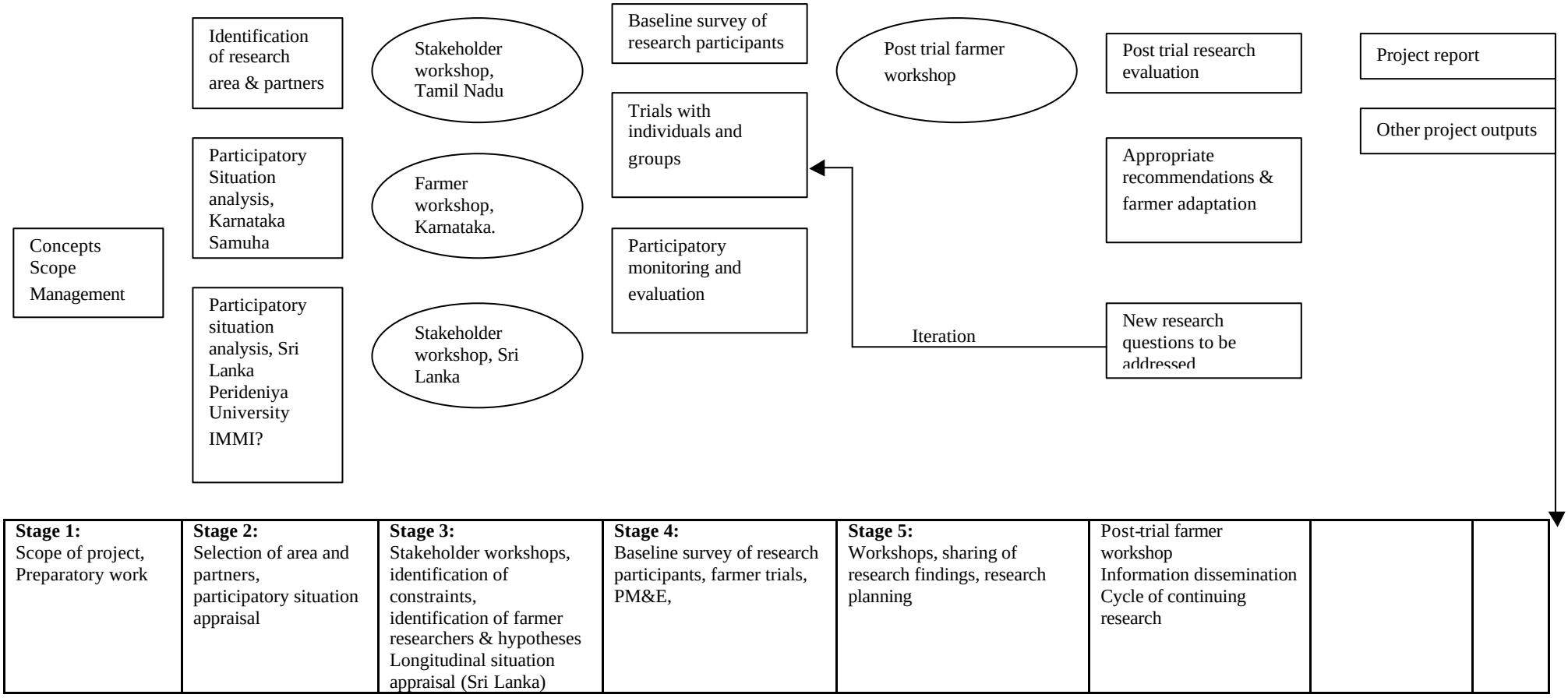

Figure 1: Project stages.

2 Stage 1

2.1 Scope of project

Research focus

The arid and semi-arid tropics are areas in urgent need of development. As home to a large proportion of the world's poor these regions face a future of scarcity of food and insufficient water for consumption and irrigation of crops. It has been predicted that India and Sri Lanka will face a fresh-water crisis in the near future (Nigam *et al.*, 1998), and as much water is currently wasted due to inadequate management and conservation practices there is a need for more integrated approaches to water management ((Redding, 1990). The majority of surface water bodies in India and Sri Lanka are used primarily for irrigation. Although large-scale irrigation systems cover more surface area and supply a greater area of farmland, most farmers are dependent on small-scale systems for their daily livelihood (Wolf, 1986). Irrigation systems are often very inefficient water distribution systems, and studies suggest that the efficiency of water use could be improved. The integration of aquaculture (which can be non-consumptive in terms of water use) has the potential to increase food production and improve the efficiency of the use of small-scale irrigation water resource (Harrison, 1996); (Pretto, 1996). The focus of improved rainfed water management is increasingly at the catchment level. The Indian government currently spends some US$300 million on a variety of watershed development programmes in semi-arid areas (Barr, 1998), and watershed development is a huge development initiative in Sub-Saharan Africa and other semi-arid areas of the world. Such investments have resulted in the creation of large numbers of new farmer and community managed water storage systems. In Sri Lanka and Southern India large-scale rehabilitation of ancient community managed cascading tank systems has take place over recent decades. Despite this potential, attempts to integrate fish production into these water bodies are few and have only been considered relatively recently (Haylor and Stewart, 1998).

Two closely related DFID projects are looking at aquaculture in irrigation systems. The DFID ARP[1] project 'Small-scale farmer-managed aquaculture in engineered water systems' (project R7064) aims to identify social and bio-economic constraints to the introduction of aquaculture into farmer-managed irrigation systems and to develop and promote effective approaches to aquaculture. Intended beneficiaries include the rural poor, which in India belong to the Scheduled Castes (SCs)[2] and Scheduled Tribes (STs)[3]. Target groups in Sri Lanka include low caste, landless, youth and women's groups. A closely linked DFID Engineering Programme project is investigating the potential for integrating aquaculture into medium and major formally managed irrigation systems of semi-arid areas.

2.2 Preparatory work

A literature review of aquaculture and farmer-managed irrigation was carried at the project proposal stage. This revealed the need for integrated approaches to water management, the under-utilisation of water used for irrigation purposes, and the magnitude of resource-poor farmers depending on such water bodies. Likely collaborators and target institutions were identified including the DFID KAWAD project, ICAR[4] Fisheries Institutes, KVKs[5], Panchayats[6], FFDAs[7], and NGOs such as Prarambha, Samuha, and ActionAid. In Sri Lanka the Agribusiness department of Peradeniya University was identified as the principle collaborator for the preliminary phases of the project.

[1] ARP: Aquaculture Research Programme
[2] SCs: lower castes identified by the Indian government as a means of classifying castes for the allocation of benefits.
[3] STs: all tribals. SCs and STs together constitute the 'socially and educationally backward classes of citizens'. The terms form the basis for policies of protection and positive discrimination.
[4] ICAR: Indian Council of Agricultural Research
[5] Krishi Vigyan Kendra (Farm Science Centres), run by ICAR these centres carry out agricultural extension activities, including some aquaculture.
[6] Panchayat: local governing body
[7] FFDA: Fish Farmers Development Agencies under the DoF

3 Stage 2

3.1 Selection of research area and partners

The geographical focus of the project is the regions of the semi-arid tropics where fish is of major dietary importance and an integrated approach to water management by farmers most needed. The water scarce regions of Karnataka, southern India, and southern Sri Lanka were chosen as appropriate project focus areas. In Karnataka watershed management is a relatively new activity, involving the construction of small farmer-managed water bodies for rainfall harvesting, groundwater recharge and the prevention of soil erosion. In Sri Lanka (as in many parts of India) watershed management mainly exists in the form of the ancient cascade tank systems. By investigating aquaculture options in both traditional and modern watershed development structures the research results are likely to have broad applicability. Furthermore the linked engineering project on aquaculture in large-scale irrigation systems also focuses on irrigation systems in southern India (the Bhavani System in Tamil Nadu) and Sri Lanka (Mahaweli H system). This provides excellent opportunities for linking the two projects to produce exhaustive guidelines (to engineers, extension workers and policy makers) for integrating aquaculture into irrigation systems of arid areas.

An inaugural project visit was made in February 1998 by Graham Haylor and Dave Little to Karnataka and Sri Lanka to establish links and plan activities with key collaborators. In Karnataka contact was made with the Peninsular Aquaculture Division (PAD) of the Central Institute for Freshwater Aquaculture (CIFA) and representatives from Samuha, an NGO very active in watershed development. A visit was made to the northern drought-prone districts of Koppal and Raichur where Samuha carry out the majority of their watershed development, and the collaboration between the Institute of Aquaculture (IoA) and Samuha on a participatory situation analysis for aquaculture was established. For further information on Samuha, see Working Paper 9, 1998. In Sri Lanka an MoU was established with the Agribusiness Department of Peradeniya University to collaborate in a participatory situation analysis and provision of logistical support. Contact was also established with IIMI (the International Irrigation Management Institute). Whereas in India location of the wider research area was effectively determined by the nature of the collaboration entered into, in Sri Lanka this became a component of the primary situation analysis (see section 3.4).

3.2 Sustainable livelihoods framework

An appreciation of the importance of participation in development, along with increased understanding of the role of the environment and an emphasis on sustainability, has led to the formulation of the sustainable livelihoods framework. The 1997 UK White Paper on International Development commits the Department for International Development (DFID) to promoting "sustainable livelihoods" and to protecting and improving the management of the natural and physical environment. These objectives are expected to contribute to the overall poverty eradication goal (Carney, 1998). Livelihoods can be said to comprise capabilities, assets (material and social) and activities required for a means of living. They are sustainable when they can withstand stresses and shocks and maintain or enhance capabilities and assets, both now and in the future, whilst not undermining the natural resource base.

A conceptual framework for sustainable livelihoods has been developed by the Institute for Development Studies (Scoones, 1998). Livelihoods are described as built upon *Natural, Social, Human, Physical* and *Financial* capital assets vulnerable to trends, shocks and local cultural practices. Livelihoods are defined by *transforming structures* (e.g. institutions, government) and *processes* (e.g. laws/incentives) which determine who gains access to which type of asset, its effective value and thus which strategies and activities are attractive to whom. Aquaculture as a livelihood option may contribute to the robustness of and increase the opportunities available to individuals / groups / communities by building up their *asset* base.

The sustainable livelihoods framework is visualised in Figure 2.

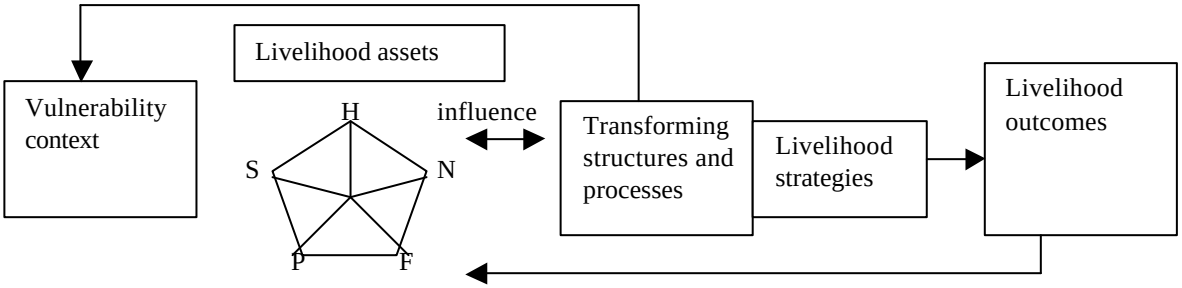

Figure 2: Sustainable livelihoods framework. Key: H = Human Capital, N = Natural Capital, F = Financial Capital, S = Social Capital, P = Physical Capital. Adapted from (Carney, 1998).

3.3 Participatory situation analysis Karnataka

A participatory situation analysis investigating the economic and technical feasibility and the social acceptability of the production of fish in farmer-managed irrigation systems in arid and semi-arid regions of Karnataka was carried out. Field research took place from 6 April to 21 May 1998 and included a 'Rapid Rural Appraisal' of four villages in Koppal and Raichur Districts, Karnataka, and semi-structured interviews with representatives from the Government Department of Fisheries, marketing organisations, academics and other relevant institutional sectors within the state. Villages were selected on the basis of the frequency of small-scale farmer-managed irrigation water bodies as well as on socio-economic characteristics such as caste-composition and literacy levels.

The draft outputs of the situation analysis were shared with, and feedback encouraged from project collaborators and organisations involved with the uptake of project outputs in Karnataka in a field visit in August 1998.

Below the findings from the situation analysis are briefly outlined within the sustainable livelihoods framework.

Livelihood assets

The asset pentagon indicates the relative access to different capital assets. The centre of the pentagon, where the lines meet, represents zero access to assets, the outer perimeter maximum access. Asset analysis can form a useful basis for a debate about suitable project intervention points in order to determine which capitals are important to escape from poverty. In research projects it is useful to ask how the outcomes of the research may change the shape of the pentagon. The overall shape of the pentagon may be established for generalised communities, social groups or individual households. Figure 3 is a generalised diagram of the relative access to resources for marginal farmers belonging to SCs or STs in northern Karnataka, as established from the participatory situation analysis.

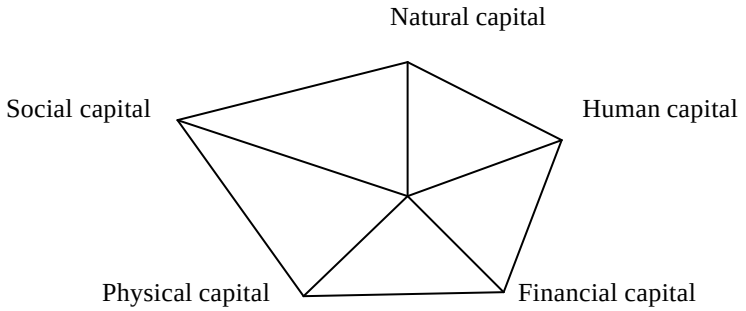

Figure 3: Asset analysis for SC and ST farmers in Raichur and Koppal districts, Karnataka, India, as established in the participatory situation analysis carried out March – May, 1998.

Human capital

The skills and knowledge base of poor communities in northern Karnataka vary a lot from village to village, between sub-groups within villages and even between members of households. The generally very low position of women in India and the practice of dowry has led to a preference for and favouritism of male children, mainly because daughters will leave home taking dowry whereas sons will give future autonomy and authority over daughters-in-law and grandchildren (Mosse, 1993). This preference for sons over daughters is so pronounced in India that it has had a significant effect on the sex-ratio (ratio of women to men, expressed as the number of females for every 1,000 males in the population). The sex-ratio of the villages investigated varied between 868 and 956 women per 1000 men. Literacy levels on the whole are very low, especially for women (2-7% contrasted to 7-35% for men in case study villages). For poor households children constitute an important farm labour resource and many children are therefore not send to school. Boys are always educated in preference to girls. Child mortality is low, but higher among girls than boys and the nutrition and general health of boys is better than that of girls. Both men and women work on the farm, and in the poorest households also as farm labourers for others. In addition women also perform all household work and child-minding duties so on average work between 2.5 and 5 hours more than men per day. Because women have the sole responsibility for looking after children their ability to take on off-farm work can be restricted if no other female members of the family can look after young children.

In villages near rivers or tanks stocked with fish some members of the community know about fish species, habitats, capture techniques, and spawning periods. However there is no local knowledge about aquaculture techniques, species used, feed, fertilisers, husbandry procedures etc.

Both men and women vote, but women stated that they do not know anything about politics, have no interest in it, and that they follow the advice of their husband when voting. Illiterate people in the area are generally less aware of their rights than people who can read and write, and in some areas farmers who clearly qualify for the 'green card' (the Indian Government ration card given to farmers below the poverty line) do not know how to obtain it.

Natural capital

The natural capital in the region is very limited. Water resources are scarce and farming activities limited to dryland agriculture (typically 0-4 ha per farmer) and smaller irrigated areas (typically 0-1 ha per farmer). Resources potentially useful for aquaculture livelihoods include four types of farmer-managed water body, the characteristics of which are shown in Table? below. As can be seen each water body has multiple functions, and the integration of aquaculture may conflict with existing water uses such as human and livestock drinking.

Table 1: Small-scale farmer-managed water bodies in northern Karnataka.

Type	Seasonality (post rains)	Principal water source	Primary uses (other uses)	Ownership and access
Check dam	3 months to perennial	Rainfall	Silt and water harvesting (livestock, pumped irrigation)	Owned by community or government (occasionally farmer), used by community or farmer
Farm pond	3-4 months (most) to perennial	Rainfall	Ground water recharge, small –scale irrigation (domestic)	Owned by farmer, used by farmer
Open well	Mostly perennial	Ground water	Irrigation (livestock, domestic)	Owned by farmer, used by farmer
Farm irrigation pond	Farmer managed	Ground water (pumped)	Irrigation (livestock, domestic)	Owned by farmer, used by farmer

Source: situation analysis from Karnataka, March-May 1998.

Common crops include many suitable for use as supplementary feed in aquaculture, but presently all crops by-products are used for a multitude of purposes (human and livestock consumption, marketing, fire, house construction etc.). Livestock kept in the villages include cows, buffaloes, oxen, goats, sheep and chicken. Cows, buffaloes and goats provide milk, and goats, sheep and chicken are eaten. Oxen are used for draft work and organic fertiliser is obtained from cows, buffaloes, oxen and also goats to a minor extent. Furthermore all livestock can be sold and thus provide an additional income for the farmer.

Men own all the land, livestock, and water resources. Local wealth rankings carried out as part of the situation analysis showed wealth to be directly related to (especially irrigated) land holdings. Landless people constitute the poorest, most marginal part of society. Although both men and women work on the farm and look after the livestock, women generally have no decision-making powers relating to the management of land or water resources. Furthermore social taboos restrict the access of women to the farm and livestock at certain times.

Financial capital

Big differences were found between the different villages in terms of credit. In the richer villages very few farmers borrowed money, whereas in the poorer villages the majority of villagers were in debt for certain parts of the year. Most farmers borrow money during June, July and August for seed and fertiliser, and repay their loans after the harvest in September-October. Greatest indebtedness thus occurs at a time when water bodies need to be stocked with fish seed and inputs for aquaculture are most likely to be required.

Farmers borrow money from banks (12% p.a.), private village lenders (36% p.a.) or from savings and credit groups started by Samuha (36% p.a.). Most money is spent on agricultural purposes (seed, fertiliser, pesticide and farm labourers) but some households borrow money for food. All families interviewed managed to pay back these smaller loans within 2 to 6 months after taking them out. Bigger loans such as for houses, wells or pumps generally took longer to pay off. The total amount of money borrowed per year varies from Rs. 1,000-20,000 (~£17-333), but these figures may not be accurate estimates as there was a general feeling amongst the researchers that farmers would exaggerate their poverty because they were hoping to obtain support from the research team. Private money-lenders are mainly used by illiterate farmers, who stated that they 'did not know how to' access banks, and for emergency credit for other farmers.

Farmers income arise from the produce (crops, livestock) they sell and the money they earn as migratory workers or farm labourers in the local area. Men are in charge of finances, and for all work, men are paid 1.5 - 2.5 times more than women (payment for labourer work range between Rs 10-50 per day (~£.0.17-0.83)). Most farmers in the area have 'green cards', which

are ration cards provided from the Indian government to the people below the poverty line. SC and ST farmers are eligible for a variety of government subsidies. Thus in Akanksha villages ST and SC farmers are eligible for 95% and 90% subsidy respectively on the construction of farm ponds (total cost Rs 3,000).

Very few farmers use banks for saving. Land, livestock and gold jewellery are used as liquid assets and sold in times of hardship.

Physical capital
The access to villages varies primarily with their proximity to larger towns. Most villages are only accessible by dirt road, and are only infrequently serviced by public transport. Usually there are only one or two telephones in a village, a couple of radios and often no television. Electricity supply for SC and ST households are subsidised by the State government, so most villages have electricity but power cuts are commonplace. Telefax and computer internet access are normally not available, and even if they were not most villagers cannot read or write. Markets are normally held in bigger towns nearby, where farmers can also by newspapers, access banks and government offices etc. Women are normally not allowed to leave the village without travelling in pairs or (preferably) accompanied by a male member of the family. All Samuha villages have been supplied with village wells for the supply of clean water but sanitation / sewage facilities remain almost non-existent.

Social capital
The NGO Samuha operates mainly by increasing social capital in their project villages. The formal village structures existing in all Samuha villages are shown in Table? Through these groups villagers are responsible for planning their own development and managing their own funds.

Table 4: List of village organisational bodies in Samuha project villages. Akanksha and Kanakanala refer to different projects.

Institution	Description
Women's Self Help Groups	Self help groups are responsible for tree nursery projects as well as acting as village savings groups. Some villages have just one self help group, others have two or more. The quality of groups vary from village to village, but most have successfully increased the power of women in the villages by making them responsible for financial matters.
Woni (street) Gumpu (group)	Each household in a street select a female representative and these together form the Woni Gumpu. The Woni Gumpu operates as a credit and savings group, with each household donating a set amount of money every week. Group members can borrow money at a rate of 3% interest per month.
Grama (village) Samuha	All Woni Gumpu members in a village.
Grama (village) Samiti (committee)	Each Woni Gumpu elects one representative into the Grama Samiti. Each Grama Samiti thus represents one street or 5 to 15 households if the street has more than 15 households. The Grama Samiti makes decisions regarding funds (i.e. who can borrow how much).
Jana (people) Samuha	All farms in the village are represented by one male each in the Jana Samuha.
Jana (people) Samiti (committee)	Each group of 5 to 15 farmers selects one representative in the Jana Samiti. The Jana Samiti makes decisions regarding crops and farming.
Watershed Implementation Committee (WIC)	Elected members from the Grama and Jana Samitis. Numbers from each vary from village to village, but generally the ratio is about 3:8 (Grama:Jana Samiti).
Community Economic Asset Committee (CEAC)	Two elected members from each of the Grama and Jana Samitis. The CEAC is responsible for the collection of money from the villagers and using them for agricultural items.

Village Health Committee	Elected representatives from the Grama and the Jana Samitis (normally in the ratio of 9:2 Grama:Jana Samitis).
Village animators	Individuals selected by the Watershed Management Committee in Kanakanala villages. Duties include note-taking and reporting to Samuha on the meetings of the Grama and Jana Samitis.
Team leader and team secretary	Samuha staff in charge of Samuha activities in Akanksha project villages.
Village volunteers	Similar function to Village animators above, but for Akanksha villages.

Source: semi-structured interviews with Samuha staff.

Vulnerability context

Trends

The vulnerability context of aquaculture livelihood strategies in northern Karnataka is subject to trends. These include rapid population growth (about 2% p.a. in India) coupled with falling groundwater levels and decreasing availability of wild fish stocks. Access to farmer-managed water bodies is increasing because of the watershed development activities in the area, but there is a lack of recommendations for aquaculture in these water bodies and Indian extension efforts concentrate on semi-intensive and intensive options in perennial water bodies. People in the area have been excluded from the mainstream political processes but constitutional amendments in 1992 and 1996 provide a basis for elected village representatives (*Gram Panchayats*) and give additional powers to the combined assembly of all voters in a village including executive rights over natural resources. Village development falls under the formal leadership of elected Panchayat leaders whereas the settlement of disputes (marriages, religion and culture) come under the guidance of unelected traditional leadership. As outlined in the description of human capital, women have very few decision-making powers both in the community and the household. The already high vulnerability of women is likely increase in the future as dowry values continue to rise, and sex-ratios in the country show a falling trend as can be seen from Figure 5.

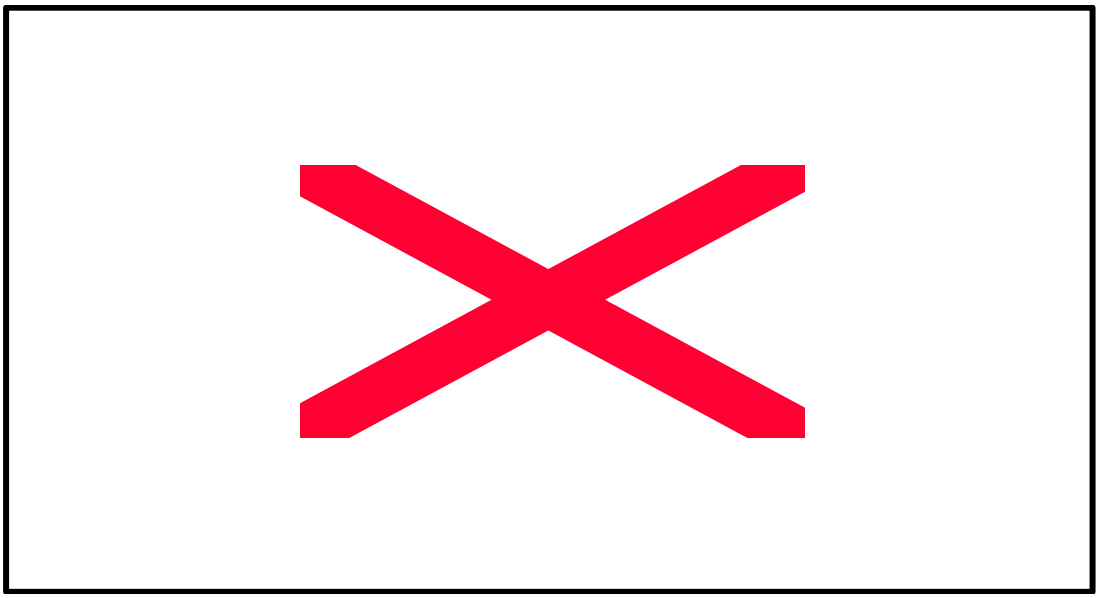

Figure5: Male and female literacy levels and sex-ratio of India from 1901-1991. Source: (India, 1991).

Shocks

Climate constitutes the major shock to livelihoods in the area, where prolonged dry spells during the crop-growing period results in occasional crop failure, with ensuing human and livestock health consequences.

Seasonality

The dominant south west monsoon is active from June through to September (kharif growing season) and the less intensive north west monsoon from October to December (rabi growing season). Most people in the area are farmers. Dryland farmers only have one crop a year, in the kharif season, but families with irrigation can obtain an additional crop in the rabi season. Farmers are busiest in the main harvest season (September – November), where, in addition to harvesting their own crops, most households have members migrating for work harvesting paddy in the irrigated regions of the State as well.

The major sources of income in the region are from crop and livestock sales and payment for work as agricultural labourers or migration work. Men typically get paid twice as much as women for agricultural work. The major expenditures are seed, fertilisers, pesticides and events such as treatment for illness or marriage. Most families borrow money once or twice a year from banks or local village lenders, and pay back loans after harvest.

During the dry summer months food availability decreases, and many families in the area only just manage to get three meals a day. During the rainy season waterborne diseases such as malaria are commonplace.

Transforming structures and processes

Currently in India there is little incentive or support for aquaculture initiatives appropriate to resource poor farmers. Research focuses on perennial water bodies and high-input systems, with the result that most of the *transforming structures* and *processes* acting in Karnataka result in aquaculture livelihood options, which are unavailable or unattractive to poor farmers (Appaji, 1991); (Sivasankar *et al.*, 1991); (Suresh and Selvaraj, 1991).

The key structures are national and local line agencies; the Departments of Fisheries (DoF); the Indian Council for Agriculture Research (ICAR) fisheries institutes; and a number of academic departments. The Department of Fisheries (DoF) has the responsibility for the auctioning of fishing leases for government owned water bodies, fish seed production, stocking of tanks and reservoirs, provision of extension services, and administration of subsidies of bank loans (together with implementing banks). The Fish Farmers' Development Agencies (FFDAs) under the Department of Fisheries (DoF) train farmers in, and provide financial assistance for, the standard techniques of composite semi-intensive carp culture recommended by research institutions such as the Central Institute for Freshwater Aquaculture (CIFA). Also part of the Department of Fisheries is the Karnataka Co-operative Inland Fisheries Federation (KCIFF), an organisation which attempts to improve the regional fisheries marketing infrastructure through the establishment of a cold chain. This includes cold storage facilities and transport and franchised refrigerated retail outlets. These outlets guarantee a fixed minimum price to both the consumer and the producer and could potentially offer a means for co-operative fishermen to break the traditional debt-bondage exploitation of monopolistic wholesalers.

Livelihood strategies and outcomes

Farming is the major livelihood strategy of the area. Most farmers own only unproductive dryland, but some have a small holding of irrigated land as well. Major sources of income are the selling of crops, vegetables and livestock, and poorer households also earn money working as agricultural labourers and / or migratory workers. Migration has a very negative impact on family life and most families would prefer to work closer to home if they could. Land is considered the most valuable asset but land accumulation rarely occurs, on the contrary land fragmentation continues to decrease landholdings. Assets accumulated at times of wealth is mainly livestock and jewellery, although a number of farmers are starting to invest in the construction of on-farm water bodies for irrigation, tubewells or pumps. Most households borrow money for farming inputs which are paid back at the end of the farming cycle. In low-income families both men, women and children work on the farm or as labourers, whereas in higher caste families women and children stay in the house.

Participatory situation analysis Karnataka outputs:
10 working papers presenting findings from a participatory situation analysis.
Project Summary Report

1. Raichur District: Site for a Study of Aquaculture Development in the Semi-arid Tropics
2. Methods for Participatory Information Gathering and Analysis
3. Socio-economic Analysis of Villages in Relation to Aquaculture Potential in Raichur District, Karnataka, India
4. Investigation of Gender Issues in Relation to Aquaculture Potential in Raichur District, Karnataka, India
5. On-farm Resources for Small-scale Farmer-managed Aquaculture in Raichur District, Karnataka, India
6. Inland Fisheries Resources and the Current Status of Aquaculture in Raichur District and Karnataka State, India
7. An Investigation of Aquaculture Potential in Small-scale Farmer-managed Irrigation Systems of Raichur District, Karnataka, India
8. Indigenous Freshwater Fish Resources of Karnataka State and their Potential for Aquaculture
9. Institutional Linkages of Relevance to Small-scale Aquaculture Development in Karnataka State, India
10. Fisheries Marketing, Demand and Credit in Raichur District, Karnataka, India

3.4 Participatory situation appraisal Sri Lanka

In Sri Lanka a three tier screening process was used to select areas for detailed field research. Secondary information (from Governmental and NGO sources) was used to define the first two tiers based on administrative boundaries, and subsequently field level investigation used to resolve to the final watershed defined unit of research. Collective community-based water and land management at the wider watershed level can lead to increased options for on-farm water management at the individual level (Pretty, 1995) (Barr, 1998). Hence the meso-watershed (containing hydrologically connected series of tanks draining to a common point) was justified as the fundamental unit of research. This resolution process is described below.

An agro-ecological zone covering some 75% of the countries lowland dry zone and nearly 50% of the total island area was identified as an area for primary research. The area is suitable for the project focus because of the:

- low and erratic water availability with heavy dependence on traditional rain-fed tank irrigation-based crop production.
- predominance of small-scale seasonal crop production and marked seasonalities in food availability, income and employment opportunities.
- high levels of rural poverty as evidenced by high and rising levels of chronic protein malnutrition.

Districts within North Central and North Western Provinces were selected for detailed screening (areas within conflict zones to the North and East were excluded, as were areas to the South for logistical reasons). Straddling North Central Province is the Mahaweli H irrigation system, part of the Mahaweli development programme (initiated in 1975 to relieve population pressure in the West). This is the project area selected for the linked large-scale engineering programme. It is envisaged that this proximity will facilitate investigation of potential synergies between communities managing large and small-scale irrigation systems. Secondary data including poverty indicators, water availability and potentially enabling institutional presence were over-laid to identify seven administrative areas for the final phase of screening. Within the targeted districts 14 cascading systems of small seasonal tanks were rapidly screened using site visits, mapping exercises and key informant interviews. Two of these systems (incorporating a total of 21 tanks and 9 villages) were the subject of detailed participatory livelihood analysis which also included comprehensive assessment of fish production, marketing systems and consumer preferences. This work was undertaken in collaboration with field staff the NGO's CARE and IFAD and the Government Samurdhi

Welfare programme in different villages. Summary results of this situation analysis are presented below within the sustainable livelihoods framework. Because of the physical and socio-economic complexity found in these systems, three further cascades systems identified in the screening process are the subject of an on-going longitudinal analysis (see section 4.4) in collaboration with staff of Peradeniya University and logistical support from the Mahaweli H authority.

Livelihood assets

The asset pentagon (section 3.1) shown in Figure 6 shows the relative access of marginal farmers in Puttalam and Kurunegala districts to livelihood capitals, based on the results of participatory situation analyses undertaken during December 1998. The deficit in social capital and the relatively high endowment in human capital compared to the Karnataka situation is immediately apparent. This is explained in the following sections.

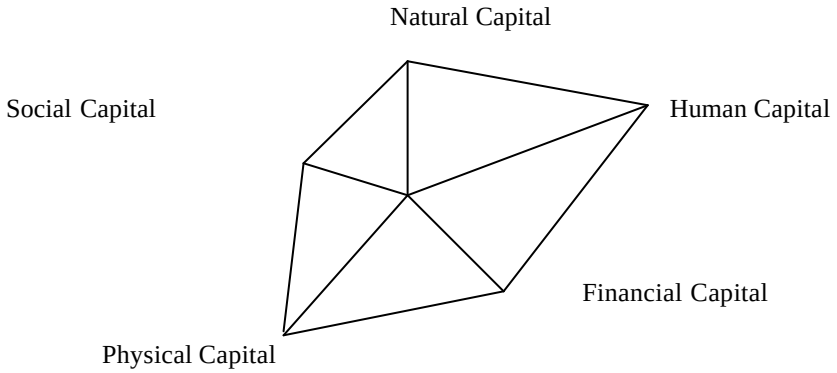

Figure 6: Asset analysis for Sri Lanka farmers.

Natural Capital

Life in villages of low-land Sri Lanka has traditionally revolved around ancient rain-fed village tanks, the heritage of an ancient hydraulic civilisation. Large-scale rehabilitation of these tanks has permitted extensive re-colonisation of the dry-zone over the last 60 years. An estimated 18,000 tanks are clustered into 3,500 to 4,000 small tank cascade systems with greatest concentrations in the selected project areas of the north west (NW) and north central? (NC) provinces. Slightly over half of these tanks are operational, 80% of which are 25ha or less. Seasonality is highly variable between tanks (ranging from 4-12months) and years and this is one of the major constraints to aquaculture. Seasonality, size and water retention tend to be lowest in upper catchment areas, which then become home to the most resource poor and impoverished communities. All but the smallest tanks (<5ha) are state owned and community managed. Primary use is for paddy irrigation (typically only supplementary irrigation is possible in upper catchment areas, with consequently lower yields). Secondary priorities for bathing, domestic and livestock purposes (but no human consumption) are unlikely to conflict with aquaculture. Although identified as having great aquaculture potential (De Silva, 1988), fisheries currently occupy a low priority for most farmers for a variety of bio-technical and socio-economic constraints (see section 5.1). As community managed resources they offer potential for the participation of the most disadvantaged groups in society, including landless, low caste, women and youth. Privately owned agro-wells which extract ground water for small-scale irrigation were also identified as having aquaculture potential.

Fig 7. Insert STC Schematic:

Farming activities in these rain-fed areas are limited to dry-land agriculture (typically 0-3 ac) and smaller irrigated areas (90% of plots are less than 1ac). The most marginal groups exhibit greatest dependency on often highly erosive dry-land cultivation. Tenurial systems of land

directly effect the right to use water. Many Paddy lands are still held under secure tenancies created under the Agrarian services act of 1958, which protected the rights of traditional sharecroppers (no such rights are extended to dry-land farmers). Reforms introduced in 1981 resulted in extensive alienation of formally leased state-owned lands, yet encroachment remains a widespread phenomenon particularly in upper watersheds where 7-11% of farmers in study villages were illegally settled or still in the process of settling their claims.

Assessments of nutrient flows indicate extremely high natural productivity in seasonal tanks (due to their shallow depth, intensive grazing on extensive draw-own areas and nutrient rich drainage inflows). Thus low-input / low-risk enhanced fisheries options, which rely only on seed inputs and low-cost environmental modifications are highly suitable options, especially where little indigenous knowledge of aquaculture exists (see section 4.3).

An estimated 70% of protein intake in Sri Lanka comes from fish consumption (NARA 1997). In the dry interior the rural poor prefer cheaper, locally available (and therefore fresh) inland fish, whereas more affluent urban populations prefer marine fish. An estimated 90% of inland fish production originates from capture fisheries in only 74 major perennial reservoirs (De Silva, 1991). Due to the institutional situation (see 'vulnerability context' below) no accurate up-to-date national production statistics are available, though it is suggested that production levels have still to recover to pre 1990 levels (estimated at 40,000 tonnes in 1989). Daily catch data collected for one major reservoir confirms the primacy of the exotic tilapia *O. mossambicus* in the fishery (averaging 95% of all landings by weight) and the loss of indigenous bio-diversity. It is also recognised that both inland and marine capture fisheries are reaching their maximal sustainable yield levels under current systems of management, whilst demand for fish is increasing (NARA, 1997). The importance of realising the hitherto un-exploited potential of fisheries in seasonal tanks is evident in this context and is also consistent with government policy outlined in it's current strategic fisheries development plan (MOFARD, 1995)

Human

With enviable education, primary health, gender equality indicators and middle human development status (UNDP, 1997), Sri Lanka is widely recognised as a welfare model. Yet government policies emphasising survival (resulting in spectacular reductions in infant mortality), belie a persisting state of malnutrition amongst much of the rural community. An estimated 20% of all children are born underweight (the fourth highest rate in the world - (UNDP, 1997), whilst stunting (an indicator of chronic, malnutrition) is estimated to effect 36% of pre-school children. Stunting levels are increasing once again after food based government welfare was recently replaced with income based relief (UNICEF 1997). The wide disparity between welfare (education and health) and economic development is cited as one of the main reasons for Sri Lanka recording the second highest suicide rate in the world in (UNDP, 1997). Highest levels are amongst 15-25 year olds who also experience the highest rates of unemployment. Women's status is generally superior to that of women in India, with men and women having comparable literacy (both >70% in study villages), nutrition and health levels. However women still face discrimination in local labour markets (receiving an average of £1.30/day or 2/3 of male pay for unskilled farm labour), land ownership and participation in institutional decision making. Social taboos restrict the range of agricultural and other activities women are able to participate in, yet they work longer hours than men (combining productive and reproductive tasks). Women are also increasingly becoming the victims of a rising trend of domestic abuse. Both men and women take an interest in politics, but women tend to follow their husbands lead in voting. The female-headed households encountered arose exclusively as a result of male bereavement. As males inherit most land, women are most likely to migrate from their home villages after marriage.

The decline of caste demarcations amongst the Singhalese population has undoubtedly improved the status of women (dowries are now rarely exchanged, especially amongst the

poorest groups). How ever inter-caste marriage is still extremely rare and in rural areas caste remains a potent indicator of social status. Low caste groups are likely to have the poorest literacy, housing standards and access to land and water resources. Although no taboo exists on part-time fishing activities within seasonal tanks, professional full-time fishing, processing and distribution is still regarded as the preserve of low caste groups. This can be viewed as a positive factor where it reduces the likelihood of elite's moving into livelihood opportunities associated with increased fish production.

Although many farmers were found to have a rich knowledge of fish species, habits and indigenous fishing techniques, a low input sustainable system of fisheries management, which brought benefits to the whole community, has eroded with the village institutions responsible for regulating them. No indigenous knowledge of aquaculture techniques existed and this was in part responsible for the failure of one tank stocking effort. Many farmers expressed great interest in participating in trials to gain such knowledge.

Social

The institutional capacity and consequently social cohesion of villages visited was generally weak. Community participation in village based institutions is low, with a general lack of co-ordination between groups addressing common issues. The only active and truly indigenous organisations are geared dealing with distress rather than bringing about social and economic development (e.g. death benefit groups). The effectiveness and activity of other organisations is dependent on levels of outside intervention. Farmers' organisations that are also responsible for the management of tank fisheries often met only a few times per year to co-ordinate irrigation calendars. Women's participation (in all but death benefit societies) was negligible. In this context, the family becomes the most important source of reliable mutual support, yet even this unit is threatened by high levels of female labour-migration (which have significantly outstripped male levels since the early 1990's) and increasing male alcoholism with negative impacts on child education and nutrition. More positively, poorer villages within upper catchment areas are likely to be the most recently settled and consequently demonstrated the strongest kinship.

Institutional strengthening and enhanced community participation are key objectives of the NGO's CARE and IFAD and the Government welfare programme Samurdhi, whose collaboration facilitated participatory information gathering in these villages. Potential exists for collaboration with these organisations for establishing farmer trials in the next phase of the research. Other linkages (most notably with NDF and the PRDP) continue to be explored in continuing longitudinal situation analysis. Details of these organisations can be found in Appendix 18.

Physical

In addition to their poor access to natural resources, communities located in remote upper-watershed areas are also most likely to have the worst physical infrastructure including access to surfaced roads, mains electricity, permanent housing, sanitation and adequate protected water supplies. The mobility of these communities is restricted during the rainy season, a factor compounded by a trend of reductions in holdings of draught animals (often the only means of negotiating flooded tracks). Public transport, although regular, is overcrowded and generally only available on surfaced roads. These factors compromise the access of the poorest groups to services (banks, health care, education, extension services and markets located in nearby towns). With the exception of a few village boutiques (grocery stores) and occasionally primary schools, few such services were present in study villages. However health care networks are well developed with regular visits by health workers to villages, and less than 10% of women now give birth at home (village midwife – pers. com). Weekly markets held in larger towns or at major road junctions are venues for the sale of cash crops (vegetables, fruits, spices) and dried fish by both small and large-scale vendors.

Financial

Over 70% of villagers interviewed were under the official government poverty line (household income less than Rs 1,500 or £13 per month) and were entitled to welfare benefits. Two schemes initiated by successive political regimes are operational (Janasaviya and Samurdhi). Correlation exists between political affiliation and the scheme under which payments are likely to be paid. Janasaviya recipients (initiated by the previous government) are ineligible for benefits under the current Samurdhi Programme and tend to receive lower payments. Families receiving remittances from family members who work abroad are also ineligible for welfare. Recipients are obliged to open accounts with state banks into which a small portion of their benefits are paid for a fixed period. Out-with these obligations, farmers take little advantage of formal savings and credit institutions, instead coping strategies, including borrowing, focus primarily on mutual support within kinship groups. Many poorer farmers rely on credit for food items from village boutiques and credit is also available from village moneylenders (15-20% per month interest). The main requirement for credit is for agricultural inputs during August to September. Traders often supply this credit for guarantees of sales at the point of harvest (when prices are lowest). The high interest associated with these informal credit systems ties many poor families into a circle of debt, but their flexibility and ease of access (i.e. low collateral requirements) ensure their continued use. Consistent with the weak institutional capacity in most villages, small savings and credit activities are few or reserved for distress payments. Village level Samurdhi animators (who are active in all villages) are responsible for the establishment of small credit and savings groups with 5-6 members. Although livestock holdings are generally low, amongst poorer groups they are held primarily as a liquid savings asset which can be readily converted to cash particularly during drought seasons.

Vulnerability context

Trends

Although population growth is currently relatively stable (around 1% p.a.) Sri Lanka is already the 21st most densely populated country in the world (UNDP, 1997). This has resulted in a number of trends, which are increasing the vulnerability of livelihoods in the lowland dry zone of Sri Lanka. Widespread land fragmentation and the associated difficulties in collective water management have negative impacts on production, particularly under seasonal tanks. An unregulated proliferation of private agro-well construction (following removal of import restrictions and increased availability of diesel pumps) has resulted in a dramatic reduction of the ground water table in many areas and availability of water in community tanks. Forest cover has decreased from 74% to 22% of total land area over the last 50 years (De Alwis 1981) and within study villages encroachment of forested catchment areas above tanks has accelerated rates of tank siltation whilst reducing inputs of useful organic materials. Over the last 20 years 95% of farmers have switched to modern high yielding / high input varieties of rice, leading to losses in indigenous bio-diversity and farmer dependency on expensive pesticide and inorganic fertilisers in place of on-farm organic additions and IPM techniques. Farmers report profits now beginning to fall of as soils become exhausted.

In 1958 all but the very smallest tanks were taken into state ownership bringing an end to a tradition of community ownership, and maintenance (only operation continued to be communally managed). From the early 1970s the government began to engage in large-scale tank rehabilitation under a series of bilateral development programmes. At the same time it began to adopt policies aimed at revitalising full community participation in operation and maintenance, realising it lacked the ability to generate sufficient resources to effectively maintain an increasing stock of operational tanks. Despite significant physical impacts less was achieved in the way of farmer mobilisation until more participatory styles of intervention were adopted. Later programmes have realised the importance of diversifying production options away from increased paddy production alone and the need for inclusion of farmers with no access to irrigated land. More recently many development organisations have begun

to recognise the potential of integrated aquaculture options to generate the financial capital required by community based organisations to offset the increasing costs of tank management and decreases in agricultural productivity.

Prior to 1977, farmers benefited from assured markets and high production subsidies under a centrally planned economy, which stressed self-sufficiency in food production. These benefits along with protectionist exchange controls and import quota restrictions were gradually abolished as part of a liberalisation process, which aimed to encourage greater market orientation and efficiencies amongst producers. Although these policies have resulted in sustained growth in GDP, the majority of poor farmers with small production surpluses have little access to these new markets. Instead production is orientated towards increasing household food security (eschewing cultivation of potentially more lucrative and less water consumptive cash crops). A new sector of middlemen has emerged and a minority of wealthy farmers continues to amass and control the bulk of means production and exchange in the rural sector.

In 1995 nine Provincial Councils were created resulting in extensive devolution of decision-making powers to provincial and district level, including dispersion of development budgets.

Shocks

The severest and most recurrent shocks are caused by the increasingly erratic nature of seasonal rainfall patterns. Over the last two 30-year normal periods flood and drought events have increased in frequency and mean annual rainfall levels have fallen by 12.5% (GOSL meteorological office). This has resulted in a reduction of cultivation effort during the more vulnerable secondary growing season and consequently greater retention of stored water during this time than in the past. Widespread encroachment of forestlands has brought increased conflict with marauding wild animals. Associated crop (and occasionally life) losses have forced widespread abandonment of upland plots in the remoter villages. Both these shocks impact heavily on the most marginal resource poor farmers.

Sri Lanka is in the 16th year of an ethnic conflict between minority Tamil and Singhalese Buddhist populations. Although the war is a major drain on the country's economy, many families in the predominantly Singhalese project areas now rely on remittances from family members employed in the armed services or security positions. Within the Singhalese community two violent youth insurrections have resulted in even greater loss of life than the long running ethnic conflict. Many of the female-headed households encountered in the situation analysis are a consequence of these insurrections.

Although superficially displaying a successful democratic tradition with seven changes of government since independence, the system of patronage and highly communal nature of party politics here is one of the main causes of conflict in the country, especially during election periods. This divisiveness reduces the potential for collective community action, increases dependency on government intervention and leads to short-termism in development planning.

Seasonality

The research area receives a mean 1230mm (1961-1990) rainfall per year unevenly distributed over two growing seasons (60-70% falling during the major season). Consequently livelihoods here are characterised by a predominance of small-scale seasonal crop production, subject to marked seasonalities in food availability, prices, income, employment opportunities, credit requirements and health (through water borne diseases and seasonal food deficits. Overlap in these factors results in periods of greatest vulnerability occurring from July to September. Suitable aquaculture options incorporate staggered harvesting and processing components to overcome price depression associated with seasonal gluts.

Transforming structures and processes

These are the institutions, organisations, policies and legislation that shape livelihoods, and are most intimately linked with the formation of social capital. As no indigenous tradition of aquaculture exists in Sri Lanka, initiation of suitable transforming structures and processes to facilitate adoption are critical. In the 1980's trials undertaken as components of two strategic inland fisheries development plans, demonstrated good production potential in seasonal tanks (though for various reasons resulted in little community adoption). Between 1989-1994 a catastrophic politically motivated withdrawal of all state patronage for the inland fisheries sector, led to an almost complete loss of trained (extension, monitoring and regulatory) personnel, institutional memory and seed production capacity for food fish. Little has been achieved to reverse these losses which continue to handicap current development efforts (today most fisheries effectively remain open access with resulting problems of over-exploitation). Limited training facilities exist at the two remaining government seed production facilities, and two universities offer postgraduate courses in fisheries management and aquaculture. Current MOFARD policy for developing seasonal tanks focuses on community based common carp and tilapia fingerling production programmes in collaboration with NGO's. As no private sector seed market currently exists, the plan incorporates a seed supply and buy-back scheme to be phased out when the envisaged markets develop. Collaborating NGO's (programmes mostly in the planning stage) include GTZ, Sewa Lanka, SLCDF, the Small Fisheries Federation and the PRDP. In the NW Province a government agency, the Wayamba Development Authority, is implementing a similar programme. Watching briefs have been established with these institutions who participated in the regional workshop (see section 4.1). Few aquaculture recommendations currently exist to support these programmes. Research on intensive cage culture options and rice fish options are currently being undertaken by NARA, however these options have little relevance to seasonal tank producers.

Livelihood strategies and outcomes

Livelihood strategies are intimately connected with the beneficial livelihood outcomes that individuals or groups seek. Within study villages almost 70% of villagers derive their primary source of household income from farming activities. Dryland crops are grown under a traditional pattern of 'slash and burn' (highly erosive) shifting or fixed highland cultivation, whilst vegetables and other cash crops are also grown in smaller home-gardens. The primacy of irrigated paddy has decreased as a consequence of increasing land fragmentation and reduced water availability. Similarly livestock holdings have decreased with reducing availability of pasture and increased farm mechanisation. Wealthier farmers with access to ground water resources and storage facilities can produce cash crops for niche markets avoiding seasonal gluts. Most asset poor farmers with small seasonal surpluses and poor access to emerging free markets still adhere to traditional production orientated strategies emphasising household food security. Most families supplement house-hold income through seasonal labour migration or remittances from family members engaged in formal employment. Illegal leasehold or sharecropping arrangements with farmer under major irrigation systems are common. Poorer farmers are likely to be tied into a debt cycle where the future price of their crops is fixed by traders who supply them with agricultural inputs and have little opportunity to realise fair prices for their produce. Although agriculture still provides the base for local food security many farmers express a desire to move away from increasingly marginal and high-risk farming activities to the security of waged labour. Few such opportunities exist locally, resulting in rising levels of long-term migration particularly by women who are moving into a burgeoning textile sector in urban free trade zones or overseas employment as housemaids. High levels of unemployment amongst well-educated youth (who record the highest suicide levels) is recognised as a critical problem and this group has rightly become a focus for development efforts. A populist government rural re-construction programme pursued earlier in the decade has fuelled a home building trend whereby many farmers invest any profits or savings they accrue into stockpiling materials for

construction of permanent housing rather than increasing or sustaining agricultural production.

Aquaculture production in seasonal tanks has the potential to yield more fish than the consumption requirements of producer households necessitating a thorough investigation of market opportunities. The bulk of locally produced fresh fish is distributed by an extensive network of two-wheeler vendors who take fish to sell in villages or at road junctions. Because of these extensive local markets, unlike the market for seasonally harvested agricultural produce (much of which is exported to urban areas), exploitative wholesale transactions with middle-men are the exception. Although individual profits are low they are equitably distributed to consumers, vendors and producers alike[8]. Such livelihood strategies are most likely to be adopted by the poorest landless or marginal farmers. Although women are excluded from fresh fish sales, they participate in processing activities (drying and curing) and the small-scale turnover of dried fish (and cash crops) in weekly markets. Men and women's participation in these activities is confined mostly to the dry seasons, when on-farm labour requirements, labour migration opportunities are lowest and fish production levels from perennial reservoirs are highest. This potential also coincides with the periods of greatest food insecurity.

Preliminary research hypotheses investigating aquaculture strategies compatible with these livelihood strategies and outcomes are detailed in section 4.3. Although not explicitly identified as an outcome by farmers, these strategies are also compatible with more sustainable use of the natural resource base Further characterisation of livelihood outcome indicators will be elicited during the longitudinal situation analysis and farmer meetings later in the year.

Outputs situation analysis Sri Lanka

1. Puttalam and Kurunegala Districts; Site for study of aquaculture development in the lowland dry-zone of Sri Lanka and methodology for participatory information and analysis.
2. Inland fisheries resources and the current status of aquaculture in Sri Lanka, Puttalam and Kurunegala districts.
3. Fisheries marketing systems and consumer preferences in Puttalam and Kurunegala Districts of Sri Lanka.
4. The nature of small-scale farmer managed water resources in Sri Lanka, Puttalam and Kurunegala Districts.
5. An investigation of on-farm resources with relevance to aquaculture in farmer managed irrigation systems of Puttalam and Kurunegala
6. Districts.Socio-economic analysis of villages within cascading tank systems of Puttalam and Kurunegala districts.

4 Stage 3

4.1 Stakeholder workshops

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

[8] This is in contrast to the situation found in Raichur District (India). With poor knowledge and access to consumer markets producers often unwittingly operate under exploitative tied credit relationships, where monopolistic wholesalers export the bulk of production to distant urban markets.

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 planning any 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 combine 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.

India

A combined Stakeholder Workshop for the 'Aquaculture in Small-Scale Farmer-Managed Irrigation Water Bodies' and the linked large-scale irrigation project was held in Coimbatore, Tamil Nadu on the 19th and 20th of November 1998. A total of 35 participants represented government development and research organisations, university agricultural, fisheries and irrigation research, NGOs, farmers and fishermen's co-operatives. Participants came from the UK, Tamil Nadu and Karnataka. Full proceedings are reported in a separate working paper.

The workshop began with a series of presentations based on available secondary data to provide context for the following discussions. Commissioned by six of the participating institutions, the presentations reported on the nature of the inland water resource including major and small-scale irrigation systems, the current status of aquaculture in Karnataka and Tamil Nadu, and an economic analysis of aquaculture. Production from inland fisheries over recent years was reported to have stagnated in both states. The bulk of existing production depends on enhancing capture fisheries for Indian major and exotic common carps in reservoirs, rivers and seasonal village tanks through government sponsored stocking programmes. Karnataka State is an area of high natural bio-diversity. However in both states, catches of indigenous species have declined dramatically due to over-exploitation and increased environmental pressure. This includes negative impacts of large-scale water resource development on natural fisheries. Subsequent papers identified hitherto unexploited opportunities for low input, poverty-focused aquaculture options in small, seasonal water-bodies and niche environments within the command areas of large-scale irrigation systems. Existing policy on the management of large-scale systems was perceived to be focused predominantly on irrigation and hydro-power.

The stakeholder analysis was based on three sessions.

Session 1: Participants were grouped into small stakeholder groups, including government development organisations, NGOs and farmers' representatives, government fishery staff, university irrigation, agricultural and fisheries research. 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 response from all participants was positive. The main constraints to their participation in the project were seen as a shortage of time and other resources.

Session 2: Participants were divided into four heterogeneous groups and were asked to consider potential issues of conflict and how best to address the poverty focus. Two main

issues identified were lack a multiple-use management approach in large-scale irrigation systems and the lack of a poverty focus in research. The need for research into integration of irrigation and fish production was agreed and the current lack of suitable management and technology recommendations was noted. Finally the role of the project in improving dissemination of information and improving co-ordination and collaboration was suggested.

Session 3: Formulation of research agenda. Participants were divided into four heterogeneous groups and asked to consider where knowledge gaps existed for aquaculture in large-scale and small-scale systems and generally. Most of the outputs generated were common to large and small-scale systems. Representatives of the DoF, ICAR institutes and an NGO with watershed management experience focused on farmer-managed irrigation systems.

Freshwater fish production in Karnataka is currently reported to be approximately 90,000 thousand tonnes annually, or one third of the estimated capacity of the State water resource base (Kumaraiah, 1998). Poor and mismatched seasonal seed availability continues to be a major constraint. State sponsored development interventions have focused on encouraging private sector seed production, the establishment of an intensive pond aquaculture sector and formation and strengthening of co-operative fishermen's organisations within the established capture fishery sector. Projected internal rates of return, which did not accurately reflect the risks involved in intensive aquaculture ventures, were reported to have weakened investment enthusiasm in the private sector over recent years and growth has been slow. There is a need for research into sustainable strategies for the further development of freshwater resources and fisheries aimed at poorer people.

Farmer-managed irrigation systems: It was agreed that although small-scale water bodies are highly accessible to the poor, no policy initiatives or recommendations currently exist for integrating aquaculture into such resources. Participants generated a list of different types of small water-bodies with having potential for aquaculture. The results were ranked for research importance (Table ??) and their relative abundance in Karnataka State (Table ??). Perceived as being most abundant were; surface ponds, farm irrigation tanks and check dams. Results of research ranking were more equivocal. Farm irrigation tanks and mini tanks achieved markedly lower rankings than the other water-bodies.

Table 2. Small-scale water-body types ranked by research importance.

Participant	A	B	C	D	E	F	G	H	I	Mean rank
Farm pond	4	3	2	7	4	3	7	7	7	4.8
Farm irrigation tank	2	5	1	2	3	2	2	2	2	2.3
Open well	3	1	5	6	6	1	6	6	6	4.4
Surface pond	5	6		5	1	6	5	5	5	4.5
Check dam	6	2	4	3	7	5	4	3	3	4.1
Nala bund	7	4	6	4	5	7	3	4	4	4.9
Mini tank	1	7	3	1	2	4	1	1	1	2.3

A-I = Different respondents. 7 = most important, 1 = least important

Table 3. Small-scale water-body types ranked relative abundance within Karnataka State.

Participant	A	B	C	D	E	F	G	H	I	Mean rank
Farm pond	5	2	3	4	6	4		3.5	4	3.6
Farm irrigation tank	7	6	7	3	2	3	3	3.5	3	4.2
Open well	2	1	1	1	7	1	1	1	6	2.3
Surface pond	6	7	4	5	1	6			5	5
Check dam	3	3	5	6	5	5			3	3
Nala bund	4	4	6	7	4	6			4	4
Mini tank	1	5	2	2	3	2	2	2	1	2.2

Aquaculture technology: Issues of poor seed availability and species choice were raised. Common carp was suggested as the species with greatest potential in terms of seed

availability, tolerance of a wide range of water quality and good feeding and growth characteristics. Tilapia was considered to have similarly good characteristics and also good potential for in-situ breeding, but doubts were raised over the legal status of introductions within Karnataka. Although occupying a strategic feeding niche, grass carp was considered to be less tolerant of poor water quality. Stunted Indian Major carps were considered to be widely available and have good potential for stocking the most seasonal water-bodies. Several indigenous carp species; *Labio fimbriatus, L. calabasu, and Puntius pulchellus* were considered worthy of investigation, but are relatively slow growing compared to major and exotic carps.

Outputs of stakeholder workshop - Coimbatore Nov 98.

1. Position papers (based on secondary data sets):
   - The Nature and distribution of Major Irrigation systems in Tamil Nadu and their potential for aquaculture.
   - The Nature and distribution of small-scale farmer managed irrigation systems in Karnataka and their potential for aquaculture.
   - Participatory Technology Development: Perspectives from an NGO
   - The Present status of aquaculture in Peninsular India
2. Notes on Stakeholder analysis sessions
3. Notes on Research agenda formulation with NARS.

The Farmer Workshop for the 'Aquaculture in Small-Scale Farmer-Managed Irrigation Systems' project was held in a local village in Koppal, Karnataka, 20-21 April 1999. Participants included IoA staff, Samuha staff, farmers from Samuha villages (most of whom had participated in the situation analysis) and representatives and farmers from the NGO Dhan Foundation in Tamil Nadu.

The workshop had four components: the feedback of situation analysis results to farmers, the sharing of information about aquaculture between IoA staff and farmers, the identification of key constraints to aquaculture for the different water bodies and the formulation of a research agenda.

Session one: feedback from participatory situation analysis. The key findings from the participatory situation analysis were fed back to farmers.

Session two: information sharing. Prior to the workshop (March 1999) general aquaculture guidelines were produced and distributed to Samuha and the Dhan Foundation, and in April teaching sessions were held to further acquaint Samuha staff with these. On the first day of the workshop these 'aquaculture basics' were presented to farmers, after which farmers with experience of fish farming or fisheries shared their knowledge with the rest of the forum.

Session three: identification of key research topics. Farmers were divided into water body specific stakeholder groups (farm ponds, open wells, check dams and tanks) and asked the following questions:

- what would you need to try aquaculture?
- how do you think it could be done?
- what do you think the positive impacts of aquaculture may be?
- what do you think the negative impacts of aquaculture may be?

The needs were broadly categorised into human (knowledge), social (group formation, institutional support from Samuha) and financial (assistance to obtain fish seed) capitals. Section 4.2 shows this classification. From the identification of farmer priorities, combined with the research interests of Samuha and the IoA, the research agenda was loosely formulated. Farmer identified research topics can be seen in Appendix?.

Session four: identification of farmers interested in participating in research. After the research priorities had been formulated, farmers who were interested in a visit from the project team (IoA and Samuha staff) were identified, and a visit schedule was planned.

Unfortunately not all farmers who participated in the situation analysis could be present at the workshop, and it proved especially difficult to ensure the attendance of women, mainly because of the overnight stay involved. The participation of the women present was limited, mainly because they were inadequately facilitated.

The workshop was documented on video by the Stirling video team.

Sri Lanka

The 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 Department of Peradeniya University and aimed to canvass opinion on aquaculture options in both large and small-scale irrigation systems. Proceedings of the workshop are reported in a separate working paper.

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 recent institutional history of government support for the fisheries sector (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 (papers 3 and 4). The socio-economic and gender issue paper stimulated lively discussion especially regarding the importance of poverty and gender. The subsequent stakeholder analysis was based on three sessions.

Session 1: Participants were grouped into seven small groups; donors, government development organisations, NGOs, government research organisations, university irrigation research, university agricultural/fisheries, and one female group. 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 (Appendix?). 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 a 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 developing 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 ??). 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, cages in water bodies and 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. The question of whether, if fish seed were available at the right size and time, they would lead to measurable impacts on production given the importance of self-breeding and recruiting of exotic tilapias. In turn it was unclear if these benefits would 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.

Outputs of stakeholder workshop - Kandy Nov 98.

1. Position papers (based on secondary data sets):
   - The nature and distribution of major irrigation systems in Sri Lanka and their potential for aquaculture.
   - The nature and distribution of small-scale farmer managed irrigation systems in Sri Lanka and their potential for aquaculture.
   - The present status of inland fisheries in Sri Lanka
   - Socio-economic and gender issues in Sri Lanka and their relevance to aquaculture development.
   - Production of aquatic organisms in large and small scale irrigation systems.
3. Notes on stakeholder analysis sessions
4. Notes on research agenda formulation with NARS.

4.2 Key researchable constraints

The major constraints to aquaculture as identified in the farmer workshop in Karnataka were categorised under the different types of capital assets. These can be found in Table? Work in Sri Lanka is in a less advanced phase. Constraints to aquaculture in seasonal tanks cascades of Sri Lanka as identified during the participatory situation analyses are listed in table ??.

India

Table 4: Farmer-identified needs for aquaculture categorised into capital assets in the sustainable livelihoods framework. Outputs from the Farmer Workshop for 'Aquaculture in Small-Scale Irrigation Systems' in Koppal Karnataka, 20-21 April 1999.

Capital assets	Aquaculture needs
Social	Formation of groups for using common water bodies, buying seed and do marketing activities. Field visits to farmers already doing fish farming.
Human	Knowledge about aquaculture practices, specifically: suitable species, feeds & fertilisers, stocking & harvesting practices, how to obtain seed.
Financial	Credit for the purchase of seed and cage / hapa materials if needed.

Sri Lanka

Table 5: Summary of constraints to uptake of culture based fisheries in STC's, categorised into capital asset types based on participatory situation analysis in Puttalam and Kurunegale districts Dec 1998.

Constraint	Research Options:
Natural capital	
Smallest seasonal tanks often owned by religious estates or privately owned.	Site specific constraint. Investigate attitude of religious authorities and different tenure potentials (leasehold, kinship linkages, sharecropping).
High turbidity during rainy season reduces productivity, fingerling growth and survival and flooding brings risk of escape and ingress of predators.	• Construct low diversion bund around tank to redirect surplus inflows. • Strategic use of lime to enhance solids settlement.
High predation pressure from rich indigenous fauna, especially the snakehead (Ophiocephalus striatus) can dramatically reduce fingerling survival.	• Undertake fingerling production to predator resistant size in smallest seasonal tanks (which can easily be cleared of predators during the dry season). • Install screens on spillways to prevent upstream migration during rains. • Mechanical protection from avian predators (i.e. lines across tank)
Encroachment of aquatic macrophytes (Salvenia and Hyrdilla) reduces tank productivity and impedes harvest (especially in shallow, semi-seasonal tanks).	Physical clearance or biological control (potential for using fish species).
Over-application of pesticides and reduced dilution effects in seasonal tank cascade systems leads to chronic toxicity problems in lower tanks (or where tank bed cultivation is practised).	Focus of research project undertaken by Graham Taylor (IoA) March/April 1999.
Human capital	
Lack of indigenous knowledge of aquaculture practices.	Produce recommendations on choice of species, seed procurement, stocking and management options.
Religious attitudes may restrict participation and predator eradication (i.e. where air breathers survive in residual muddy areas).	Non researchable (such attitudes are less entrenched with younger farmers)
Social capital	
Lack of social cohesion required for community participation in aquaculture options in shared water resources.	Formation of fisheries groups within existing institutions for purpose of seed procurement, production, processing and marketing activities.
Conflict with primary usage of water for	Conflict resolution through integration of fisheries groups

irrigation (i.e. where farmers pump out dead storage for emergency irrigation).	within existing water user groups (farmers organisations). Selection of tanks based on cost benefit and risk analyses.
Poaching (threat especially great in smaller isolated tanks)	Potential for community policing as component of group activities.
Financial Capital	
Lack of group micro-credit or savings activity.	Potential for such activity within fisheries groups.
Potential for marketing gluts and reduced profitability during driest months.	Investigate potential for staggered production programmes. Investigate potential for value addition and enhanced storage (i.e. smoking and curing options).

4.3 Identification of farmer researchers & research hypotheses

India

Following a post-workshop meeting with Samuha staff and a two-day exposure field visit by IoA staff, the research focus was determined. It was agreed that research activities should be limited to about 35 farmers representing four different types of water body (farm pond, check dam, farm irrigation tank, open well) in Lingsgur, Deodurg and Kustagi taluks[9]. Because the Department of Fisheries already stocks major and medium tanks, it was decided to leave these out of the research. It was also agreed during the workshop that all farmers expressing an interest would be provided seed on credit if they so wished. Visits were subsequently made to individual farmers to confirm their interest and their potential to participate (based on an assessment of water availability and other constraints). Where possible simple physical modifications, which should be completed prior to stocking, were recommended (i.e. to reduce the likelihood of flooding or drying, silt loads, well collapse, removal of toxic plants etc). Stocking recommendations (species[10] and numbers) were also produced for each farmer. Short listed farmers were invited to attend a second one day workshop (1/6/99) where feedback on the site visits were presented to farmers, information on basic aquaculture options were again reviewed and further farmer derived indicators for assessing aquaculture impact were elicited. For logistical reasons participants in the monitored trial were finally restricted to five village clusters. The location of these sites are shown in Appendix ?? (also shown are the location of the four villages participating in the preliminary situation analysis).

Table 6 Shows a summary of participant numbers to be included in the monitored trial. For OW's, FP's, and FIT's numbers refer to individual farmers and to groups of 3-5 farmers in the case of CD's. Included are three 'Pampanagar' women's groups each with five members (no women with individual access to water resources were recruited). One of the check dams listed (Towegera Campus) will be managed by staff of the NGO Samuha. This represents a provisional total of thirty three water bodies in the monitored trial and a total of forty nine participating farmers. With the exception of on Lingayet farmer all participants belong to non-vegeterian ST, SC or OBC groups. The results of other farmers out-with the monitored trials will be briefly assessed at the end of the project.

[9] Taluk: sub-administrative region

[10] Stunted (1yr old) rohu and mrigal and advanced common carp fingerlings are seed options available from local government and private hatcheries during the pre-monsoon season. Samuaha staff have been instructed in transport and maintenance techniques and the first fish have been moved to two designated distribution points ready to supply to farmers.

Table 6: Summary of participants in monitored farmer trials categorised by water body type and village (Individuals or groups attending farmer workshop 1/6/99).

	Mallapur	Janmardi	Mdgouda/Pilligunde	Pai Doddi	Towegera / Nandapur
OW	5	4	1	4	1 (Towegera Campus)
FP	1	1	0	3	0
CD	0	1	0	2	5 (inc. 3 PNS groups)
FIT	0	0	5	0	0
Total	*6*	*6*	*6*	*9*	*6*

Note: OW = Open Well, FP = Farm Pond, CD = Check Dam, FIT = Farm Irrigation Pond.
PWDS = Pampanagar Women's Development Society (these are rehabilitated members of a the Devadasi caste, formerly temple prostitutes).

Farmers participating in the workshop formulated a number of research interests for each water body. These are shown in Table 7 below.

Table 7: Research topics identified by farmers at the April Karnataka workshop.

Group	**Potential research suggested by farmers**
Check Dam	Group formation for aquaculture (small groups of farmers with land close to CDs or women groups with access to check dam). Extensive fish culture for 6 months. Semi-intensive fish culture in (inputs: organic fertiliser and terrestrial vegetation).
Open Well groups	Experiment with aquaculture in brackish open wells. Semi-extensive fish culture for at least 6 months (input: rice and sorghum when fish are small, leaves, manure and ricebran when fish grow bigger). Extensive fish culture in wells. Investigations on how to protect fish against frogs and snakes. Deepening of wells to increase the time of water availability.
Farm Irrigation Tank	On farms where open well is used for drinking water, construction of farm irrigation tank supplied by tubewell for aquaculture. Use of land near farm irrigation tanks to grow inexpensive fodder for fish.
Farm Pond	Experimentation with different types of feed. Experimentation with different stocking densities. Experimentation with use of nets to screen pump intake to avoid fish being pumped out. Investigations of fish tolerance to high turbidity during rainy season. Investigation into the feasibility of growing fish in only 3-4 months in very seasonal ponds.
Tank	Group formation of interested farmers / landless, renting access to tank from village or government. Experimentation with the use of hapas in tank. Experimentation with different means of protecting against theft. Semi-intensive fish culture in small tanks (inputs: organic and inorganic fertiliser and terrestrial vegetation).

Because of the great variation in functions and uses of the different water bodies as well as within each water body category, a loose research framework was thought most suitable.

The framework is *exploratory*[11] and the main objective of the trials is to identify aquaculture livelihood options, which are available and attractive to marginal farmers. The project aims to devise and then test *livelihood strategies* (based on a mixture of local traditional knowledge and contemporary scientific knowledge) against *livelihood outcomes* using farmer and scientist derived indicator categories like more income, increased well-being, reduced vulnerability, improved food security and more sustainable use of the NR base. By using a

[11] See e.g. Lightfoot, C. (1987). Indigenous Research and On-farm Trials. *Agric. Admin. & Extension* **24**, 79-89., Gosling, L., and Edwards, M. (1995). "Toolkits: A practical guide to assessment, monitoring, review and evaluation," Save the Children, London, UK.) and Lawrence, A., Haylor, G., Barahona, C., and Meusch, E. (1997). Participatory indicators for farming systems change: matrices for learning in farmer-managed trials in Bolivia and Laos. *In* "International Workshop on Participatory Monitoring and Evaluation", pp. 18. AERDD Agricultural Extension and Rural Development Department,IRR, Philippines..

participatory approach the project aims to devise livelihood strategies which can influence transforming structures and processes in favour of poor people. In the trials, the approaches and strategies used by the farmers are investigated, as are the indicators by which farmers measure their success. This research approach has been used with success in Laos (DFID project R6380CB).

Knowledge about specific aquaculture options for the different water bodies and credit for seed is made available to participating farmers. The monitoring scheme is designed to enable the detailed follow-up of the approaches taken by each individual farmer and the evaluation of the relative success of each venture as measured by indicators identified by the farmers, Samuha and the IoA.

The research will provide

- Indirect support to financial capital via the development of a farmer informal association. Because of the uncertainty associated with experiments, any risks associated with the aquaculture trials must be underwritten by the project. Samuha will therefore facilitate the establishment of a farmer informal association, of which all groups and individuals participating in the research will be members. The money required for the purchase of seed will be provided to the association, and the lending out of these funds to individuals or groups managed by farmers themselves.
- Direct support to human capital by the training in aquaculture.
- Indirect support to social capital via the formation of informal association (horizontal network) for the management of loans to farmers for purchase of seed.

Research questions addressed by the trials are as follows:

- Can increasing the versatility of the water resource use help reducing the vulnerability of groups and individuals, by cushioning users against shocks. An attempt to identify suitable indicators to measure this impact is part of the current baseline survey in India.
- Is it better to use large fingerlings to stock the ponds? This could involve some farmers stocking large fingerlings and adding the inputs they can, and others stocking small fingerlings and adding what they can. Tested by analysing the cost of the two different treatments (large fingerlings cost more but larger fish would sell for more, they may also show better survival), measure farmer satisfaction (would he/she do it again if he did not receive support for inputs?) etc.
- Which of the four water bodies (farm ponds, open wells, check dams, farm irrigation tanks) are most suited for fish culture in the project area? Tested by comparisons of fish yield, return on farmer investment and farmer satisfaction (measured by quantification of farmer indicators as well as in-depth interviews) for different water bodies.
- Can aquaculture in community owned check dams provide a sustainable livelihood option for marginalised women's groups (subgroups of the Pampanagar Women's Development Society (PWDS) in the project area? Tested by economic analysis of trials and monitoring of participant indicators of success as well as comparison of livelihood strategies before and after aquaculture.

The water body specific aquaculture guidelines can be found in Appendix 4. These were intended to constitute a working document for Samuha and IoA staff into which further knowledge and recommendations can be included once farmers and researchers learn more about possible options for aquaculture in these systems.

Sri Lanka

The following researchable hypotheses are based on results of the participatory situation analysis undertaken in December 1998 together with knowledge gaps identified from a literature review. Hypotheses are presented after brief statement of relevant background knowledge.

In Sri Lanka, the following conditions commonly found around seasonal tanks:

- There is a traditional subsistence fishery, but no indigenous tradition of aquaculture.
- Regular disruption of natural fish recruitment occurs, necessitating periodic restocking.
- High yields are possible from culture based enhanced fisheries in seasonal tanks, with no requirement for additional fertilisers or supplementary feeds. Early trials using polycultures of tilapias, and exotic carps yielded 120kg to 2.3t/ha (mean 820kg/ha) in a single growing season (Chakrabarty 1983). This compares to mean production levels of 256kg in perennial tanks (De Silva et al 1991).
- Highly erratic water availability and high predation pressure were attributed as the main causes of the wide yield fluctuations observed in early trials.
- Limited technical, extension, private and public seed production capacity in Sri Lanka continues to be major constraints to uptake of culture based fisheries in seasonal tanks.
- Conventional hatchery based restocking programmes (devolved to community level) continue to be the favoured approach of development institutions in Sri Lanka. Although such programs can work technically, they have not been shown to work sustainably, and the impacts of poor local people have not been demonstrated.

In this context, greater emphasis should be placed on the lowest cost/risk enhancement systems, which aim to increase or sustain existing production levels in the face of increasing environmental pressure. Stock enhancement requires a cost-effective means for mass production of young fish. Ideally suited to this role are naturally recruiting and locally available tilapia species. Tilapias have the ability to grow rapidly in short seasonal growing periods and are tolerant of extreme water quality fluctuations common in seasonal tanks. A simple method of ensuring adequate seed, is to stock breeding tilapia and ensure that predation pressure early in the season is low (i.e. using tanks that dry out and consequently where densities of predatory fish such as snakehead are low). Subsequently, fingerlings of a suitable size can be used to stock less seasonal tanks where predation will be concentrated on their off-spring (this will also enhance the by catch of higher value predatory species especially the snakehead *Channa Striatus*). Previous studies have demonstrated that greater natural productivity is associated with decreasing surface area (Amarasinghe 1998). Thus accelerated growth could be achieved by the selection of the smallest tanks for advanced fingerling production. Communities in the mid to upper watershed may have access to both small and intermediate sized tanks suitable for in situ fingerling production and on-growing respectively. The following research hypotheses are consistent with these observations[12].

- (I) Frequently shared access to water resources, kinship linkages and institutional overlap between neighbouring communities in upper watersheds indicates good potential for aquaculture options which require separate seed, broodstock and out-growing components. Such options could in turn, help to improve social cohesion at the village and wider watershed level.
- (I) There is good potential for in-situ production of advanced fingerlings in small highly seasonal tanks, free of predators by stocking with mature tilapia broodstock sourced from larger perennial tanks at the onset of the NW monsoon.
- (I) Such broodfish could be produced in tanks holding water year-round within the same cascade. Communities could be encouraged to trade broodfish to those with seasonal tanks requiring them early in the season.
- (I) There might be potential to enhance this system by seasonal tank communities selling small food fish to perennial tanks for fattening in cages and then' buy-back' for use as broodfish

[12] Hypotheses are prefixed as first (I) or second (II) order hypothesis. First order hypothesis represent the most extensive, simple and lowest risk interventions should be tested before or independently of second order hypotheses, which seek to further enhance production systems and marketing networks.

In addition to seed inputs low cost fisheries enhancements often incorporate simple habitat modifications favourable to production of useful species. Elevated turbidity levels during the rainy season can impact directly on fish health and reduce primary productivity when it is most critical for fingerling advancement. Turbidity levels are dramatically increased by the widespread encroachment of forested catchment areas for cultivation purposes.

- (I) Turbidity levels can be controlled by constructing low bunds around the tank which can be used to divert runoff waters after the tank has filled to a suitable level. These measures would reduce early season turbidity allowing earlier stocking and higher productivity, while reducing the risk of loss of fish during spillage.
- (II) There might also be potential for investigating if liming prior to inundation, (which accelerates precipitation of suspended material and ensures removal of residual predators) improves productivity.

Production in seasonal tanks is typically concentrated into two months at the end of the dry season (July – August) when supplies from the major reservoir fishery are also at a maximum and prices are at their lowest seasonal level. Poorer farmers are more likely to purchase smaller tilapias (as little as 50g), being less costly than larger 'table-size' fish. The smallest specimens (<120g) are more likely to be sold as dried fish. Dried fish is relatively more important to the protein intake of poorer groups.

- (I) Greater yields and market prices can be achieved by staggered harvesting of table size fish. This also will bring indirect benefits to poorer consumers through increased production of smaller, more affordable fish.
- (I)There is potential to widen the production window further if end of season surpluses were dried either for home consumption or marketing when prices have recovered.
- (I) Women's groups have potential to become involved in the processing and marketing of the smaller dried fish (i.e. between 50-150g).

Sri Lankas share of the world ornamental fisheries market has been increasing since the industry became established in the early 1980's. The industry has enjoyed good price stability over this period. In addition to a portfolio of 50 culturable exotics, 58 indigenous species constitute an ornamental capture fishery (Mee 1993). As most former government hatcheries have switched from food fish to more lucrative ornamental production, seed availability is good. Small-scale growers are beginning to undertake grow-out production on a contract basis. Such production is easy to initiate and requires relatively low start up capital, production inputs, or water resources and production can take place throughout the year. Constraints identified by consumers and producers include poor flow of information along marketing channels, lack of species variety, poor quality standards and unreliability in supply (Gunasekara 1998)

- Small-scale ornamental production offers good potential as an income generating activity, particularly for women's groups. Ponds could be created in homesteads providing optimal accessibility of the water resource.
- Culture of indigenous species may be possible, giving potential for wild sourcing of stock and biodiversity sustainability options.

4.4 Longitudinal Situation Analysis Sri Lanka.

Preliminary work in Sri Lanka revealed a much greater complexity in the bio-technical and socio economic situation compared to that found in India. Access to water resources is determined by a complex overlay of hydrological inter-linkages and communal management of tanks, whilst liberalisation of the economy is bringing rapid and often negative impacts on the livelihoods of the rural poor. Consequently an extended longitudinal situation analysis undertaken by Staff from Peradeniya University and the Institute of Aquaculture was initiated

in April. This will further characterize the marketing and production potential for aquaculture outputs based on the low input enhanced fishery system and other research hypotheses proposed above. This six-month phase will reach completion in September after which workshops will be held to share information and elicit a farmer determined research agenda and monitoring indicators. Initiation of on-farm trials will then commence with the onset of the principle rainy season in October/November.

Field work will be focused around 3 cascade systems identified in the initial screening process the locations of which are shown in Appendix 2. Marketing components will also consider regional (urban) markets in Kandy and Anuradhapura.

Marketing Thrust - Aims:

Available research and information on fisheries marketing in Sri Lanka is heavily biased towards urban markets predominantly for marine fish. Further research is required to characterise the nature of markets for inland fish in poorer rural areas. Specific aims are as follows:

- To further characterise existing seasonal patterns and trends in demand and supply for inland fish species with potential for culture fisheries in seasonal tanks (principally carps and tilapias), substitutes (marine fish and meat products), different forms (dried, cured, smoked, large and small) and differences between different socio-economic groups.
- To further characterise fish processing systems and potentials for value addition, targeting niche markets, seasonal and daily risk avoidance/salvage strategies.
- Characterisation of marketing networks and participant perspectives at the regional (urban) and sub-regional levels and potential entry points for lower socio-economic groups (inc. landless, women and unemployed youth).
- Potential for fresh and processed inland products to penetrate urban markets and niche markets (i.e. Tamil Plantation communities).
- Ornamental fisheries: Whereas good basic knowledge on small-scale production technology's exist, little insight exists into the potential for low-income groups to market their products in a profitable and sustainable manner. Case studies will be used to assess the stability and accessibility of future markets.

Production Thrust - Aims:

To define the potentials, benefits and constraints for the practice of aquaculture production by low income groups in cascading seasonal tank systems. Bio-physical and socio-economic factors will be assessed over a six month time frame to see how aquaculture options could fit with other livelihood components.

Bio-Physical:

Agro-ecology: What is the nature of the water resource? (Seasonal availability of water, quantity and current uses). Access, ownership (who makes decisions) of tanks and ground-water systems and current uses, winners and loosers. Observation of seasonal characteristics of water bodies (encroachment, productivity, turbidity, fish production etc). Mapping of cascade systems Land access and ownership, cropping systems and seasonal patterns.

Socio-economic:

Range of income generating activities and seasonal patterns (cropping systems, livestock, labour). Potential for community participation within villages (especially by farmers, women's and fishers institutions) and at the wider cascade level.

Details of research activities designed to achieve these aims are included in Appendix 9. Data recording sheets are shown in Appendices 10-16 and a time-table for this phase of research in Appendix 17.

4.5 Stage 4

4.6 Participatory monitoring and evaluation

Farmers who manage complex systems are continually developing their farming systems and livelihood strategies via their own experiments, by slightly modifying their farms or crops and evaluating the outcome, and adopting practices that seem beneficial. In order to evaluate what is beneficial, farmers informally monitor their own experiments, making mental notes on approaches that seem to work well. This informal research is often not carried out in a very 'scientific' manner, farmers do not necessarily separate their treatments or record the results, and are therefore often losing important information. Traditionally the information needs for farmers and scientists are different. Scientists are interested in research yielding unequivocal 'hard data' results that can be replicated elsewhere, and therefore normally monitor biological or economic parameters such as fish growth, return on investment etc. However, farmers make decisions on the viability of new technology on the basis of not only biological or economic parameters, but also factors such as social esteem, risk diversification, opportunities gained, increased utility, accumulation of liquid assets and many more (see e.g. (Lightfoot, 1987) (Gosling and Edwards, 1995). The failure of many aquaculture technologies extended to farmers is caused by a lack of incorporation of farmers' evaluation criteria into product design, with subsequent development of inappropriate technologies. For research to generate sustainable recommendations, there is therefore a need to monitor both farmers' and scientists' evaluation criteria.

To monitor farmers' evaluation criteria, (Lawrence *et al.*, 1997)) recommend eliciting farmers' indicators[13] for a successful trial, and ranking or scoring these indicators with individual members of the farming household to establish the relative importance of parameters before, during and after the trials. New indicators should be added as they appear, and the ranks or scores supported by in-depth interviews recording why farmers' prioritise what they do. This can be combined with scientists' indicators on the research monitoring form.

4.7 Baseline survey

In co-operation with Samuha staff allocated as field workers to the project, a preliminary baseline survey form was developed, tested in the field, modified as needed, and tested again, until all were happy with the format. The final baseline data collection form (English version - field workers use a Kannada translation) can be found in Appendix 5.

The baseline survey records basic information about the farming systems and water resources. In addition the current pattern of meat (including fish) consumption is established, and the patterns of income and expenditure described. To obtain information on the impact of aquaculture on the farming system, field staff are asked to facilitate the drawing of livelihood strategy charts (farm resource flow diagrams) which shows the interrelationship different income sources, resources, activities etc. Systems diagrams can be drawn again at the end of the trial, to show changes to the livelihood strategy occurring as a result of the experimentation, and can form a focus point for in-depth discussions with farmers of the impacts of the trials. Lastly on the form, male and female members of the household are asked to list and prioritise (by scoring[14]) their expectations (positive and negative) to aquaculture. This provides a set of farmer-derived indicators, which can be transferred to the monitoring

[13] Indicators are specific, explicit measures of a situation brought about by changes in the environment, social actions or activities, which enable measurement of variance over time, space or social category Rennie, J. K., and Singh, N. C. (1996). "Participatory Research for Sustainable Livelihoods: A Guidebook for Field Projects," International Institute for Sustainable Development, Winnipeg, Manitoba, Canada..

[14] Scoring was chosen over ranking because scores contain more information than ranks Maxwell, S., and Bart, C. (1995). Beyond Ranking: Exploring relative preferences in P/RRA. , 28-34.. The scoring system used assigns an independent number (between 0 and 10) of scores to each parameter, thus allowing independent comparisons of indicators regardless of the total number scored.

form, for each household participating in the trials. Guidelines to field staff for data collection can be seen in Appendix 7.

4.8 Farmer trials

The current status of farmer trials (inc. water body types, ethnic and gender breakdown of participants etc) is described in section 4.3. Small subsidies will be given to ensure these very poor farmers are not exposed to undue risk, but adoption and adaptation of fish culture will be carefully monitored to assess sustainability.

4.9 Trial monitoring

A trial monitoring form was developed with Samuha project field staff. An initial outline of the form was developed with field workers, tested in the field, modified and tested again until a user-friendly final product had been developed. The form (English version – field workers use Kannada version) can be seen in Appendix 6.

The monitoring form records in detail the inputs of feed, fertiliser and labour to the aquaculture activity. Mortalities and their causes are recorded, as are fish catches, and subsequent consumption or sales. Physical parameters (water area and indicators of water quality such as colour, temperature and smell) are measured, and farmer derived indicators (both those identified during previous field work with farmers and new ones) scored.

A user-friendly Access database has been developed, into which all collected trial information will be entered by field staff (this package will also generate the record sheets required for data collection).

5 Stage 5

5.1 Post-trial farmer survey

After trials are completed, IoA and Samuha staff will carry out an in-depth survey of the farm households. The starting point for discussions with the household will be the baseline and monitoring forms for the trial. From these forms, the research team will ask for elaboration on farmer opinion about the experiment, reasons for changes of management / variation in the prioritisation of indicators etc. indicated on the form.

5.2 Post-trial farmer workshop

A post-trial farmer workshop has been planned for December/January 1999 for farmers to feed back on the research process and share their findings with other farmers, Samuha and the IoA. The aim of incorporating a forum for farmers to share their experiences in the project framework is to ensure sustainability and relevance by creating broad access to the knowledge generated.

5.3 Future research

The aim of the present project is to achieve a better understanding of the factors affecting small-scale farmer management of water resources, and to carry out research into aquaculture options over one water storage cycle. It is clear that results from just one cycle of research will enable only outline recommendations indicating the likely suitability of such water bodies for aquaculture and possible successful management approaches. To yield clear recommendations for diverse and complex areas, however, multiple cycles of research are normally needed. It is therefore intended that the research agenda developed with stakeholders to modify and improve outline options would be addressed in a follow-up phase of the project (phase two of the initial project logframe) investigating the options for a period of further two water storage seasons.

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Appendix 1. Location of Research Areas in Karnataka State India.

Appendix 2: Location of research areas in Sri Lanka.

Appendix : Karnataka project staff

Samuha has allocated the following staff to the aquaculture research project:

Name	Background	Job description	Responsibilities
Basaiah Yelbarga Male Full time	Local farmer turned Samuha animator, PRA experience Language: Kannada only	Field worker	Collecting information in field, keeping farmer files, communication of data to Gourri, arranging logistics (group formation, money matters, field visits, workshops) as and when needed.
Gourri S.N., Female Part time	Law degree from local university, field work experience from last IoA visit, responsible for Devadasi group and Samuha accounting. Languages: basic English and Kannada.	Translator / data entry / field worker	Translating (Kannada to English) for IoA staff when needed, translation and computer entry of information collected by Basaiah, collection of field data (esp. from women).
Shubham Singh Male Part time	Master's degree in agriculture, project management experience, speciality dairy and poultry. Languages: good English and Hindi, no Kannada.	Data consolidator / communicator	Fortnightly consolidation of information collected by Basaiah and Gourri, monthly emailing / faxing of information to the IoA.

Additional staff:
Narayanaswami (Samuha Director, Akanksha, Kushtagi)
Channaiahswami (Samuha Director, Kanakanala, Tawagera)
Somashekar (Kanakanala Watershed Development Trainer)
will be monitoring the project on an ad-hoc basis and will be available to above staff for advice and guidance.

Appendix 3: Karnataka Farmer Workshop

Aquaculture workshop 20-21 April 1999
Idlapur village,
Tawagera

Samuha Kanakanala and Akanksha projects
Institute of Aquaculture

Workshop participants:
Villagers from Idlapur, Chikkawankalakunta, Mallapur, Pilligund, Nandapur, Kesarhatti
Institute of Aquaculture staff: Malene Felsing, Fred Phillips, Sujath Kumar
Dhan Foundation: Prof. Shanmugham
Samuha: Narayanaswami, Anil Kumar, Channayyaswami, S.S. Ghanti, Shubhan Singh, Gourri S.N., Shobha, Basaiah Yelburga, Sangappa, Nirmala, Akamma, Shivukumar.
50 men and 8 women, in total with IoA, Dhan and Samuha Staff and Idlapur villagers 90 participants.

Time table
Day 1: 20 April 1999

Time	Facilitator	Activity	Comment
15.00	Channayya	Prayer	Carried out by villager
15.10	Channayya	Welcome	Introduce IoA and Samuha staff, go through workshop schedule day 1 and 2.
15.20	Channayya	Inauguration	Carried out by villager
15.45	Ghanti	Keynote address	
16.10	Ghanti	People introduction	Ice-breaking session where everybody introduces themselves. What is their name, where are they from, which waterbody do they represent.
16.30	Malene & Anil	Purpose of workshop	Three purposes of workshop explained, emphasis on sharing of experiences, partnership.
17.00	Anil	Sharing of knowledge about fish	Group brainstorm of farmers' knowledge about fish and aquaculture, facilitated by Anil.
18.00	Anil & Malene	Basics of aquaculture	Sharing of what is known about aquaculture appropriate for resource-poor farmers in irrigation water bodies in dry areas. Fish need water but don't use any, and food (fertiliser or feed, if there is not a lot we can stock less fish and they can still grow), and the larger the fish stocked and the longer they can stay in waterbody the bigger they grow.
19.00	Malene & Anil	Fieldwork results from 1998	Sharing of what was found during IoA and Samuha fieldwork in March-May 1998 in villages in area. Including classification of waterbodies, social structure, daily and yearly activities, overall potential for aquaculture, now we need to find out if we can do research.

19.30 Finish
19.30 Songs
20.30 Dinner
21.00-22.30 Cultural programme

Day 2: 21 April, 1999

Before workshop facilitators meet briefly to reflect on how it went on Day 1, and what are tasks for Day 2.

Time	Facilitator	Activity	Comment
9.00	Ghanti	Summary of Day 1	Remind participants what happened on Day 1, summarise findings of afternoon session, briefly outline plan for Day 2.
9.15	Ghanti and Shubhan for overall section. CD: Channayya FP: NS FIT: Anil OW: Ghanti TN: Shanmugham	Farmers' views of what could be done and what problems this could present	Participants divided into waterbody groups, answering the questions: ■ what would you need to try aquaculture? ■ how do you think it could be done? ■ what do you think the positive impacts of aquaculture may be? ■ what do you think the negative impacts of aquaculture may be? Facilitators keep in mind that needs and constraints can fall into the following categories: natural (water, soil, biodiversity etc.), social (groups, linkages, networks), human (knowledge, skills, health), physical (infrastructure, communication, technology) and financial (credit, savings, pensions) capitals. Facilitate farmers to construct drawings or text on brown sheet of paper, different colour of pen for each question, and to prepare to present findings back to forum.
10.30	Ghanti and Shubhan	Groups presenting findings back to forum	Farmers present the answers to the four questions back to the whole assembly.
12.15	Malene & NS	Research questions arising from group discussions	Identification of overlap between what farmers want to know and what Samuha and the IoA want to know. I.e. state where farmers', Samuha's and IoA's agendas overlap.
12.45	NS	Identification of interested partners	Identification of farmers interested in the team visiting their village to discuss further options for aquaculture research.
13.00	Channayya	Feedback on workshop	Ask farmers what they thought about workshop, what was good and what was bad and what we should change next time?
13.45	Thanks		
14.00	LUNCH		

Keynote address, Ghanti:
Population keeps growing but our resources stay the same - to create enough food we need to optimise the use of resources - aquaculture is one of the options for diversifying the farming system. It is important that we all share our knowledge about aquaculture in order to work out whether fish farming would be good here, and how best to do it. The IoA did a brief field study last year where Malene & Francis visited your villages and asked questions about your farming system to enable them to determine the potential for aquaculture in the area. Here Malene will present the feedback to you from the work she did, and if you have any questions you are welcome to raise them. After that we will go into groups to decide on what we need to find out about aquaculture to go forward. Aquaculture follows the same principles as agriculture, it is just in water instead of on land.

20 April, 1999: MF Presentation: Purpose of the workshop
In this workshop we have four main aims.

1. To feed back the results of the fieldwork that was carried out in the villages of Jumlapur, Ainapur, Chikkawankalakunta, Pai Doddi and Mallapur. Many farmers helped us greatly in our work by giving up their time to come and sit with us and share information with us about their villages, their farming systems, and their families.
2. To share our knowledge about fish farming.
Although many farmers here have told us that they do not know anything about fish, they do know something. For example some farmers told us that certain fish taste better than others, and one farmer mentioned that if he puts manure in his pond, the fish grow faster and taste better.
Similarly the Institute of Aquaculture has knowledge about fish farming methods that are used in areas with conditions similar to those found here. The second aim of this workshop is for farmers to share their knowledge of fish farming with us, and for us to share our knowledge of aquaculture with them. The farmers' and the scientists' knowledge is represented in Figure 1. Some of the knowledge will be common to the Institute of aquaculture and the farmers - this is the area where the circles overlap in the diagram. There will also be areas where both farmers and scientists are lacking knowledge, which leads us to the fourth aim of the workshop.

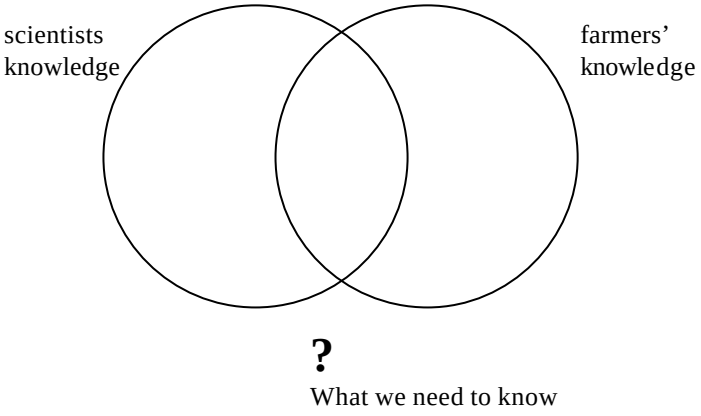


Figure 1: Farmers' and scientists' knowledge of aquaculture.

3. To identify what we need to know
This is the information which will help us to provide recommendations for aquaculture in this and similar areas.

4. To identify farmers interested in working with us to find out what we don't know
The participants in this workshop can be divided into stakeholder groups. Broadly speaking there are three groups: the farmers, Samuha and the Institute of Aquaculture. Each of us will have different ideas, expectations and interests - for example the Institute of Aquaculture wants to research sustainable options for aquaculture in small-scale irrigation water bodies, for resource poor farmers in dry areas. This means that for us the research has to focus on low-cost options for fish farming in watershed development water bodies. For the activities to qualify as research, they need to generate knowledge we do not already have, and there needs to be a certain amount of replication - farmers doing the same things - for us to be able to generalise about findings. Samuha mainly wants to explore

sustainable options for groups of farmers in their watershed projects to diversify their livelihood. Similarly the villagers present at this workshop will have certain interests - some of which are common to all of you and some of which are only common to smaller groups - for example women and men may have different interests, as will people of different castes and from different areas with access to different water bodies.
The different interests of farmers, Samuha and the IoA are represented in Figure 2.

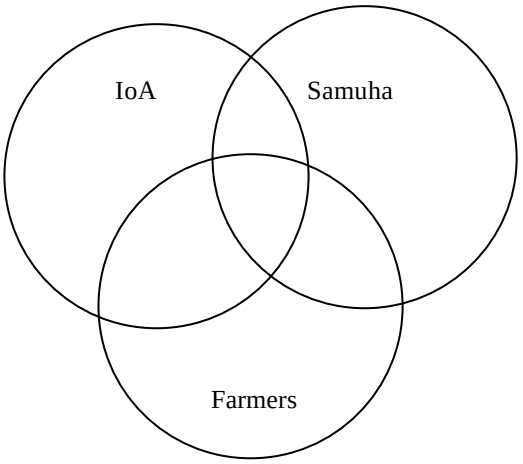


Figure 2: The different interests of the farmers, Samuha and the IoA.

Once we have shared our knowledge we can identify which interests are common to the farmers, Samuha and the Institute of Aquaculture. These can then form the basis for any further co-operation.

Sharing of farmers' knowledge of fish and aquaculture. Facilitator Anil.
First one farmer said that they have no knowledge of fish farming, that was why they came here.
Farmer from Pilligund: I tried to put fish in my OW and found that when I added manure they grow better than when I don't add anything. I left the fish there for 1 year, they are now 1.5 kg. We have eaten some of them but the rest are still there.
Farmer from Nandapur: There are also some species that don't grow very big.
Other farmer: I know 2-3 different types of fish - snakehead plus two other types. They are present in the tank, and when the tank overflows we catch them and eat them.
Farmer from Idlapur: We bought some seed and left them in the CD, but there was only water there for 2 months, so it did not work. We put in about 300-400 seed but did not catch any at all. We think that the Kali plant lining the check dam may be poison for the fish.
Farmer from Chikkawankalakunta: We caught seed from the stream and stocked 25 in our OW, fed them jowar (roti) and they grew to 250g in 2 months. We had to do work on the well, so we drained it and put the fish in a pot, to put them back into the well when we had finished the work. Unfortunately we forgot about them, and they were left in the sun and died.
Woman: We like to eat fish, most of all we like the snakefish, and also smaller fish taste nicer than big fat fish.
Farmer: Fish like to live in deeper water.
Farmers from Madurai District, Tamil Nadu: We stock fish into open wells, drinking water ponds and cattle tanks. Drinking water tanks are rainwater harvesting mini tanks of about 100x100m, used because our groundwater is saline. Our tanks are mainly used for drinking water for cattle and for human bathing.
Farmers raise fish as an addition to other farming activities. In the beginning we collected fish from natural streams and stocked them in the tanks. Of the fish collected the bigger ones were consumed by villagers and the small ones stocked into the tanks and drinking water ponds to grow bigger.
In both tanks and drinking water ponds the fish are left for 5-6 months. In the drinking water ponds they are not fed, but in the tanks they are fed locally available vegetation such as groundnut hulmes (leaves and vine), banana leaves and a local green manure crop kolinji. Furthermore the cattle drink from the tanks, so fertilise the water when they wade in.

Fish are harvested after 5 months, and are shared amongst villagers for local consumption and the surplus is auctioned, with profits used for repairing the tanks and other community purposes.
Because there is a big market for the fish we decided to buy 2000 fingerlings from a local hatchery for Rs 1000 (including transport). In 5-6 months these grew to 1-1.5kg and were sold for Rs 12,000. They were fed rice bran, groundnut hulmes and kolinji.
After this we tried deepening and desilting two ponds (1 cattle tank and 1 drinking water pond). For these we bought 25,000 fingerlings for Rs 10,000 and stocked 15,000 in the cattle tank and 10,000 in the drinking water pond. We stocked these 5 months ago and still have not harvested them, but intend to harvest when the water falls to 5ft (at present it is 6ft). We intend to give fish to local households and then sell the rest of the fish for Rs20/kg, marine fish sell for Rs40/kg in our area, so we expect a lot of customers and lots of profit.
In one of the ponds the fish started getting a black spot disease, and when we asked the experts they said to catch the fish and smear them with turmeric and put them back into the pond - but we could not do this with a big pond so we just left the fish and thankfully it did not spread.
In the cattle tank with 15,000 fingerlings we noticed that the fish started floating (dying) so we bought 4 big rice bran bags and cut a small hole in each and put one in each corner of the pond - and after this the fish stopped dying.
In the drinking water pond we only fed the fish rice bran. There is a big difference in growth rates of the fish that are fed and fertilised in the cattle tank and those kept in the drinking water pond, with the latter growing much slower.
Does anybody here know how to catch the fish from a big (1acre), deep (ft) water body? Part of the reason we have not caught the fish yet is that we don't know how to.
One local farmer said that you can buy big nets from near here, in Kompli, where a mission is producing silk and nylon nets.
Also does anybody know how to cure the black spot disease?
Sujathkumar answered that the Fisheries College in Tuticorin is doing research on it - it is a viral disease, they don't know what causes it, but it seems to be related to bad husbandry, so reduce stocking density of fish and it will get better.
Also they would like advise on what to do when the water level in the tank starts to go down and they still want to keep the fish there a bit longer - they are thinking about pumping the fish and the water from the tank into a larger reservoir nearby, but the piping must be very short distance otherwise it is too expensive. Has anybody got any other ideas?
Farmer from Ramapada District, Tamil Nadu: In 1998 we left 1500 fingerlings in the tank in April (bought for Rs 1000 including transport). After 6-7 months, in November, we caught them and they were 0.5-2.5kg. We only caught 350 fish, for which we made Rs 12,000 - the rest are still in tank to grow bigger. To prevent the fish from going out of the tank we have put a net over the inlet pipe.
Farmer from Nandapur: We had black spot disease, it was caused by Neem trees growing nearby, leaves falling into the ponds, the leaves also made the fish taste bitter.
Other farmer: We did experiments with half of a pond feeding the fish manure and the other half no manure, and the fish in the pond with manure tasted a lot better than the other fish.

Basics of aquaculture, presentation: Anil.
To do aquaculture we need three things:
1. water
2. fish seed
3. nutrients

Water:
- Green water is best
- Brown water is not so good
- More water depth is required for bigger fish than for smaller fish
- The water should not be too hot (should feel cold to the touch)
- The earlier the seed can be stocked the longer the fish can grow in seasonal water bodies, giving better harvest

Fish seed:
- Different species eat different things so polyculture is often better than monoculture
- The bigger the seed stocked the larger they will grow in short time, and less predators and more hardy

Nutrients:

- Can either feed the fish or fertilise the water
- Fertilisation:
    - Inorganic fertiliser such as DAP or Urea is the best
    - Next best is organic manure - of this chicken is best, then pig/goat and then cow dung. Urine is also good.
    - Organic manure also used for many other things.
    - Green manure is not as good as the two above but very cheap.
    - Best to add fresh manure and little and often

- Feed:
    - The better the feed the more the fish will grow, but also more expensive
    - Most things from farm can be used, have to ask you the farmers what you have available, what you can spare.
    - Some fish are vegetarian some are non-veg - and some fish eat in surface waters, some eat mid-water, some eat on the bottom.

Potential problems:

- Disease
- Theft

Malene Felsing presentation: Results of field work 1998:

Different types of waterbody:
Farm pond
Open well
Farm irrigation tank
Check dam
Tank
Nala bund - not very many

Uses of water:
irrigation
livestock drinking
human drinking
domestic (washing clothes, bathing)

Took water samples - most suitable for aquaculture, maybe too much silt in some of them.

Different groups of people:

- some eat fish
- some don't (e.g. Lingayat)

Most busy in the agricultural season - at times of sowing and harvesting. Spend most money on seed and fertiliser, some borrow from banks (1% p.m.) and others from village lenders (3% p.m.). Most pay back after harvest, but most people no money to save up individually, use Credit and Savings Groups for this. Many people have green cards or red cards. Overall most people would not be able to invest large amounts of money in aquaculture.

Both men and women work hard, but when household work is included in workload, women work the most hours every day. Men do ploughing and irrigation, women often do weeding and sowing and both men and women share harvesting. Men often take care of livestock.
Men fish and hunt, and if aquaculture was carried out, men would harvest the fish and most thought that men would feed the fish, but some said that women would. Women always cook the fish, and men clean them.
Men own most land and water bodies, but both men and women use the water. Men use water bodies for livestock drinking and irrigation, women use it for collecting water and for washing clothes.
Literacy levels differ between villages, but men are always more literate than women. Most children go to school, but if families can only afford to send some of their children to school, boys are sent in preference to girls. This means that training should not be given as books.

Constraints to aquaculture:
Most thought that the most important constraints were that

- there is not enough water for fish farming (seasonal water bodies)
- they don't know enough about fish farming (including where to get the seed, how to do husbandry)

However we think that there is enough water because as was told before fish can grow to eating size in 4-5 months. Small fish markets were found at every town market, and many people also eat salted dried fish.

21 April, 1999. Summary of what happened on day 1, facilitator Ghanti.

Asked forum what had happened the day before.
Woman: we learned something about aquaculture, how to do it, what the options are.
Man: we heard a lot about the experiences in Tamil Nadu, but we think that our conditions here are different. Our success here with fish farming will depend on our own effort.

21 April 1999: Farmer group work session.
What do you need to do aquaculture?
How do you think it should be done?
What negative impacts do you think it may have?
What positive impacts do you think it may have?

Water type / capital	Natural	Social	Human	Physical	Financial
Check Dam			Training in aquaculture practices.		Need credit for seed from Samuha.
Open Well group 1 (15, CWKK)	Have water for 5-6 months, limited food and fertiliser.	Need group formation to buy seed and do marketing activities.	Initial training plus follow up every month Information about what fish to stock.		Loan from Samuha to start with. Financial support to deepen wells to increase water retention time.
Open Well group 2 (?, CWKK)	Have water for 5-6 months	Field visits to farmers already doing fish farming would be great	Information about: How and where to get seed?		Help (money) to get seed Financial assistance to buy feed for fish
Farm Pond (11, Lingsugur, Deodurg)	Have water for 3-4 months min., limited feed & fertiliser.		Training in fish farming practices.		Financial assistance to get seed.
Tank Karnataka	Have seasonal or perennial water, food, fertiliser in group.	Support for marketing of fish (group formation). Government and village authorisation for using tank.	Need more knowledge about what species to use and what feed to give.		Assistance to get seed. Assistance to buy material for making hapas.
Tank Tamil Nadu	Have seasonal water (5-6 months min.), feed, fertiliser.	Who to approach for diagnosis of disease and cure?	Information about lots of specific issues (see research suggestions below).	Nets to harvest in large deep water bodies	

Table 1: Farmers' needs categorised into natural, social, human, physical and financial capitals. Natural capital: the natural resource stocks from which resource flows useful for livelihoods are derived (e.g. land, water, wildlife, biodiversity, environmental resources). Social capital: the social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods. Human capital: the skills, knowledge, ability to labour and good health important to the ability to pursue different livelihood strategies. Physical capital: the basic infrastructure (transport, shelter, water, energy and communications) and the production equipment and means which enable people to pursue their livelihoods. Financial capital: the financial resources which are available to people (whether savings, supplies of credit or regular remittances or pensions) and which provide them with different livelihood options.

Group	Positive impacts	Negative impacts	Potential research suggested by farmers
Check Dam (10, 7 women)	Aquaculture can increase our income and we can eat the fish. Fish eating is good for health. If we have more money we can help others, create togetherness in village and ensure there is no strife. If we add fertiliser the water will increase our crop produce when we irrigate. If we become more wealthy we will gain more respect and be 'big men'.	If we add manure we won't be able to drink the water. Most CDs public property so we may interfere with other users.	We would like to keep some fish in the CD with no feed or fertiliser for 6 months to get fish of 0.5kg (based on information from Tamil Nadu farmers). Some would also like to fertilise the water and use leaves like they did in Tamil Nadu because they know that this makes the fish tastier. Would like to get together in small groups of farmers with land close to CDs, or women groups with access to CD.
Open Well group 1 (15, 1 woman)	Fish can increase our income and food supply. Eating more fish would add to our health. If we get more wealthy we can help others more. If we fertilise the water it will also help to fertilise our fields. Dried fish meal can be used for chicken fodder as well.	If we add fertiliser to the well we cannot drink the water. If we need to use most of the water for irrigation we may kill the fish. If everybody in the village produces fish then we won't be able to sell them.	Maybe can use land near farm irrigation tanks to grow inexpensive fodder for fish? If the open well is used for drinking water could construct farm irrigation tank and pump water into this using borewell and keep fish in this. Need to investigate how to protect fish against frogs and snakes. Could investigate whether we can carry out fish farming if the water is brackish? In CWKK would like to stock seed into the OW and feed with rice and roti when the fish are small and with leaves and manure and ricebran as they grow bigger. Would like to leave the fish for 6 months at least (most OWs here perennial). If we deepen the wells maybe we can increase the time of water availability?
Open Well group 2 (?)	Aquaculture could act as income generating activity. If we eat more fish then we become more healthy. Aquaculture can help diversify our farming systems. Fish can become an asset that we can sell during hard times. Because the OW fills up after just one rainfall aquaculture is not dependent on frequent regular rainfall such as our crops - it is less risky than much agriculture. Fish can be left as 'spare' crop - they do not have to be harvested at a particular time like terrestrial crops.		How to prevent frogs from getting in and eating the fish? How much will the fish grow if we leave them in the OW without feeding or fertilising?
Farm Pond (11, Lingsugur & Deodurg)	Fish can be used for consumption and add nutrients to our diet. The fish will clean the water in our pond by eating little plants. Fish can be used for feeding our relatives when they visit instead of expensive chicken, goat and sheep which is used now. Fish can provide an additional income to the farmer. We don't have to buy feed for fish but can use whatever is available on the farm. Fish can be a sub-activity diversifying our farming activities.	Fish farming may adversely affect the local fish naturally present in the FP. If we fertilise the pond we will not be able to drink the water.	We would like to find out what feed it would be good to give the fish in FPs? We also need to find out if fish would go out in pump when water is pumped out of the FP - maybe we could use nets to screen the pump intake. We need to find out how many fish we can stock in our ponds. When it rains the silt level in the ponds go up - will this be bad for the fish? Sometimes we only have water for 3-4 months, can we still grow fish in such a short period?

Table 2: Potential positive and negative impacts of aquaculture as perceived by the farmers. Cont. next page.

Tank Karnataka	Fish can provide additional income Eating fish will make us more healthy Aquaculture can generate employment amongst people who cannot get work in nearby cities and who don't want to do coolie work (farm cannot support all family members) and amongst landless people. Aquaculture can become a secondary activity for some people to increase their food supply and income. Fertilised tank water may increase the growth of crops when irrigated with tank water.	Maybe if we add chemical fertiliser the cattle will not be able to drink the water.	Would like to explore whether can use hapas in tank? Need to develop protection against theft. Would like to do what they do in Tamil Nadu - fertilise water and feed the fish whatever vegetation is available. Have to do it as a group, rent the access to the tank from village or government.
Tank Tamil Nadu (three farmers representatives)			What is the optimum time for seeding?* Is it possible to pump water and fish from a well to dead storage of tank to provide water to seed the fish in Sep? Or to pump water from the dead storage of a tank to the smaller well? Which fish varieties are good to use?** What low cost feeds can be used?*** How to harvest fish from large, relatively deep water bodies? How to avoid large-scale mortality and spread of disease in fish? Which contingency plans to revert to if rains fail and fingerlings already introduced - transfer of water from other resources? - artificial aeration? - more feed? Scope for establishing hatcheries in villages? How best to involve women in aquaculture - feeding? - local sales? Optimum size for fingerlings introduced into tanks? Effect of soil composition on fish growth****

Table 2: Potential positive and negative impacts of aquaculture as perceived by the farmers.

*Informal experiments by farmers indicate that the fish grow better if seeded in 2nd half of Sep than later.

**Currently seeding IMC and adding big murrel fingerlings (8-10cm) after 2 months. The murrels eat the small local fish (2-3cm) that come in with rainwater.

***Presently using local vegetation such as rice bran, groundnut hulmes (leaves and vine), kolinji (local vegetable used as green manure for farming).

****Informal farmer experiments suggest that black cotton soil mixed with sandy loam is better for fish than black cotton soil mixed with clay.

Feedback session, facilitator Channayya.

One woman mentioned that she had been overloaded with information, that her head 'was bursting' because of all the new things she had learned about aquaculture.
People expressed satisfaction that they had learned about

- how to feed the fish
- that you can culture different species together
- that aquaculture can be carried out as a side activity in the farming system

They were happy that they had shared the information they had about fish farming, and especially glad that the Tamil Nadu farmers had come since these had valuable knowledge to share.
They felt that they needed to do this in groups, and felt that it had potential to increase their food security and act as an income generating activity.

21 April, 1999, Post workshop meeting with Samuha staff:

Present: Basaiah, Channayya, Gourri, Shobha, Ghanti, Anil, Shubhan, Narayanaswami, Malene.

Basaiah: Some farmers commented that Samuha arrived later than the farmers, which was not very good. Farmers at the workshop did not know that we were waiting for the last farmers before leaving. We covered all of the programme and achieved our agenda, which was goo. If we had had more time then we could have taken it more slowly on the second day.

Channayya: It was unfortunate that so few of the women invited could make it - in fact only 50% of the women invited showed up. The women present from the Pampanagar Women's Development Society were actually thinking of stocking fish in the 'beels' created from the river ('nala patches'), but they were put in the CHECK DAM group. The fact that people did not leave until the programme was over shows that they were very interested, because if farmers loose interest they just leave.

Gourri: The women were not facilitated very well - nobody addressed them much in group discussions, and this was mainly our (the facilitators') fault. It was a pity that the women from Kesarhatti could not make it but this was because somebody from the village died. The SHG can be visited later. Samuha staff also learned a lot about aquaculture from the workshop.

Anil: When we first started thinking about this workshop I did not feel comfortable having a role in it because I felt that I did not know enough about aquaculture to enable me to answer questions etc. However it was not a problem, and everything went well, and I felt like we (Samuha staff) also learned a lot. On the first day it was mainly us presenting to the farmers, and they did not say a lot, but on the second day when the group work started they were all very articulate. The more they participate the better it works, but we did not have enough time to run the whole thing as group work.

Shubhan: I think everybody present in the workshop learned a lot. It was good that the farmers from Tamil Nadu were present because they added to the credibility for the farmers. The whole arrangement was very good, the food, the tea, the setting, everything.

Ghanti: I had many questions to begin with, but they disappeared when I saw how enthusiastic the farmers were about the idea. It is important that we follow it up straight away, otherwise they will lose some of that enthusiasm. Many of the presentations included long-term concerns such as finding outside markets for high village fish production, and in many groups people were discussing long-term ideas and plans. It was good that we completed the agenda well in time for farmers to go home relatively early - then they come home in a fine mood and will discuss what happened at the workshop with the rest of the village. If they reach home really late they are more likely to curse the workshop and give negative comments to the other villagers. Samuha staff learned a lot about aquaculture from the workshop, and so did the farmers - many said that they would go ahead and stock fish now whether Samuha was introducing it as a programme or not.

Shobha: The presence of the Tamil Nadu farmers was very valuable, especially their comments about the profits they made from fish farming.

Narayanaswami: More information definitely comes up when farmers are working in smaller groups, mainly because they are intimidated by larger forum. It was a pity that we had time constraints but we still completed everything. If nothing else the workshop was great for creating awareness about aquaculture amongst farmers, and also for Samuha staff to learn about it.

Malene: I think over all the workshop was very successful, mainly because of the brilliant arrangements by the village for food and venue, the cultural programme, and not least the dedication shown by all the Samuha staff. It was great for me to see increasing enthusiasm about the idea within Samuha - because you convey that to the farmers. The Dhan Foundation presence was also very important in adding to the credibility of fish farming - farmers talking to farmers work better than me or Samuha telling them about aquaculture. I think it worked better when we removed the chairs on the second day. Of things to criticise I think we maybe wrote down too much for illiterate farmers to follow, but then there were some literate farmers and they were taking notes. I share Gourri's concerns about the lack of involvement of the women - they never said anything and in the CD group although it was composed mainly of women a man still presented the results.

Appendix 4: Waterbody specific aquaculture guidelines

Management options are as diverse within each water resource as they are between the different water resources.
Because of the marginal nature of the physical environment there are risks that fish culture will not meet farmers' needs, and any risk must be underwritten as part of the process. There are sites which could be chosen which are unsuitable because farmers could meet their own needs by catching fish from natural stocks, so even if fish can be cultured it is unlikely that it will be appropriate.
Logistic concerns may limit the selection of sites and farmer researchers to certain places rather than throughout the two districts.
Judging from results from workshop if suitable seed were available to farmers many would like to try them in these systems. Rather than developing a prescriptive approach for recommendations to farmers we favour

1. Making seed and information available to them from which they develop their own physical system and develop their knowledge.
This may involve the development of technical briefs outlining suitable approaches to utilising different water resources. These may include suggestions for improving their physical suitability through simple modifications to the structure or management of the system. They would also explain the system's weaknesses for aquaculture and potential ways to overcome these.
Options for making seed available to farmers at the beginning of the rainy season seems to be the following:
a. purchasing of locally produced common carp (believed to be available in any size)
b. availability of a range of carp species Aug-Sep at the earliest
c. locally available tilapia fry
d. purchase of hatchlings from W. Bengal

2. A hands-on technical briefing that would cover the necessary skills for farmers to stock fish successfully.

3. Seed made available to the farmers (right species, size and time).
Three basic classes of water body

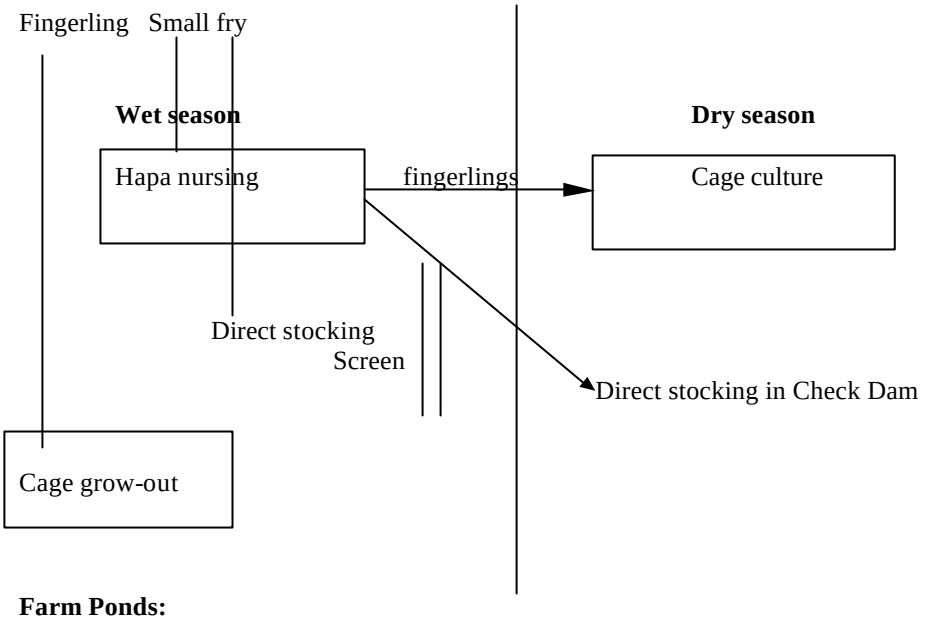
Main purpose	Potential for fish culture
Drinking water	Low potential. Fish need to be fed and if nutrients or feed put into system eutrophication will occur making water less suitable for consumption
Domestic purposes (bathing, clothes washing)	Medium. Fish may be stocked at low densities and requiring low nutrient input. Often livestock through normal practices will provide this.
Irrigation	High potential. Potentially higher densities of fish, requiring higher inputs of nutrients (fertiliser and feed), advantageous to the nutrient requirements of crops during irrigation.

Check Dams:
Main advantages:
- Because of relatively large area can stock many fish.
- High flow-rates in rainy season ensures good water quality.

Main problems:
- Often community managed. May be open access to non-fish-farmers in terms of traditional access rights and extracting/using water.
- Because water is flowing through in wet season it may be difficult to keep fish inside during periods of flood.
- Because water is flowing through in wet season nutrients (feed, fertiliser) will be lost quickly - feeding must therefore take place on trays / in bags and fertilisation avoided.
- High levels of turbidity (muddy water) during rainy season.
- Pundi may use a lot of oxygen so less is available for fish.
- Kalli plant may be poisonous to fish.

Possible technical options:
- Use of screens and nets to avoid fish loss during overspill in rainy season.

- Use of cages for nursing and or grow-out during the rainy season.
- Direct stocking of check dam at the beginning of rainy season is risky, and use of screening and cages would be dependent on how fast the water flows. Preliminary observation suggests that flows may be excessively high during heavy rains. Once rains have finished, farmer could fertilise and feed if required and fish yield would be dependent on the duration and area of water held in the check dam. This may conflict with use of water for irrigation.
- All fish species are suitable, for cage culture common carp, tilapia or grass carp would be best.
- Direct stocking stocking density as per aquaculture guidelines (0.2 fish / m^2 if no feed or fertiliser, 1-5 fish / m^2 if fertilise, 2-10 fish / m^2 if feed and fertilise.
- If cages are used these should be small (<4m^3), and stocked at high density (150-250 fish / m^3).
- The larger the fish seed stocked the better.
- For cages farmers **must** feed - if water is very green then tilapia is best, if it is less green then common carp is good, but this needs additional feed, e.g. rice bran and groundnut oilcake plus additional protein (frogs, fish, insects, fishmeal?). Approximate rule is to calculate feed requirements using Food Conversion Ratio (FCR) of approximately 5. So for every 1kg of fish produced, 5kg of feed will be needed.
- Because of the flow of water during rainy season, feeding should be done on trays or in bags - must avoid feed being washed away.
- Stakes (wooden / bamboo poles) could be used around cages to deflect objects (e.g. wood, bushes, stones) in very strong flows. CHECK DAM's higher in the watershed tend to have wider more irregular inundation areas offering potential for location of cages in more sheltered bays. Excavated areas (or borrow pits) in the check dam floor also offer potential shelter.
- Cages could be made from bamboo frames or posts and locally available net materials (availability, cost, resistance to crab damage?). Mesh size should not be bigger than the head of the fish, otherwise they will escape. Smaller cages (2m^2) stretched on bamboo frames can easily be moved by individual farmers when the need arises. Specific recommendations for cage construction are included in accompanying sheets.
- Grass carp can survive on vegetable food such as grass and other terrestrial vegetation (groundnut leaves, banana leaves, green manure plants etc.). Potential for grass carp given seed availability (nursing of seed available late this season for next year? or for dry season?). Tilapia survives well on phytoplankton (small plants in the water), and common carp needs supplementary feed, e.g. oilcake, rice bran, extra protein.



Farm Ponds:

Main advantages:

- Fill up quickly in the wet season allowing early stocking.
- Small and owned by single household and so the inputs needed (feed / fertiliser / labour) can probably be provided by the farmer.

Main problems:

- Tend to be quite small, and can therefore not hold very many fish.

- Standard 'stepped' design results in a dramatic decrease in surface area as water levels decrease, therefore stocking densities cannot be based on maximal surface areas.
- Many ponds are partially surrounded by field bunds designed to harvest surface run-off. This results in high turbidity (muddy water) and increased risk of flooding and escape in the rainy season.
- Water stays in pond for a very short time (as ponds are primarily designed for ground water recharge). New ponds constructed in Reddish Brown Earth or chalky substrates retain water for as little as 3-4 weeks making aquaculture unfeasible without modification. Retention is superior in 'karl' soils with higher clay content.
- Because they hold little water, the farmer may decide to use this for supplementary irrigation at the end of the rainy season - making less water available for fish.
- Sometimes water used for human and livestock drinking.

Possible technical options:

- All fish species are suitable.
- Farmers could use all different fertilisers (animal manure, chemical fertiliser, green manure).
- In order to avoid muddy water and flooding, diversion bunds should be constructed to completely encircle ponds. Water inlet to the farm pond could be closed once the pond is full. If this is not done, the farm pond has very little potential for fish farming.
- Dual-purpose modifications: To improve potential for fish production increase area, depth, and water retention capacity. The following methods are suggested:
  - Excavate and steepen tank sides (in conjunction with stone lining to reduce potential erosion).
  - Line walls and floors with karl soils, partially or completely to reduce seepage.
  - Plant shelter belts around ponds to reduce evaporation (Gliricidia could also feed the fish).
  - Water retention may improve with extended operation of recently excavated ponds.
- A sandfilter could be used to clean water for human or livestock drinking, or a shallow well could be dug nearby.

Open Wells:

Main advantages:

- Small and owned by single household and so the inputs needed (feed / fertiliser / labour) can probably be provided by the farmer.
- Vertical construction ensures constant surface area with depth fluctuation and reduced risk of over crowding.
- Mainly perennial.
- Frequent water exchange results in good water quality, so could potentially stock many fish.

Main problems:

- Tend to be quite small, and can therefore not hold very many fish.
- Water used for human and livestock drinking.
- Loss of nutrients (feed / fertiliser) because water stays short time in well, is pumped in and out frequently. Fertilisation is not possible if the majority of the water is exchanged every day, because the plants (plankton) do not have time to grow. Intermittent fertilisation may be possible depending on individual irrigation calendars. Irrigation is often less frequent during cultivation of the first irrigated crop (July to Sep) when higher levels of supplementary rainfall are available. During the second cultivation (Sep to March), when irrigation frequency is typically greater than once per week, fertilisation will be impracticable.
- High risk of wall collapse and fish kills in unconsolidated substrates and wells without surface run-off protection.
- High risk of flooding and increased turbidity (muddy water) in wells without surface run-off protection.

Possible technical options:

- Clean water allows stocking of high densities of fish requiring high levels of suitable feed.
- Common carp grown on high quality supplementary feed (e.g. rice bran and groundnut oil cake) or
- Grass carp / common carp polyculture based on green fodder (e.g. groundnut leaves, grass, banana leaves, green manure).
- High densities of fish will make water dirtier. One way to get rid of fish waste would be to dig a small pit at the bottom of the well for fish waste, and place pump in pit so that fish waste will be pumped out when irrigation takes place.

- A sandfilter could be used to clean water for human or livestock drinking, or a shallow well could be dug nearby
- Manage the water to always allow for 80-100cm water.
- Ensure tanks are protected by diversion bunds where potential for inflow of surface run-off exists.

Farm Irrigation Tanks:

Main advantages:

- Frequent water exchange results in good water quality, so could potentially stock many fish.
- Water level controlled by farmer.
- Can be quite big, and therefore hold many fish.
- Relatively low cost to produce (in comparison with open well).

Main problems:

- Loss of nutrients (feed / fertiliser) because water stays short time in well, is pumped in and out every day. Fertilisation is not possible if the majority of the water is exchanged every day, because the plants (plankton) do not have time to grow.
- Mainly options for richer farmers if feeding high quality supplementary feeds (e.g. groundnut oil cake and rice bran), since these are expensive.
- Where tanks are constructed using surface bunds (employing one pump), often there is no minimum drawdown (permanent water storage) and tanks are likely to be very shallow.
- Where FITs are converted from farm ponds (employing two pumps), all the same constraints other than water retention apply.

Possible technical options:

- Deepen surface tanks and manage the water to always allow for 80-100cm water.
- Ensure converted farm ponds are protected by diversion bunds where potential for surface run-off inflow exists.
- Clean water allows stocking of high densities of fish requiring high levels of suitable feed.
- Common carp grown on high quality supplementary feed (e.g. rice bran and groundnut oil cake) or
- Grass carp / common carp polyculture based on green fodder (e.g. groundnut leaves, grass, banana leaves, green manure).
- Farmer could grow fish fodder on banks of tank e.g. grass for grass carp.
- If farmer does not irrigate very often can fertilise water, but must ensure that water is changed often enough to stay clean enough for fish.

Appendix 5: Baseline data collection form.

Code:

Date		Village	
Farmer name		Age & gender	
Caste		Green / red card	
Survey no		Dryland	
Irrigated land		Filled out by	

Look at waterbody with farmer: CD FP OW FIT

Source of water (groundwater / rainwater)?

Who owns water body? Who owns land around water body?

Water colour: Frogs/snakes/birds nearby:

Kalli nearby:

Are fish kept in the waterbody – Yes / No (circle)? If yes answer the following:

How many	Where from	How long	Fed or fertilised	Uses

What are the maximum and minimum water depths and areas?

	When (month)	Water depth (ft)	Area (ft^2)
Driest Period			
Wettest Period			

When does it hold water? Start month: Finish month Perennial

How many times in the last 5 years have the following events occurred

A. The walls collapsed?

B. The water body has flooded?

C. Any other problems?

What is the water used for by whom? Man and woman to score the importance of the different uses of the water body (most important: 10 stones, least important: 0 stones).

Water use	**By whom (farmer, family, community, men or women etc?)**	**Score man**	**Score woman**
Washing			
Bathing			
Human drinking			
Livestock			
Irrigation			
Fish production			

Does the household use any other water bodies (e.g. village wells, communal water), and for what:

Household Composition – Indicate the frequency in each group:

	Males	Females
Younger than 5 years		
Between 5 and 17 years		
Older than 17 years		
Literacy (all ages above 5):		

Which types of meat does the family eat?

Meat type	**How often eat?**	**Score (max. 10 min. 0 stones on each meat)**
Chicken		
Goat/sheep		
Fresh fish		
Dried fish		
Wild animals		
Pig		

Where do you get your fish from?

	Source(s)	**Quantity**	**Cost (Rs)**
Fresh fish			
Dried fish			

When do in the year do you eat most fresh and dried fish?

Farming system:
Main crops, months of these:

How often do you irrigate your land during rabi and kharif seasons (frequency per week or month).

Do you use pesticides? If so how much, when, how much cost (Rs)?

Livestock numbers:

Oxen	Sheep	Buffalo	Cow	Chicken	Goat

Income / expenditure:
What is the total yearly income of the household?

Selling of crops or vegetables (% of total income)?

Work outside own farm (% of total income)?

Migration: who, when, where, how much money make (% of total income)?

How much money do you spend a year on the following?

Seed	Fertiliser	Pesticides	Household goods	Other

Do you ever have to borrow money (i.e. for household and cultivation purposes?)

For what	From whom	When	How much	When paid back	Interest rate

Food Security:

How many month is your production usually sufficient for?	J	F	M	A	M	J	J	A	S	O	N	D
Which months do you have least food & why?												
How does your household usually cope with food shortages? (circle and rank)												

1. Adjustments to meals (quantity*)		2. Food substitution (quality*)	
3. Borrow from relatives/friends		4. Credit	
5. Labour migration		6. Household asset sales	
7. Redistribution of family members		8. Mortgage of assets / livestock	
9. Sale of livestock		10. Food aid (Govt, other agency).	
11. Remittances / income transfer		Other?	

* Note details on any changes in quality and quantity.

Livelihood strategy flow diagram including water resources, household, land, livestock, market and flow of fertiliser (how much inorganic?), food, water, income (complete on separate sheet as necessary).

Notes for diagram:

What type of fish farming would you like to try? (which waterbody, what food / fertiliser, any modifications to water body needed?, cages / screens?).

In which waterbody	Type of feeding *	Type of system (cages, screens etc).

* Indirect (fertiliser only), direct (rice bran, jowar etc only), composite (both direct and indirect).

What inputs (on-farm and off-farm) is the farmer is willing to use for fish farming (direct feed, organic and inorganic fertiliser etc)?

What do you think will be the impact indicators for fish farming? How can you measure this? Score the importance of these (most important 10 stones, least important 0 stones).

Expected good outcomes	**How can you measure this?**	**Score man**	**Score woman**
1.			
2.			
3.			
4.			
5.			
6.			
Expected bad outcomes	**How can you measure this?**	**Score man**	**Score woman**
1.			
2.			
3.			
4.			
5.			
6.			

Appendix 6: Trial monitoring data collection sheet

Date		CODE:	
Farmer name		Survey no	
Last visit date		Filled out by	

Look at water and fish with farmer:

Colour of water? Smell? Temperature (°C)

How have water levels and quality varied since the last visit?

Max (ft)	Max area (ft^2)	Min (ft)	Min area (ft^2)	Rainy days (No)	Water quality

What other uses of the water have there been, by whom (if used for irrigation, how many times and how much?).

Can you see the fish (ask farmer to throw a handful of food in, see if fish come to surface)? Comment on size, number, feeding behaviour etc.:

What fish losses have occurred, when, since the last visit. Estimate numbers and explain?

Predation	Poaching	Disease	Water quality	Other reasons

Farmers comments and questions on performance since last visit?

Questions:

What have you put into the water since last visit?

Feed / fertiliser (name each type)	Amount put in (handfuls, kg, g, bucketfuls)	When put in (what days)	Source (market / farm)	Cost (Rs)

How much time have you spent caring for the fish?

Who (relationship, age, gender)	Task (feeding / fertilising / harvest / watching etc.)	Time spent

Have you harvested any fish? If so complete the following table.

Reason for harvest*	How many	Size (kg)	When	If sold	
				Where	Price Rs

* Indicate details of household consumption, gifts and sales.

What was the condition of harvested fish (appearance etc).

What is the frequency of other fish and meat substitute consumption since last visit?

	Meals per week	Source	Quantity and cost
Fresh fish			
Dried fish			
Chicken			
Other*			
Other*			

* Indicate type of meat.

What sizes and kinds of fresh fish have you purchased?

Have you changed anything in the management of the fish? If so what, when, why?

Man and woman to list and score the main good things and the main bad things about fish farming in their water body (each parameter max. 10, min. 0 stones). How are the good and bad things measured?

Good outcomes	**How do you measure this?**	**Score man**	**Score woman**
1. Improved nutrition			
2. Improved income			
3. Improved self esteem			
4. Improved social status			
5. Improved group dynamics			

Can the farmer think of any new good impacts of aquaculture? If so please add these, their measurement and scores to the list below.

Good outcomes	**How do you measure this?**	**Score man**	**Score woman**
6.			
7.			
8.			
9.			

Bad outcomes	**How do you measure this?**	**Score man**	**Score woman**
1. Loss of labour inputs			
2. Loss of capital inputs			
3. Loss of social status			
4. Loss of self esteem			
5. Loss of alternative productive and domestic uses of water.			

Can the farmer think of any new bad impacts of aquaculture? If so please add these, their measurement and scores to the list below.

Bad outcomes	**How do you measure this?**	**Score man**	**Score woman**
6.			
7.			
8.			
9.			

Both man and woman asked: how do you feel about the experiment (positive / negative)? Why?

Man	Woman
Positive aspects	Positive aspects
Negative aspects	Negative aspects

Appendix 7: Information collection guidelines

General points about collecting information from farmers:

- Try to make appointments with the farmer to ensure that he / she has time to see you.
- Always explain why you want to see the farmer, introduce all members of the team, and explain why you are there, and how long you plan the session to last. Explain for us to learn from the experiments, the research must be monitored regularly, which is why we ask to see the farmer every two weeks.
- Take the farmer to the water body - it is essential that you see the water body yourself - if you need to you can go back to the village for the conversation.
- Always be polite to the farmer - he / she is giving up a lot of time to participate in the research and we are grateful for this, and respect that farmers are often very busy, especially during the agricultural season. This include not interrupting the farmer, looking straight at him / her during conversation, not eating / yawning etc. during the interview.
- Avoid asking leading questions but leave questions open ended - e.g. 'what are the main benefits of fish farming?' rather than 'is increased income one of the benefits of fish farming?'. Remember that whilst you may think you know what the farmer wants to say we are really interested in what he / she says, not what you think.
- Facilitate the farmers to draw their livelihoods and farming systems. Remember that resource flow diagrams are drawn for us and the farmer to learn about the farming systems and the connection between different resources etc. Because the map is drawn by the farmer it belongs to the household, and it is therefore best to copy the map in the field and leave the original with the farmer.

Appendix 8: Research Staff Sri Lanka.

The following staff are currently engaged in the longitudinal situation analysis in Sri Lanka.

Name	Relevant background	Job description	Responsibilities
Dr Sarath Kodithuwaku Part-time	Lecturer on agricultural economics. Expert on rural entrepreneurship and ornamental fisheries marketing.	Local Project Co-ordinator:	Budget allocation, arranging logistics, field visits for data validation, participation in design of market research agenda.
Mrs Yoga Perera.* Part time	Graduate with extensive project management experience	Research Secretary	Logistical support.
Mr Francis Murray** Full time	Aquaculture specialist	Researcher	Research design, orientation and training of research assistants. Field level data collection.
Mr Yasanta Nawaratne* Full time	Agricultural extension graduate	Research Assistant	Data collection in field, data entry and analysis, communication with IoA on fortnightly basis.
Mr Harsa Booleseriya* Part time	Agriculture graduate	Research Assisitant	Data collection in field, data entry and analysis, communication with IoA on fortnightly basis.
Mr IM Gunewardene* Part time	Over 30yrs agricultural extension experience, extensive knowledge and application of PRA techniques.	PRA Consultant	Field level data collection. PRA methodology design. Training of RA's and participation in data collection in field.
Ms Malika Perera* Part time	MsC agricultural Economics. Co-ordinator of Gender Unit.	Research assistant.	Secondary data collection; Colombo, Kandy.

***** Agribusiness Centre – Peradeniya University

** Institute of Aquaculture – Stirling University

Associated Personnel:

Mr Niel Bandara, Residential Project Manager Mahawelli H irrigation system (provision of accomodation (Giribawa DS area), transport and computer access for field staff).

Mr S Jayesekara, Field officer, National Development foundation, Galgamuwa (Provision of accomodation and village entry points for villages in Galgamuwa and Anamaduwa Divisional secretariats).

Appendix 9: Activities and guidelines for longitudinal Situation Analysis in Sri Lanka

Aims of the longitudinal analysis (see section ??) were loosely divided into marketing and production thrusts. Summaries of research activities designed to achieve these aims are listed below. Data collection forms for the baseline and longitudinal components of this analysis are included in appendices: A timetable for this phase of research is shown in Appendix ??.

Marketing Thrust - Activities:

Regional and sub-regional markets can be envisaged as operating at different levels of market space broadly equating to urban and rural markets respectively in Sri Lanka. This notion of market space has important consequences for the form of interaction occurring between actors in market networks. Traditionally, interactions between actors at the sub regional level are likely to be determined by a morality imposed by the personalised village form (i.e. regulatory sanctions may be non-economic, deals are more dependant on status, informal credit and inter-linkages between different time periods and dimensions – Lewis et al). This necessitates the use of non-economic methods of analysis such as direct participant direct observation. Transacting parties at the regional level are likely to be less intimate and more amenable to more conventional economic analysis (i.e. analysis of price, income, supply elasticities of demand).

1.1 Sub-Regional (rural) Markets:

- *Fish producers and marketing intermediaries*: SSI's with producers (fishermen) modalali, assemblers, two-wheeler, van-vendors, boutiques, junction/wayside and Pola vendors. Checklist: Seasonal effort, volumes, demand and supply, prices species composition, processing (inc. yield calculations) and marketing (collective and individual) relationships with intermediaries.
- *Secondary production data:* Daily catch and effort statistics from Kandamale Reservoir to be collected once per month with prior agreement of MOFARD representative.
- *Consumers:* SSI's with consumers in focus villages of targeted cascades. Checklist. Preferences ranking excercises across identified wealth groups. Consumption frequency and sources for different fish species, forms (size, dried etc) and protein substitutes. Purchasing patterns; sources, volumes, prices and trader relationships (credit, kinship etc). See Appendix 2.
- *Marketing orientation*: SSI's with villagers and key informants: Checklist: Marketing activities associated with different agricultural and livestock production systems of farmers, collective, individual, tied credit relationships, relative contribution to consumption and income generation. Differences between different wealth groups highlighted.
- *Ornamental Fisheries***:** SSI's with women's PRDP facilitated contract out-growing groups at Mihinthale DS and contractor at Galgamuwa DS. Checklist: Production systems (species, water resource types and access, farmer and contractor identified production and marketing constraints, cost benefit analysis (production, transport costs, yields), marketing relationships (tied credit etc), prices and stability (within monopoly relationship), final (export?) markets for fish and outgrower, contractor margins. Identification of any other ornamental production under seasonal tank systems.

1.2 Regional (urban) Markets:

Markets in Kandy and suburbs (i.e. Katugustota and immediate rural areas) and similarly in and around Anuradhapura to be used for this analysis. This is an ancillary focus and should be undertaken at lower frequency to above activities (i.e. once per month).

- Checklists identified for sub-regional markets (above) used to characterize marketing networks, supply and demand amongst different socio-economic groups (where does demand for marine fish give way to inland fish).
- Potential niche markets for fresh products amongst Tamil Plantation communities investigated using consumer surveys.

- Secondary data on price trends: Weekly food commodities bulletin (ARTI). Wholesale and retail prices for fresh, dried, meat substitutes, Rice at Regional (Colombo, Kandy) and 'Out-station markets' (Tambutegema) to be entered on prepared ACCESS data-base.

For all Semi-Structured Interviews, identify socio-economic status of participants at all levels of marketing network. For producers and intermediaries assess contribution to livelihood, seasonal contribution and historic changes in participation.

2. Production Thrust –Activities:

2.1 Cascade Survey: For 3 cascade systems identified during screening process, complete basic characterisation of all villages and waterbodies within systems using Key Informant SSI (Appendix 4). 2-3 interviews completed per village. Results should be further triangulated through random interviews with farmers (focussing especially on contentious issues arising during key informant process). Completed mapping of cascade systems based on ground interpretation of 1:50,000 maps (include detail of all smaller water bodies, command and catchment areas, village, minor roads, tracks and plot contour profile.
2.2 Depth baseline survey**:** Based on Key informant results, select 3-4 villages and associated waterbodies for depth longitudinal survey.). This should include communities with access to the range of waterbodies required for the production system identified in the research hypotheses. Selection should also attempt to include the most marginal groups identified during the cascade survey (landless, women, lower caste, unemployed youth etc). All the smallest seasonal waterbodies and associated communities/households with potential for fingerling production should be included in this analysis. Commence with detailed key informant wealth ranking using format included in appendix 4. Plot results on village map (using names of head of household). Use at least 2 key informants per village and resolve major discrepancies through ground triangulation. Use these maps as a basis for stratified random sample of households in each wealth group using depth baseline survey using individual farmer SSI (appendix 5). Interview a minimum of 5 farmers in each wealth group and attempt to interview equal number of men and women (also include coverage of the landless, different age groups etc.). This process will probably continue throughout the remaining research period. Seasonal Livelihood Calendars should be produced 2-3 knowledgeable farmers in each village (attempting to include all different social groups).
2.3 Longitudinal Survey: This will focus on further characterisation of the following areas

- *Livelihood systems/security*: Seasonal changes in the range of income generating activities (cropping, livestock, labour). These should be quantified as far as possible (costs of inputs, margins and benefits of outputs) and the relative contribution to income and consumption identified. This will allow an assessment of the potential financial impact of aquaculture on different groups and how it could fit in with seasonal livelihood activities.
- *Community participation:* Further characterisation of the activity of indigenous institutions, linkages and potential for co-operation of groups at different cascade levels?
- *Water availability and access:* Direct observation of water bodies (water levels, depth, basic quality, encroachment by weeds), who is using how much water for what, who manages this, how?
- *Fisheries production:* Who is harvesting fish, how often, quantities and sizes of different species, predation, poaching, disease etc.

Appendix 10: Markets 1. -Baseline Consumer Survey.

Code:

1. Identification:

Date/Time:		Enumerator:	
Location:		Head of Household:	
Informant name:		Occupation:	
Occupation:		Household Profile (2):	
Profile (1)			

(1) Ethnicity (S,T,M,O) Religion (B,H,M,C,O) Age, Male/Female (M,F).
(2) Total No, No. male female children, Children's age range.

Wealth Rank:

2. Preferences:

2.1 Indicate in order of preferences for identified fish species (i.e. marine fish, tilapia, snakehead and carps) with reasons.

2.2 What do you look for when you buy fish? – List responses

2.1 Rank the following (3 = most important)

	Quality	Cost	Taste
A.			
B			

A. = Fresh fish. B = Dried Fish.

2.2 Do you prefer to consume small or large fish why (indicate 150g demarcation with hands)?

2.3 Do you consume small or large fish most frequently.

2.4 If mostly small fish what are the reasons for this?

2.4.1 Rank the following reasons for consuming small fish?

Cost	Availability	Other (specify)

Other Preference checklist items: Hot/Coolness, colour preferences.

3. Consumption frequency (fish and substitutes):

3.1 When did you last eat fresh and dried fish?

3.2 On average over the year how often do you eat the following food items (indicate stated frequency in most suitable column (if never – why?)

	Once per week or more	Once per month but < 1x per wk.	Less than once per month	Never! (Why?)
Fresh inland				
Fresh marine				
Dried inland				
Dried marine				
Tinned				
Poultry				
Beef/mutton				
Wild game				

3.3 When during the year do you eat most and least fish – why?

3.4 How do price and availability vary seasonally (and historically)?

3 Sources of fish and substitutes and weekly expenditure:

4.1 Where do you buy the following items from and what is your weekly expenditure?

Item	**Source (circle most frequent)?**	**Why? (1)**	**Purchase freq and Kg.**	**(2) Weekly Expenditure**
Fresh inland				
Fresh marine				
Dried fish				
Tinned				
Poultry				
Beef/mutton				
Wild game				

(1) Cost, availability, choice, convenience, quality, trader relationships etc.
(2) If purchased less than once per week, determine monthly expenditure and divide by four. Circle Result.

4.3 How often do vendors visit your village and what choice do they give you (marine fresh etc?).

4.2 How far are other outlet(s) from your hometown.

4.3 Do you ever eat fish from your village tank? (Details: i.e. Self caught, gifted, purchased from whom, why not etc?).

4.4 Who in the family normally buys, processes and prepares the fish?

5. Food Security

How many months is your production usually sufficient for?:												
How many month was your production sufficient for last year?	J	F	M	A	M	J	J	A	S	O	N	D
What are the 3 most important causes of food shortage? – Rank												
How does your household usually cope with food shortages? (circle and rank)												
1. Adjustments to meals	2. Food substitution											
3. Borrow from relatives/friends	4. Credit											
5. Labour migration	6. Household asset sales											
7. Redistribution of family members	8. Mortgage of assets / livestock											
9. Sale of livestock	10. Food aid / stamps.											
11. Remittances / income transfer	Other?											

Observations:

Other Checklist (add own items): Home processing, preservatives, knowledge of marketing networks?

Appendix 11: Markets 2 - Longitudinal Consumer Survey

Note: Identify 2-3 respondents from different social groups within each village as a 'consumer panel' and repeat this survey every 2 weeks.

1. Identification:
Date and Time: Location: Respondent code:
Or fill in identification details (see part 1) if new respondent.

2. Consumption patterns and expenditure
2.1 Recall of types and quantities of fish and meat products consumed during the last week (sizes, dried and fresh fish forms), what were the sources and prices paid (credit).

Food item	**Form / Size**	**Quantity**	**Price**	**Source**

2.2 Twenty-four hr. food consumption: List varieties of foodstuffs consumed for indicated meals.

	Food items:	Ingredients:	Notes:
Morning			
Afternoon			
Evening			
Snacks			

(Extrapolate freq. by food type: Cereals, pulses, milk products, Veg/fruits, fish & meat substitutes).

2.3. If fish was consumed how were different types or forms prepared?

2.4. What are the reasons for differences in consumption patterns since last interview (i.e. changes in income, availability/source, credit, prices, substitutes).

2.5. Have consumption patterns differed within the Household? (esp. women and children?)

3. Income:
3.1 What have been the main sources of the families income (labour, production sales, remittances, credit , savings etc) and food consumed since last visit (with monetary values if possible)? Itemise, and rank the results in order of priority.

Observations (surroundings, condition of family etc):

Appendix 12: Markets 3 - Specimen SSI Record Sheet (Vendors)

Code:

Identification:

Date/Time:		Informant name:	
Location:		Occupation:	
Enumerator		Profile (1)	
		Wealth rank (2)	

(1) Ethnicity (S,T,M,O) Religion (B,H,M,C,O) Age, Male/Female (M,F).
(2) Based on occupation, housing, food security etc. P = Poor, M = Medium, B = Better off.

Situation Description:

Responses:	**Observations:**

Checklist: Seasonal effort, volumes, demand and supply, wholesale and retail prices, species and form composition, processing (inc. yield calculations), storage, marketing relationships and networks (tied credit, sources of stock etc) historic trend in preceding criteria, margins (inc. overheads: transport stall etc), collective organisation, secondary/primary occupations.
Observations: Transaction patterns (question consumers), female participation in formal marketing situations, product quality.

Appendix 13: Production 1 - Key informant questionnaire / interview,
With Samurdhi, GN personnel, Farmers leaders – Triangulate with different sources.

Village Profile: Repeat for identified villages in cascade. Note Observations on capacity of informant (4 = Highly credible, 1 = Lowest).

Code:
Authority (4-1):

1. Identification

1.1 Village and Key Informant Identification:

Date:		Enumerator:		Village(s):	
District:		DS Division:		GN Div	
Name and Category of Key informant(s)		Name:		Designation:	
		1.			
		2.			

2 Village Demographics:

2.1 Ethnicity, Religion, Caste, Gender and Education by village:

No. Hseholds:		Total Male:		Total Female(1)	
% Ethnic Composition		Sinhalese:		Muslim:	
		Tamil		Other:	
% Religious composition		Buddhist:		Christian:	
		Hindu:		Muslim:	
% Caste Composition (2):		Govigame:		?	
		?		?	
Education:					
% Male literacy:		% Female literacy:			
% 6-17year olds not schooling:					

(1) Explanation for skewed sex ratio ?:
(2) Ask question 5.1 prior to completing this question.

2.3 Welfare: How many households in the village receive the following.

A. Samurdhi		> Rs 500 per month	
B. Public Assistance (Mahajana sevaka)			

2.4 Wealth ranking: To be correlated with other findings where possible.
A. What do you consider a sign of wealth (resources/assets, consumption, income, credit etc)?

The following criteria in the following table are suggested to permit comparability:
B. Indicate No's of households based on indicated or specified criteria:

	Poor - Temp/Semi (1) - Insecure every year (2)	Middle -Semi -Insecure some yrs	Better-off -Permanent -Always 3 meals per day
1. Housing (1)	Temp. or semi-temp.	Semi-temporary	Permanent
2. Food security (2)	Insecure every year	Some years	Never
3. Mean ac Paddy (3)			
Rank (No or % Households)			

(1) Semi- temporary houses have are a combination of tile, cajun, mud and brick or cement.
(2) Ability to consume three meals per day throughout the year.
(3) Ask informant to decide ranges of paddy in each category.

- For villages selected for depth interview, plot ranks (referring to head of household) on village map for subsequent stratified sampling.

3. Village Resources:

3.1 Landlessness: How many households have No access to the following?

No Paddy*	No Upland/Chenna	Both

3.2 How many farmers sharecrop/lease paddy? Where? Which wealth group?

3.3 How many villagers are illegally encroached (who, where?):

3.4 Tank Resources.

Name of Tank(s)	Access (1)	Max area (ac)	Command area (ac)	Spill freq (2)		How long, (2)	When? (3)	Drying freq (3)	Months (avg)of water	Cropping Intensity (4)	
				Y	M					Y	M
a.											
b.											
c.											
d.											
e.											

(1) Ownership and access of tanks: CPR = communal property resource, P = private, T = Temple.
(2) Averaged over the last 5 years for Yala and Maha.
(3) How many times has the tank completely dried out during the last five years?
(4) What is the avg. %age of command area cultivated during maha during the last five years for Yala and Maha

Notes on tank access to privately or temple owned tanks.

3.5 Other Irrigation Resources:

Type (quantify):	Number	Irrigated area (ac)	Access/ Ownership:	Use for drinking water? (indicate main source).
Stream/Ela:				
Agro-well:				
Tube-well:				
Other Well				
Other:				

Indicate number and irrigated area (in brackets). Indicate which is main supply of potable water.

3.6 Other Village resources:

Community land (ac):		Km to forest:			
Km to nearest town.		Km to minor Road			
Education and Health:					
Facilities, quality and Km from village:					
Extension services (in village or km from village):					
Co-operative society (milk, forestry):		Govt. welfare / village projects).		Bank:	
Agrarian service center,		Other.			

Notes Including NGO, and other development activities in the village:

4 Community Participation:

4.1 Village institutions: Include credit and savings, farmers organisations, women's groups..

Community Organisations: (triangulate with female respondents)		
Name:	1.	2.
Initiated when by whom:		
No. members		
Months since last met		
No. Female office bearers:		
Achievements (why not?).		

Name	3.	4.
Initiated when, by whom?		
No. members		
Months since last met		
No. Female office bearers:		
Achievements (why not?).		

Notes inc. other organisations:

4.2 Tank rehabilitation (years, programme) and farmer participation in maintenance, operation and management?

5 Cascade level linkages:

5.1 What are the main causes of conflict between and within villages (political, resource, social)?

2.2. Are different groups physically separated? Where? History?

5.1 What are the kinship, institutional and resource linkages between different groups and villages (intermarriage, GN and Samurdhi divisions, multiple membership of village organisations (i.e. death donation and FO's) labour exchange, informal credit sources, schools, access to land and water resources, mortgaged land, livestock etc)?

VI. Livelihood activities

6.1 What are the main cropping and livestock systems (paddy, chenna (or upland) and homegarden) practiced in the village and what is their relative importance to different wealth groups.

6.2 What evidence of diversification is there in these systems (i.e. OFC's, intercropping, staggered production, processing, storage) – which wealth groups?

6.3 What are the main types of off-farm labour migration, when are they, how far away and what is their relative importance to different wealth groups.

6.4 How many families receive remittances from family members who have migrated for longer term migration.

6.6 What are the main sources of credit (informal/formal).

6.3 Sustainability: How has the productivity of chenna and paddy systems changed. On average how many bushels of paddy are produced per ac now and how many 10 years ago (what are the reasons for changes).

VII Fisheries production and availability:

7.1 Who controls fish harvesting from the tanks, who participates and how is this integrated with other water use management?

7.2 What is harvested (species composition and volume) and what happens to it (consumption, who buys, prices, who benefits)?

7.3 How have fish production patterns changed historically (has the tank been stocked? With what results? How has availability of indigenous fish changed, what problems i.e disease?).

VIII Market Orientation

8.1 Where and to whom do farmers typically buy their production inputs and sell their outputs?

	Inputs (A. Item/ B. location)	Outputs
Paddy		
OFC's		
Upland crops		
Veg and fruits		
Livestock		
Other		

8.2 What is the relative importance of these production systems and what proportion of different outputs are sold or consumed.

8.3 What is the character of the relationships between farmers and traders (credit, labour exchange etc).

8.5 What collective marketing activities take place in the village?

8.6 Who are the most and least successful farmers and why?

9. Food-security

9. 1 What is the relative proportion of food insecurity and what are the main coping strategies.

Appendix 14: Production 2 - Depth Household Questionnaire and SSI:

1. Identification*:* Code: K I Wealth Rank:

1.1 Village and Respondent Identification:

Date:		Time:		Enumerator:	
Village		DS Division			

2. Other Demographic information*:*

A.Respondent:		Age:		Sex:	
B. Head of House:		Age:		Sex:	
Primary Occupation A.		Primary Occupation B.			
2ndry Occupation A.		2ndry Occupation B.			
Religion		Ethnicity			
Caste		Literacy: (1)			
Marital status		Wealth Rank: (2)			

(1): Ability to read and write.
(2): Wealth category based on interview and observation (personal possessions, living conditions etc.):

2.1 Household membership (No's)

Age group	Male			Female		
0-5						
6-17 / literacy / schooling						
18-55 / No's						
>55						
Total Numbers:						

2.2 What is the employment status of youth in the household (12-25)?

3. Resources and assets*: (circle options where possible):*

House (Circle):	Temporary (mud, cajun),	Semi-temp. (mud, tile or cement floor)	Permanent (Brick, tile).
Latrine:	Sealed:	Pit:	None:
Durables: (1)			

(1) Indicate ownership of valuable possesions, TV, Radio/ cassette , bike etc.

3.1 Table: Land holdings and crop systems *(circle options where possible):*

Type*	Km from Home.	Owner-ship	Season cultivated	Area (ac) cultivated	List crops cultivated.
a.		Owned/ Leased/ encroached	Yala		
			Maha		
b.		Owned/ Leased/ encroached	Yala		
			Maha		
c.		Owned/ Leased/ encroached	Yala		
			Maha		
d.		Owned/ Leased/ encroached	Yala		
			Maha		

*Paddy, Upland, Chenna, Homegarden (use initial letter). If off-farm indicate location.

Notes:

3.2 Table: What livestock do you own? *(Indicate a)number, b)sales and c) purchases during last year, d) value of sales e) reason for sale.*

Draft cattle:				Dairy Cattle:			
a.	b.	c.	d.	a.	b.	c.	d.
e.				e.			
Goats:				Poultry:			
a.	b.	c.	d.	a.	b.	c.	d.
e.				e.			

List other livestock held.

3.3 What agricultural implements do you have (borrowed, shared, rented (from whom), owned):

3.4 Did you receive any assistance from Government or NGO's last year (inc. Samurdhi – how much)? List:

4: Water Resources:

4.1 Where do you get water from to irrigate your field (Agro-well, Tank (name), Ela, Other)?

4.2 What else do you use the tank for? (Ring following criteria and rank priority):

	Irrigation	Bathing	Fish	Livestock	Domestic	Bricks
Rank						

4.3 Do you use any other tanks, where, name for what purpose?

4.4 Who owns and maintains identified tank(s) and who has access to it/them for what purposes?

V. Cascade linkages:

5.1 How are people related in the village. Do you have relations in any other villages in the cascade system (name head of house?).

5.2 Are you a member of any institution, which includes membership from more than one village?

5.3 Do you rent, lease, share, compete for land and water resources with neighbouring villages (i.e. fish, water, land, grazing?).

5.4 Are there political, social, cultural, resource differences/conflicts between neighbouring villages.

VI Livelihood activities (over last year):

Marketing

6.1 What Crops did you cultivate during Maha and Yala season?								
Maha Season?	Acres	Inputs Purchased			Quantity Produced			
Crops grown:		Item	Rs/kg	Quantity	Total	Consumed	Sold	Rs/kg
Paddy								
OFC's								
Vegetables								
Other								
Yala Season?	Acres	Inputs Purchased			Quantity Produced			
Crops grown:		Item	Rs/kg	Quantity	Total	Consumed	Sold	Rs/kg
Paddy								
OFC's								
Vegetables								
Other								
6.2 What crops do you grow in your home garden?:								

6.3 What crop failures (%) have you experienced over the last 5 years (why)? Paddy Kg/ac?

6.4 Where, how, to whom and when do you sell your produce and do you receive a fair price (tied credit)?

6.5 Who are the most and least successful farmers, why?

6.6 What other sources of income do you have?:				
Source	When	Days / month	Wage / day (or unit)	Total income (per unit)

7 Health status:

7.1 How many children under two years have died in the last year (male, female).

7.2 Access to health services (Km, freq): Family health worker, clinics.

7.3 What diseases (and frequency) has the household suffered from in the last year.

8 Household Problems:

8.1 What are the major problems you face in meeting you household needs?

8.2 How are you addressing these problems?

8.3 What are the major changes that have taken place in your household over the last 5 years.

Observations:

Appendix 15: Production 3 – Part 2: Seasonal Livelihood Calendars:

Complete for a range of farmers in different wealth and gender groups.

Notes: Construct calendars indicating contribution of following checklist items during each month of the year. Attempt to show seasonal distribution and quantity. Templates should be constructed with Seasons (Yala and Maha) entered to aid informant orientation (see examples in PRA literature).

Checklist:

For different cultivation systems (Paddy, chenna, upland):

- Field Preparation
- Sowing
- Weeding/maintenance
- Harvesting.
- Adding organic fertilisers
- Adding inorganic fertilisers
- Adding Pesticides
- Selling Ouputs

Labour migration (paid work)

- Farm labour
- Other paid work?
- Farm work by children

Household tasks

Overall work load

Indebtedness

Food insecurity

Appendix 16: Production 4 – Longitudinal water quality/use Survey and SSI

Complete the following form for all villages associated with villages identified for depth study. – Characterise water availability etc. with 3-4 knowledgeable farmers. Repeat section III onwards every two weeks for each water body as far as possible.

1. Identification:

1.1 Village and Respondent Identification:

Tank name:		Tank code:*		Enumerator:	
Village:		DS Division			
Max Water (ac)		Command (ac)			
Est Catchment (ac)		Ownership:			

*First 2-3 letters of cascade followed by number of tank (numbered within cascade).

1.2 Describe the general condition of the tank (bund maintenance, sluices, spillways)?

1.3 When was the tank last rehabilitated, what was carried out (bund, sluice, spill, distribution, de-silting) by whom?

1.4 Describe condition of immediate catchment area (forest coverage, encroaching cultivation or housing etc.), what permanent obstructions (trees, rocks are in the tank).

1.5 How is the tank managed with respect to fisheries (who participates, when, how)?

2. Water availability:

2.1 How many times in the last 5 years did the tank spill (when and for how long?) and run dry (A. for irrigation, B. for fish)?

	99/98	**98/97**	**97/96**	**96/95**	**95/94**
Spilling freq?					
Which Months?					
How long?					
Run Dry freq A					
Run Dry freq B					
Which Months?					
% CI Yala					
% CI Maha					

3.Tank Water Quality (Recorded every two weeks).

Date and Time:					
% Max water spread Est.					
Est. Average depth (m)					
Height below Spill level (m)					
Water Temp oC					
Water Colour (1)					
% Weed Encroachment (2)					
No.Days of water issue since last visit.					
Days rainfall since last visit? (3)					

(1) i.e. Brown, slightly brown, clear, slightly green, very green. Green water indicates good productivity, brown water indicates high silt load.

(2) Indicate for Olu, Salvenia, or water hyacinth.

(3) Keep daily rainfall log whilst in the field (i.e, hours, intensity, windy - calm, overcast –clear).

Notes on informants (inc. codes if possible):

4 Other water Sources:
4.1 Is there an Agro-well(s) under/in the tank? Describe location size and construction.

4.2 Water Quality (Recorded every 2 weeks if possible):

Date:					
Water Temp oC					
Water Colour					
Depth of water (m)					
Water table level (m)*					

***** The height between water surface and ground level.

Observations: (Indicate Date and time and weather conditions):

Checklist: Who is using tank water for what purpose and where are they from, observed and reported fishing activity (by whom, species, sizes, quantity, consumption or sale etc), predator levels, informants, Sketches. Continue on separate sheets as necessary.

Appendix 17: Timetable for Sri Lanka Fieldwork May 1999 to August 1999:

Date	Marketing Activities	Outputs	Date	Production Activities	Outputs
24/5 to 31/8	**Sub-regional**: SSI's and participant observation undertaken with producers, consumers and intermediaries at identified production sites and markets around targeted cascades. Identified sites revisited once per fortnight to assess changes in participation, demand, supply, prices, processing, margins processing losses etc..	• SSI draughts typed up, quantitative data on Excel spreadsheets. • Network map of markets, actors and (perennial?) production sites around three cascades completed. • Summary and conclusions of findings compiled. All outputs sent to Stirling on Fortnightly reporting dates from 11/6.	24/5 to 11/6 (3wks)	**Phase 1**:Cascade level screening of 3 identified systems. (2-3 Key informant interviews per village – Appendix 4)	• Key informant draughts, typed up, quantitative data on Excel data base and summary report completed. • Ground truthed cascade map completed. • 3-4 villages and assoc. per cascade identified for depth screening. All outputs E-mail to Stirling by 11/6.
	Regional Markets: Kandy, Anuradhapura and Environs. SSI's with intermediaries and consumers. Identifed sites revisited once per month.	Outputs as for Sub-regional markets monthly reporting dates from 11/6.	12/6 to 25/6	**Phase 2:** Wealth ranking of 3-4 villages per cascade. (From Key Informant SSI Appendix 4).	Results plotted on village maps (coded according to head of households). Used for stratifying depth survey. Results to Stirling by 25/6.
24/5 to 25/6	**Case study 1:** SSI's with Women's Ornamental fisheries groups and contract buyer in Mihintale/ Galgamuwa.	Key Informant and SSI reports typed up and Case study report and conclusions completed and E-mailed to Stirling by 25/6.	12/6 to 31/8	**Phase 3:** Stratified Random sample of wealth groups using Depth SSI's (Appendix 5) and Seasonal maps, in 3-4 villages per cascade. 5-10 interviews per wealth group (inc. womens, landless etc).	Depth SSI draughts typed up and quantitative data entered on Excel spread sheets. Results E-mailed to Stirling on fortnightly reporting dates from 25/6*
24/5 to 23/7	**Case Study 2.** Niche market for inland fish in Tamil plantation communities around Kandy characterised.	Key Informant and SSI reports typed up and Case study report completed and E-mailed to Stirling by 23/7	12/5 to 31/8	Water body survey completed once every 2-3weeks for all waterbodies associated with 'depth study' villages.	Draughts typed and quantitative results entered on Excel Spreadsheet. Outputs E-mailed to Stirling on fortnightly reporting dates from 25/6*
24/5 to	**Secondary Data:** Collection of	Data entered onto Supplied Excell	24/5 –	**Secondary Data**: Rainfall	Entered on Excell Water body

31/9	catch composition Data Kandamale Reservoir (after consultation with MOFARD).	spread s heet (If data is available from reservoirs closer to Research areas, this should be collected). E-mail to Stirling on monthly reporting dates* from 11/6.	31/8	statistics updated for stations around 3 cascades.	database.
24/5 to 31/9	**Secondary Data:** Access wholesale/retail prices database updated from weekly food commodities bulletin.	Updated database E-mailed to Stirling on fortnightly reporting dates from 11/6* (attempt to enter a whole years data – Nov 98 to Nov 99).	9/8		Summary Report of all production and Marketing activities, assessment of results and conclusions sent to Stirling (prior to return of FM).

* Reporting Dates for Marketing and Production Outputs: Fortnightly: 11/6, 25/6, 9/7, 23/7, 6/8, 20/8. Monthly: 11/6, 9/7, 6/8.

APPENDIX 9: Logistics: Co-0rdinated by Dr Sarath Kodithuwaku.

Accommodation:

Tambutegama Mahawelli H Circuit Bungalow (contact Mr Niel Bandara, Residential Project Manager).

Anamaduwa to be arranged.

Transport:

Bike hire to be arranged by Research Assistants.

Reporting:

Occasional access to computers for data entry arranged with Mr Niel Bandara. Otherwise data entry and E-mailing to be undertaken during fortnightly visits to Peradeniya University.

Materials:

Spring balance, thermometer (inc. 20-50oC), tape measure, stationary (ring binders), PRA materials etc. sourced in Kandy by RA's before going to field.

Baseline information collection guidelines:

Look at waterbody with farmer:
Take the farmer to the water resource and look at it with him. Note down area, depth, water colour, and the changes in these from dry to rainy season.
Note down any kalli, frogs, snakes, birds, fish already present in water or nearby, as well as other water users present. If the farmer already has fish, ask how long they have been there, where they came from, how much they grow, if they are fed or fertilised etc.

Household:
Sit down with the farmer and discuss the household and the fish/meat eating patterns. Score the frequency of consumption of the different meat types with one male and one female member of the family (except for Pampanagar Women's Development Society, where only women score). For scoring give the farmer a maximum of ten, minimum of zero stones per parameter scored, with ten stones indicating eaten most often and zero stones least often. *It is important that we get an opinion of both men and women in the household as these may differ.*

Farming system:
Facilitate the farmer to draw a *resource flow diagram.* This *should show the household, the land, the water resource(s), the livestock, the fertiliser (organic and inorganic), the market, the income, the off-farm work, and the interrelationship between these* (i.e. what does the household eat, from market and land, where does the water come from for the livestock and the household, what do the animals eat, what fertilisers are used (organic / inorganic) where does the money come from etc.). Note down total income and percentage from the different income generating sources (off-farm work, selling of vegetables or livestock) etc. Percentages mean 'out of 100' - so 50% is half, 25% is one quarter, 10% is one tenth, etc.). *Remember that the diagram is not a means to an end* - it is drawn for the farmer and the researchers to gain insight into the interrelationship between the different components of the farming system. The important thing is therefore to *use the map as a resource to stimulate conversation in which we can learn more about the farm,* find out things we don't already know.
If the farmer is literate, ask him / her to write down the names of the different things on the diagram. If the farmer cannot write, note down the names on the diagram yourself. *Because the farmer drew the diagram it belongs to him / her* - so leave it at the farm, take a small copy, clearly labelled in Kannada or English to keep in trial file.
Write a detailed description of the resource flow diagram in the baseline information form. In this include any comments of interest which are not on the diagram. *Remember that information that is not written down is lost to the research!*
Establish whether the farmer ever borrows money, if so for what, when and how much, and when it is paid back.
If the farmer has more than one water body be sure to note this down, and *score the uses of all the water bodies on his / her land, with both a male and a female member of the household (except for Pampanagar Women's Development Society where only women score).* Ensure that you write down where the household gets water from for human drinking, livestock drinking, clothes washing, bathing and irrigation, plus which water is already used for fish farming if any.

Aquaculture:
Explain clearly to the farmer what the options for fish farming in his / her water body are:

<u>Check Dams</u>*:*
- During the rainy season, when water is constantly flowing over the dam, fertilisation will not be effective. However water can be fertilised in dry season.
- Use of screens and nets to avoid fish loss during overspill in rainy season.
- Use of cages for nursing and or grow-out during the rainy season.
- Direct stocking of check dam at the beginning of rainy season is risky, and use of screening and cages would be dependent on how fast the water flows. Once rains have finished, farmer could fertilise and feed if required and fish yield would be dependent on the duration and area of water held in the check dam. This may conflict with use of water for irrigation.
- All fish species are suitable, for cage culture common carp, tilapia or grass carp would be best.
- Direct stocking stocking density as per aquaculture guidelines (0.2 fish / m^2 if no feed or fertiliser, 1-5 fish / m^2 if fertilise, 2-10 fish / m^2 if feed and fertilise).
- If cages are used these should be small (<4m^3), and stocked at high density (150-250 fish / m^3).

- The larger the fish seed stocked the better.
- For cages farmers **must** feed - if water is very green then tilapia is best, if it is less green then common carp is good, but this needs additional feed, e.g. rice bran and groundnut oilcake plus additional protein (frogs, fish, insects, fishmeal?). Approximate rule is to calculate feed requirements using Food Conversion Ratio (FCR) of approximately 5. So for every 1kg of fish produced, 5kg of feed will be needed.
- Because of the flow of water during rainy season, feeding should be done on trays or in bags - must avoid feed being washed away.
- Stakes (wooden / bamboo poles) could be used around cages to deflect objects (e.g. wood, bushes, stones) in very strong flows.
- Cages could be made from hollow metal tubing and metal mesh (availability, cost, resistance to crab damage?). Mesh size should not be bigger than the head of the fish, otherwise it will escape.
- Grass carp can survive on vegetable food such as grass and other terrestrial vegetation (groundnut leaves, banana leaves, green manure plants etc.). Potential for grass carp given seed availability (nursing of seed available late this season for next year? or for dry season?). Tilapia survives well on phytoplankton (small plants in the water), and common carp needs supplementary feed, e.g. oilcake, rice bran, extra protein.
- Pundi uses a lot of oxygen and can therefore make the water unsuitable for the fish. However it also adds a lot of nutrients to the water, so if there is any way that the pundi can be soaked in a side-pond to the check dam, from where the nutrients can run into the main stream, this may enhance the natural production of the water, increase plankton levels and thereby food for the fish.

Farm Ponds:

- All fish species are suitable.
- Farmers could use all different fertilisers (animal manure, chemical fertiliser, green manure).
- If much manure and feed is used, the water quality may become bad.
- In order to avoid muddy water, the water inlet to the farm pond could be closed once the farm is full. If this is not done, the farm pond has very little potential for fish farming.
- To improve potential for fish production increase area and depth.
- A sandfilter could be used to clean water for human or livestock drinking, or a shallow well could be dug nearby.

Open Wells:

- Because water is constantly coming into the well and being pumped out, fertilisation will not be effective.
- Clean water allows stocking of high densities of fish requiring high levels of suitable feed.
- Common carp grown on high quality supplementary feed (e.g. rice bran and groundnut oil cake) or
- Grass carp / common carp polyculture based on green fodder (e.g. groundnut leaves, grass, banana leaves, green manure).
- High densities of fish will make water more dirty. One way to get rid of fish waste would be to dig a small pit at the bottom of the well for fish waste, and place pump in pit so that fish waste will be pumped out when irrigation takes place.
- A sandfilter could be used to clean water for human or livestock drinking, or a shallow well could be dug nearby
- Manage the water to always allow for 80-100cm water.
- Dig deeper pit within well to ensure refuge for fish in times of water shortage
- Screen pump inlet with net or basket.

Farm Irrigation Tanks:

- Because water is constantly coming into the well and being pumped out, fertilisation will not be effective.
- Deepen pond and manage the water to always allow for 80-100cm water.
- Clean water allows stocking of high densities of fish requiring high levels of suitable feed.
- Common carp grown on high quality supplementary feed (e.g. rice bran and groundnut oil cake) or
- Grass carp / common carp polyculture based on green fodder (e.g. groundnut leaves, grass, banana leaves, green manure).
- Farmer could grow fish fodder on banks of tank e.g. grass for grass carp.

- If farmer does not irrigate very often can fertilise water, but must ensure that water is changed often enough to stay clean enough for fish.
- Dig deeper pit within pond to ensure refuge for fish in times of water shortage
- Screen pump inlet with net or basket.

These are the options as discussed by the farmers at the workshop, the IoA and Samuha. Ask the farmer if he / she has any other ideas of how fish farming could be done in their system, and *add new (realistic) ideas to the list.* Once the farmer is familiar with the options available, ask how he / she would like to carry out fish farming - i.e. what water body, how much feed / fertiliser, use of cages / nets, digging of pits or wells or separate stores for drinking water. *Note this down in as much detail as possible in the baseline information form.*

The monitoring form lists the main indicators of success / failure of the experiment that the IoA and Samuha want to measure. However farmers themselves monitor any new farming strategy / technology, and whilst they may not write it down, it is important that we try to find out what indicators they are interested in. To elicit the indicators we can ask the farmer what good and bad impacts aquaculture may have on the farming system / family / community etc**. *Try to get as many good and bad things as possible***. Ask how each of these parameters can be measured - e.g. if the farmer says that a good impact may be that the family will eat more fish, this may be measured by them eating fish more than once a week, if a negative impact is that aquaculture will limit the use of the water for irrigation then this could be measured by noting down the times where the farmer irrigates less than he would have wanted to - or the wilting of crops etc. Use the farmers' criteria - don't prompt them or assume that they think like you. We are interested in indicators for monitoring the success of the fish farming as specified by the farmers - and it is important that the indicators noted down are voiced by the farmer not the researcher. *Ensure that the good and bad things and the means of measuring them are written down as detailed as possible* - it is not enough to write 'income' or 'food', should write a whole sentence such as 'my income will increase', 'I can use fish for food' etc. Similarly it is not enough to write 'benefits' under 'ways of measuring' - should write 'farmer will note down expenditure and income from fish farming and determine the economic benefits' etc. *Remember that while you may understand what the farmer means, an outsider reading the file will almost certainly not unless everything is written in very clear language.*

Indicators are specific, explicit measures of a situation brought about by changes in the environment, social actions or activities. They enable measurement of variance over time, space or social category. If the indicator is to be measured in a participatory way, it should be community derived and expert validated.
Formal criteria for indicator selection are validity, relevance, sensitivity, cost-effectiveness, timeliness, specificity, periodicity, simplicity, measurability, and consistency.
To get community indicators:
Discuss the concept of an indicator and agree in a small expert group of people proficient in the local language and culture on what local word to use. Some initial preparatory time needs to be taken to get this concept right in the local situation. Does indicator meet following criteria:
Valid: does it measure what we think it is measuring and not something else?
Measurable: can it be adequately measured?
Verifiable: can anybody check it?
Cost effective: it is easy to measure?
Timely: e.g. does it measure lack of success in terms of dead fish, in which case it is too late to do anything about it?
Simple?
Relevant: do everybody agree about the indicator?
Sensitive: does it measure the level of the thing that we want to know?
Specific: does it measure anything else?
Punctual: can it be measured when we need to measure it?
Precise: will it tell you a gradation of the indicator, i.e. not just yes no but shades of grey.

Ask a male and a female member of the household (except Pampanagar Women's Development Society where only women attend) to score the good and bad things, using a maximum of 10 stones for the most important parameters and a minimum of 0 stones for the least important parameters. This helps us understand the priorities of the farmer before the trial, which we later can compare with priorities during and after the trial.

Monitoring information:

Water body:
Look at the water body with the farmer. Note down the water colour, ask the farmer to feed the fish to see if they come to the surface. Note down any frogs etc. nearby.

Inputs / outputs:
Ask the farmer what inputs have been added to the pond, what their cost were, who put them in, when, how much time it took to add them etc. Note down if any fish have died, or been harvested, and whether they were used for food or sold.

Good and bad things about aquaculture:
In the baseline information sheet the farmer stated his initial expectations about aquaculture, and which indicators the household would like to monitor to judge how the experiment is going. As the trial progresses we need to know if any new indicators should be added to the list - and also what the relative importance of these indicators are. A male and a female member of the household is therefore asked to score the importance of the indicators at every researcher visit.
Lastly we ask a male and a female member of the household how they feel about the experiment - whether they are optimistic or pessimistic. Here any feelings should be noted down and the farmer should be invited to explain why, so that we can gain a thorough understanding of the household priorities and values.

Farmer files:
Each research water body is contained in one file. The file should contain the following:
- Baseline information form filled out in English
- Resource flow diagram labelled in English
- Fortnightly research monitoring forms filled out in English

Aquaculture research file:

The Aquaculture research file is the project resource file, which should contain the following:
- General aquaculture guidelines, print-out and floppy
- Specific waterbody aquaculture guidelines, print-out and floppy
- Guidelines to filling out the baseline and monitoring forms.
- Diagram of sand filter
- PRA information for the individual villages involved in the research, including no. of households, SC/ST %, literacy levels for men and women.
- Proceedings of aquaculture workshop in Idlapur, print-out and floppy.
- Any additional information which may be of interest to Samuha, the IoA or the farmers.